Water Cycle between Ocean and Land and Its Influence on Climate Variability over the South American-Atlantic Regions as Determined by SeaWinds Scatterometers

Rong Fu
Hui Wang, Mike Young, and Liming Zhou
School of Earth and Atmospheric Sciences
Georgia Institute of Technology
Atlanta, Georgia

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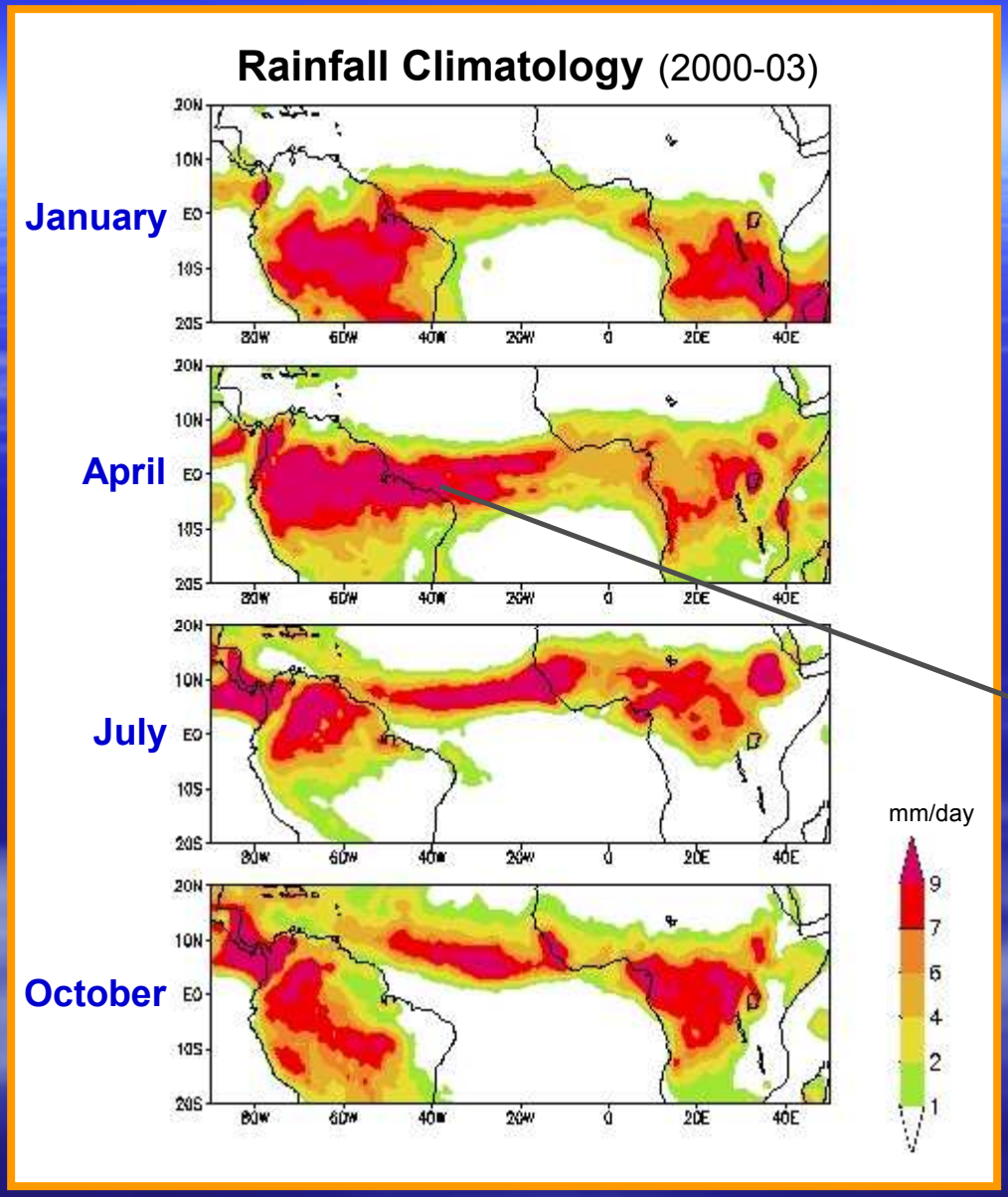
Objectives

- *Examine the influence of South American rainfall on the interannual variations over the tropical Atlantic during boreal spring; — current focus (Yr-1,2)*
- *Determine the influence of oceanic moisture transport on the South American monsoon rainfall; Yr-2, 3*
- *Use high resolution σ_o and identify the signals related to canopy wetness, to explore joint use of tandem QuikSCAT/SeaWinds σ_o and MODIS to improve the observation vegetation in cloudy condition. Yr-2,3,4*



- *Most intense SST and ITCZ interannual variability, influenced by Atlantic Niño (e.g., Chiang et al. 2002; Gu & Adler 2006);*
- *Onset and ending of Atlantic Niños;*
- *Greatest uncertainty in prediction of SST (Wang and Carton 2003), weak correlation with El Niño.*

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

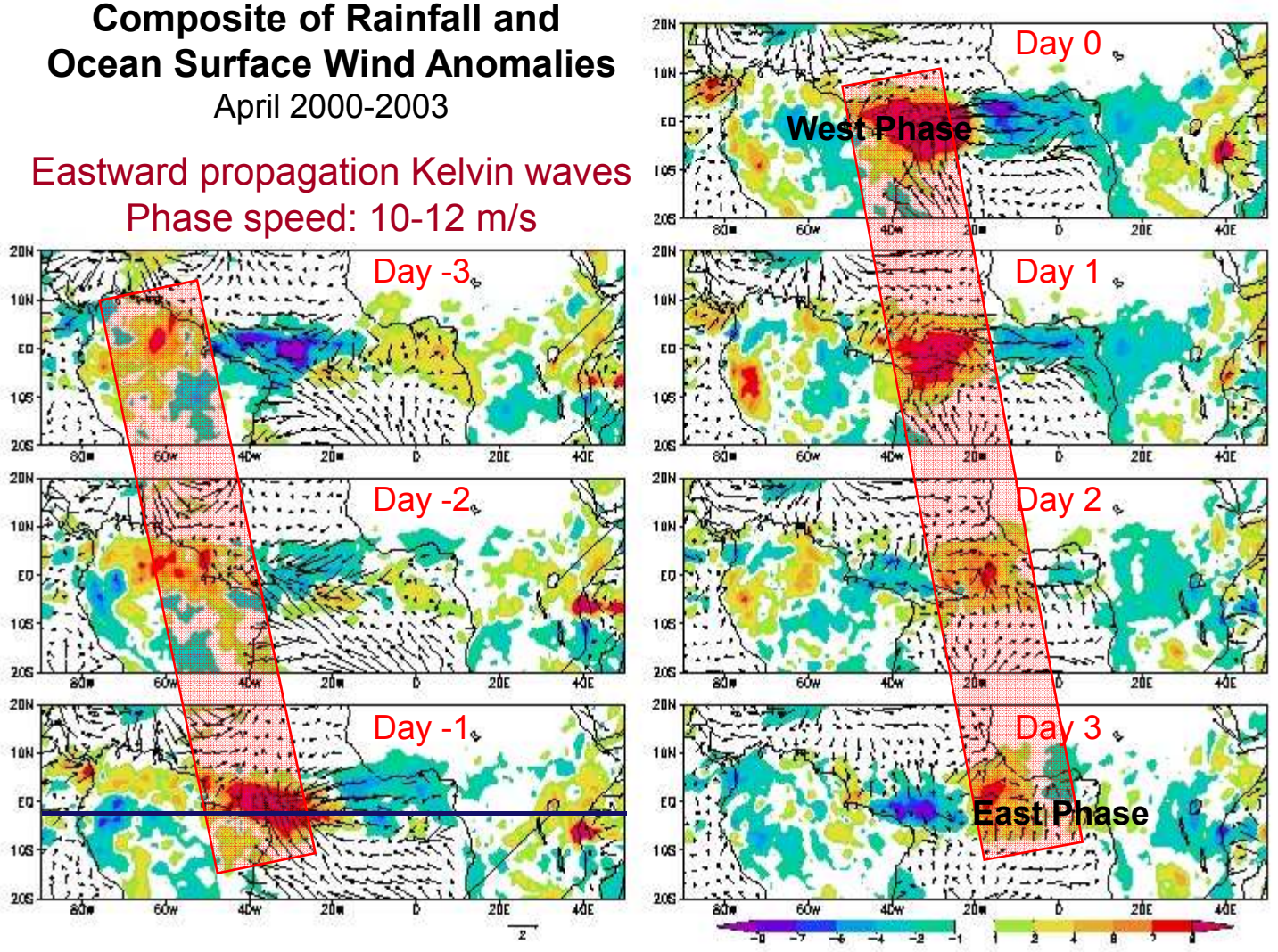
Data: TRMM

From Gu and Adler 2006

Synoptic variability of the Atlantic ITCZ is influenced by convectively coupled Kevin waves generated by Amazon rainfall:

Composite of Rainfall and Ocean Surface Wind Anomalies
April 2000-2003

Eastward propagation Kelvin waves
Phase speed: 10-12 m/s

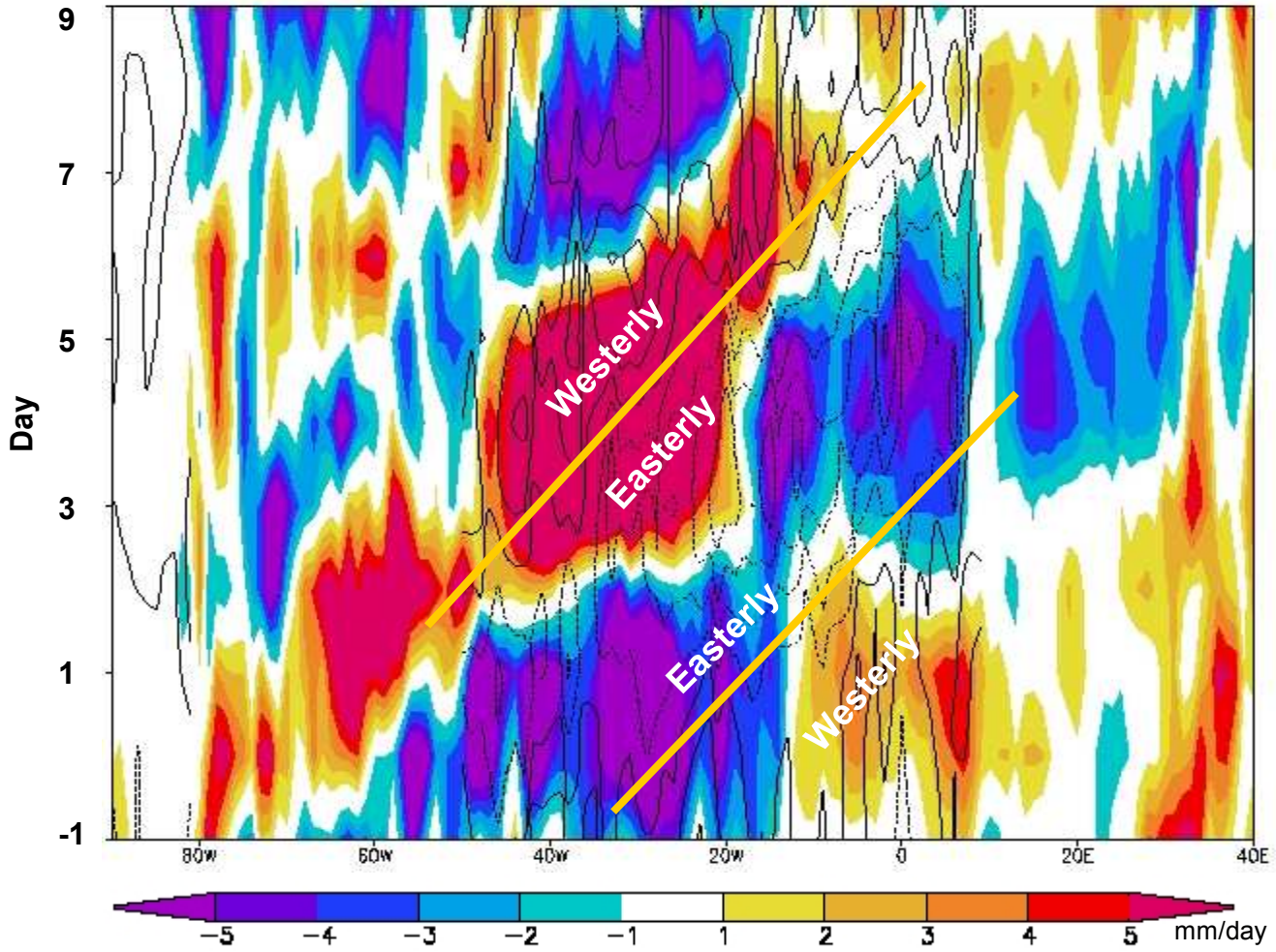


Wang and Fu 2006, J. Climate

Data: TRMM & QSCAT

Zonal Wind Anomalies Induced by Convective Coupled Kelvin Waves in the Equatorial Waveguide

Composite: Longitude-Time Diagram of
Rainfall and Surface Zonal Wind Anomalies at the Equator



Contour: wind
Shading: precip

Atlantic Ocean

Data: TRMM & QSCAT

In the equatorial Atlantic:

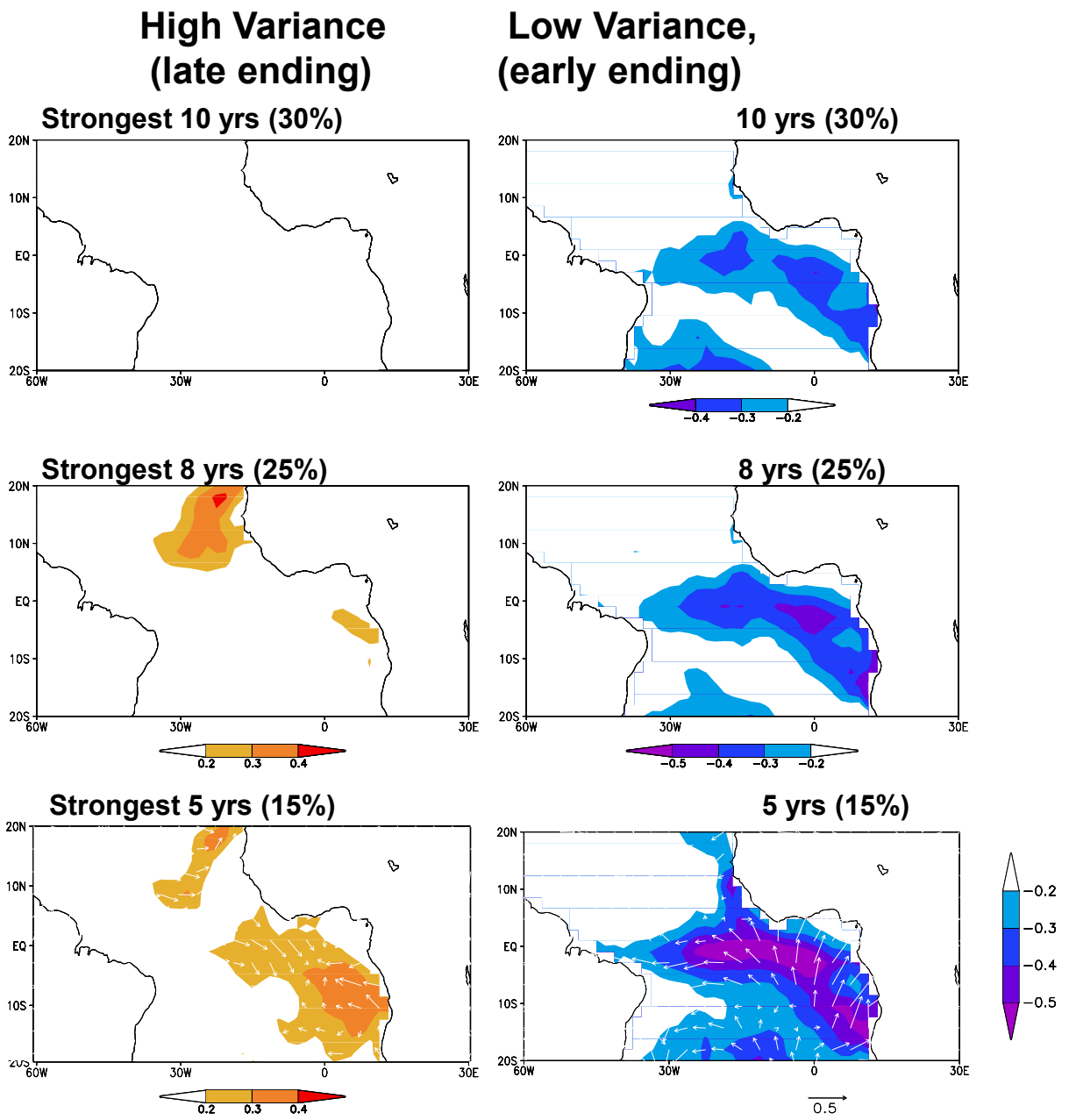
- ✓ *Strong rainfall and surface wind anomalies in the western equatorial region could be found often 1-2 months before the equatorial warming (Gu and Adler 2006).*

In the equatorial Pacific:

- ✓ *Westerly wind anomalies can induce eastward propagating increase of sea surface height and current, causing local and remote changes of thermocline and oceanic temperature (e.g., Harrison and Giese 1988; McPhaden et al. 1988, 1992; Ralph et al. 1997; Feng et al. 1998).*
- ✓ *Westerly wind anomalies represent a fundamental process for waveguide warming in the onset of El Niño and for maintaining the eastern and central Pacific warm SSTA during El Niño (Vecchi and Harrison 2000).*
- ✓ *Easterly wind anomalies generated by equatorial atmospheric waves result in sudden demise of 1997-98 El Niño (Straub et al. 2006).*

Relation between the variance of atmospheric Kevin waves and Atlantic SSTA:

OLR, SST
Period: 1975-2005



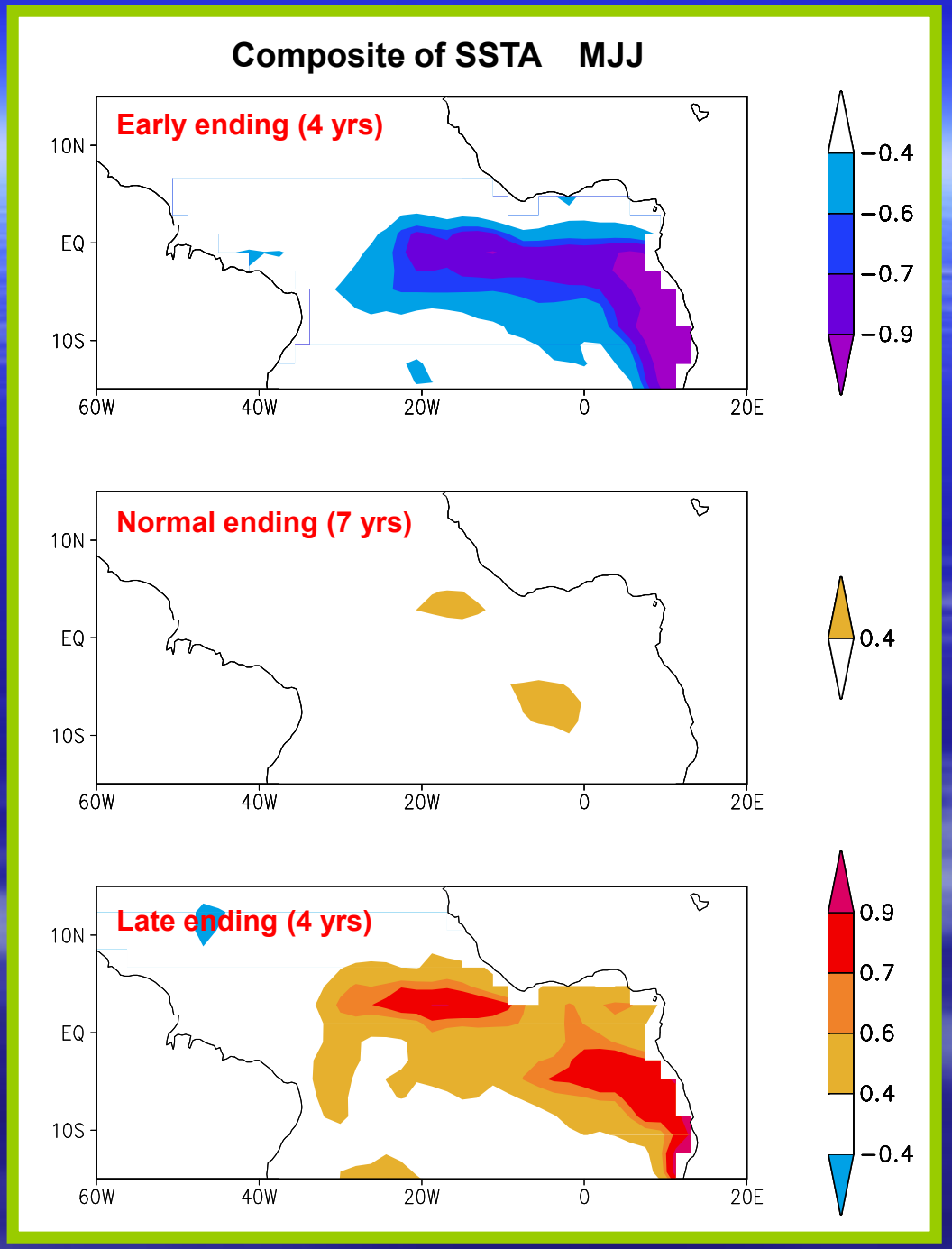
Do we need external forcing to explain the variability of Atlantic Nino?

- ***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 land surface interaction and global-scale forcing related to ENSO."*

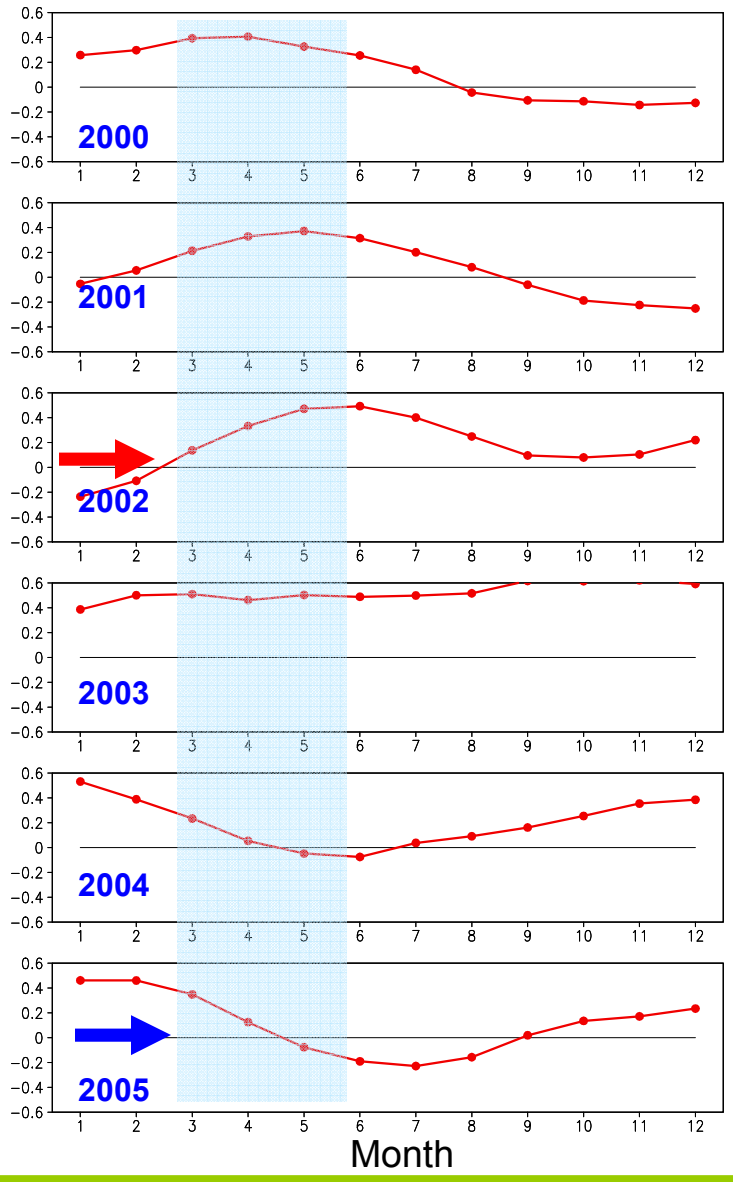
Correlation between wet season demise in Amazon and the Atlantic Niño:

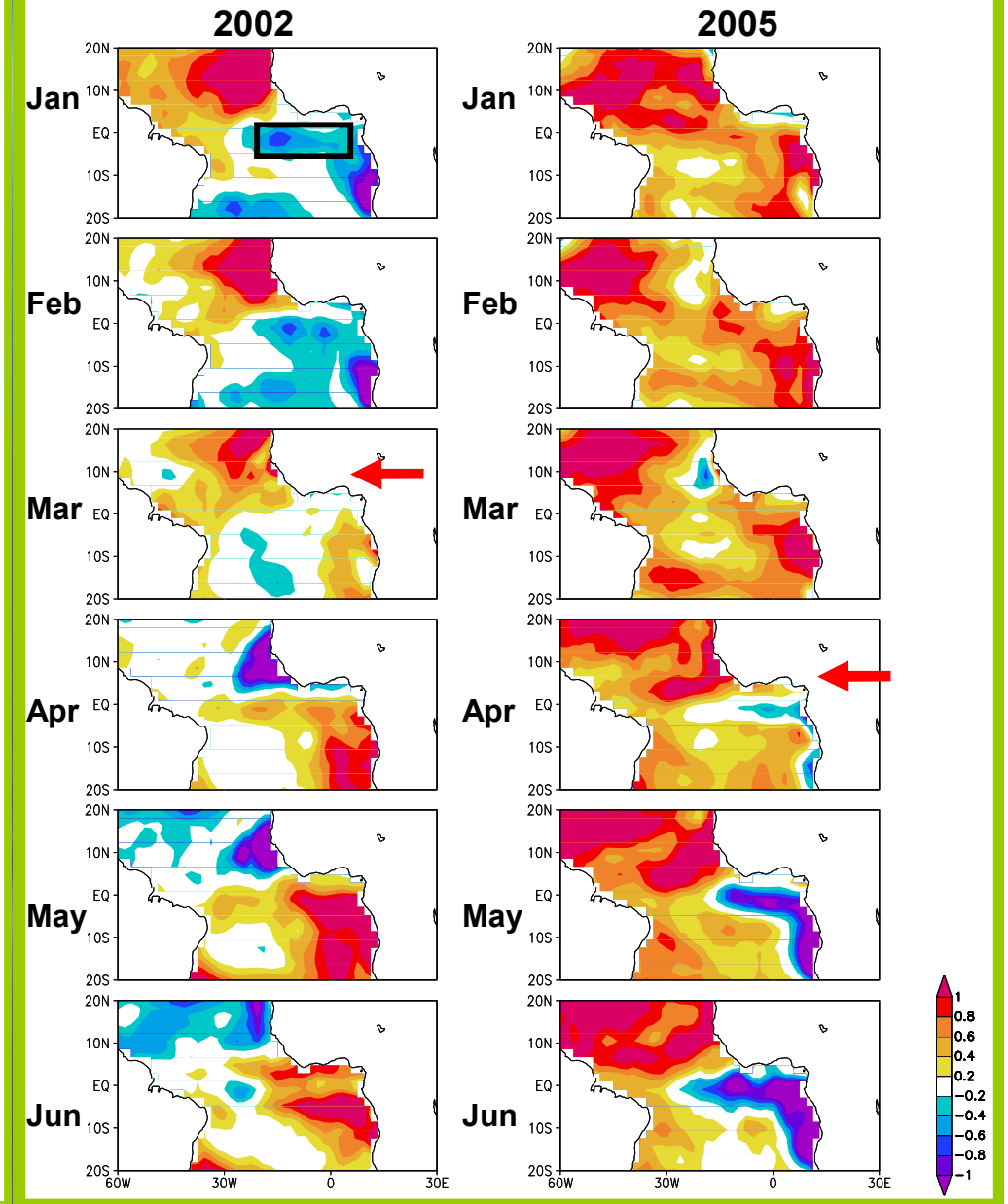
Amazon Wet season	*Atlantic Niño*
Early ending in spring Weak Kevin wave	*cold phase in summer*
Late ending in spring Strong Kevin wave	*warm phase in summer*

Data: 1979–1997
Ending date: Marengo

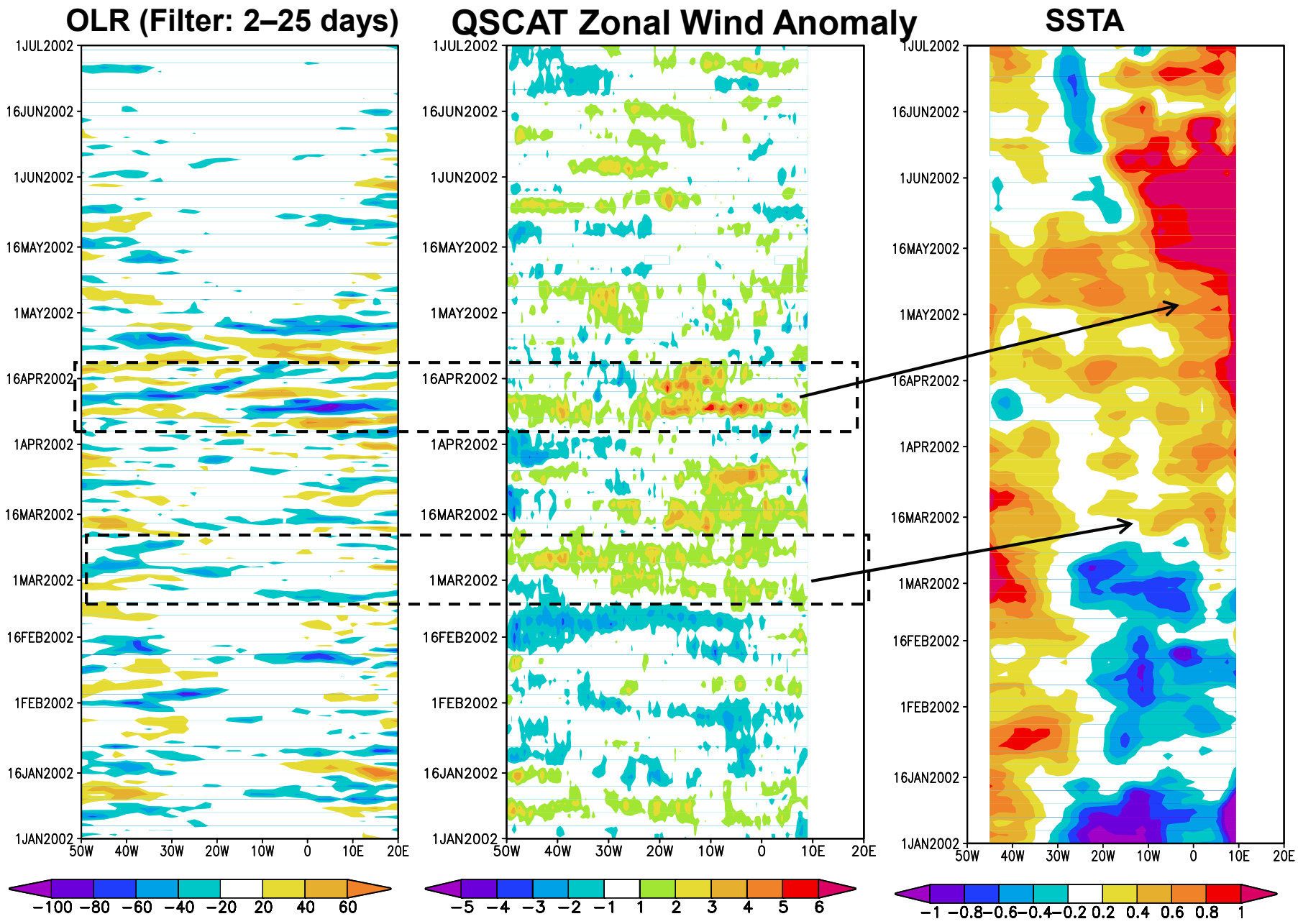


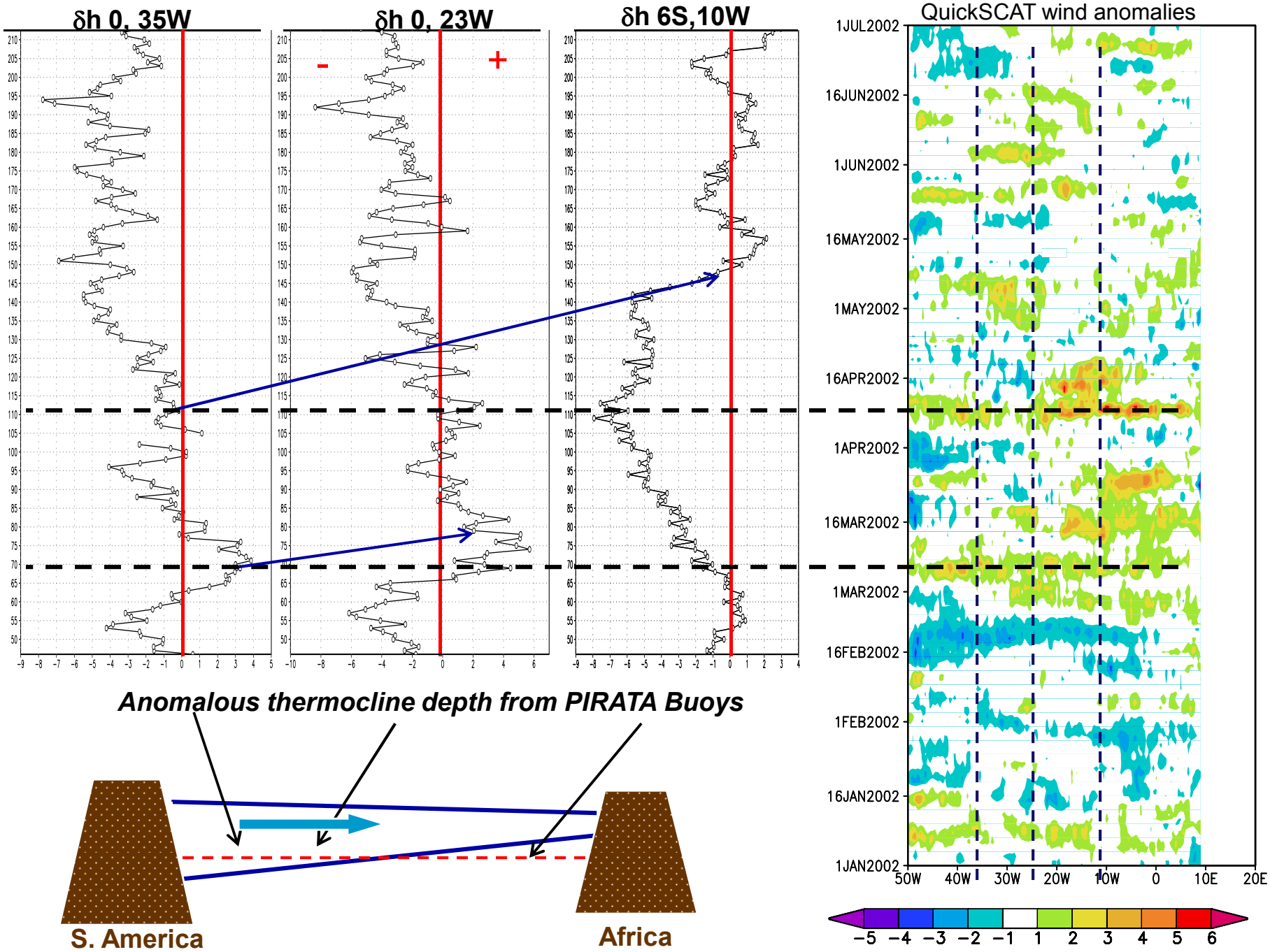
Could these zonal wind anomalies affect Atlantic Niño?





Jan 1– Jul, 1, 2002, 6°S – 2°N




δh 0, 35W
δh 0, 23W
δh 6S,10W
-
+
QuickSCAT wind anomalies
1JUL2002
16JUN2002
1JUN2002
16MAY2002
1MAY2002
16APR2002
1APR2002
16MAR2002
1MAR2002
16FEB2002
1FEB2002
16JAN2002
1JAN2002
50W
40W
30W
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0
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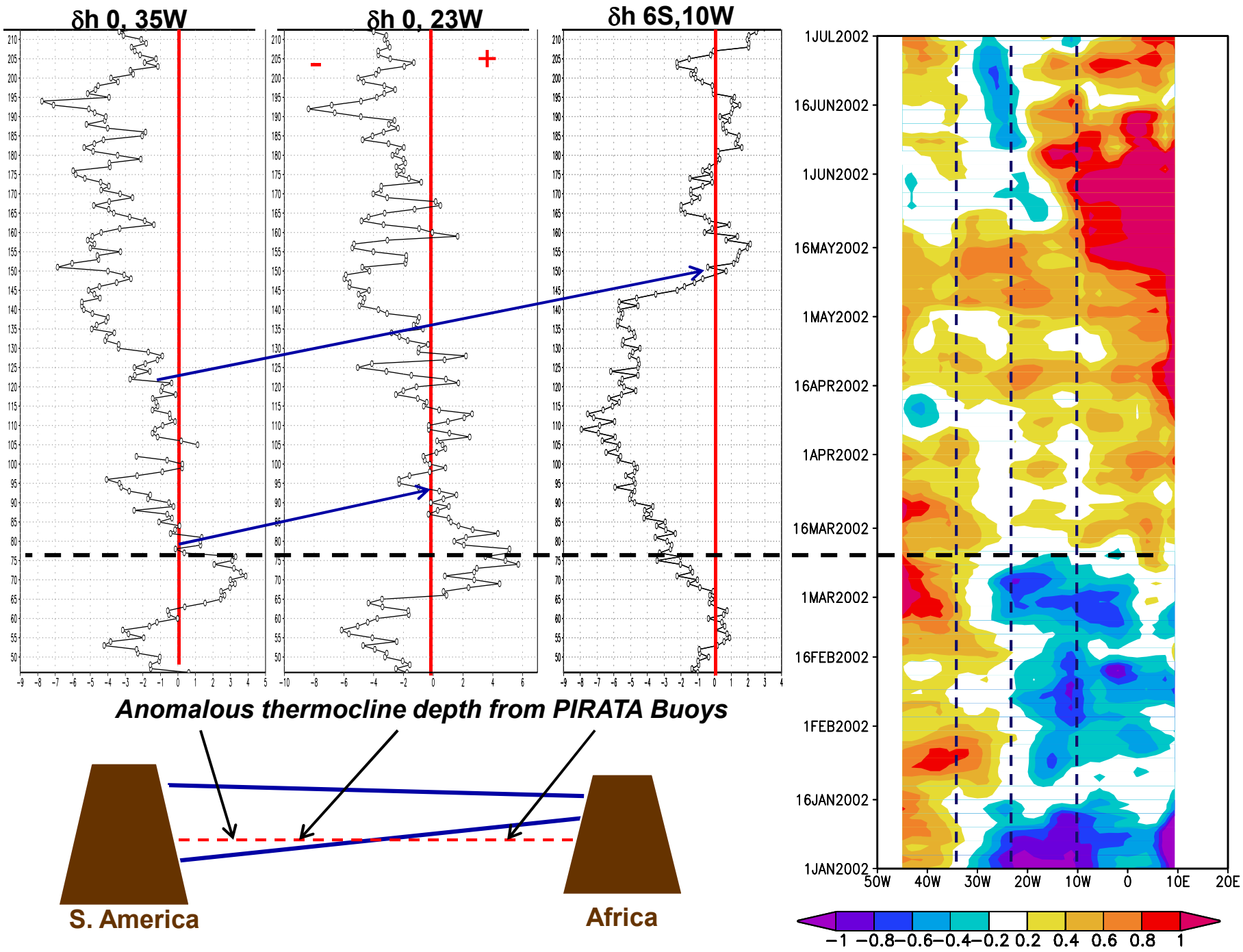
Anomalous thermocline depth from PIRATA Buoys
S. America
Africa


δh 0, 35W
δh 0, 23W
δh 6S,10W
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1JUL2002
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16MAR2002
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50W
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0
10E
20E
−1 −0.8 −0.6 −0.4 −0.2 0.2 0.4 0.6 0.8 1
Anomalous thermocline depth from PIRATA Buoys
S. America
Africa

Summary of previous and current works:

- ✓ *Convection over Amazon appears to excite convective coupled Kevin waves, which generate episodes of westerly wind anomalies over the equatorial Atlantic, especially during boreal spring.*

- ✓ *Strong westerly wind anomalies appeared to induced eastward propagating changes of thermocline depth and equatorial waveguide warming of SSTs, thus triggered the onset of 2002 Atlantic Niño. Likewise, easterly wind anomalies appeared to triggered the demise of warm SSTA in 2005.*

- ✓ *Warm and cold phase of the Atlantic Niños tend to correlate with late or early ending of the Amazon wet season during boreal spring.*

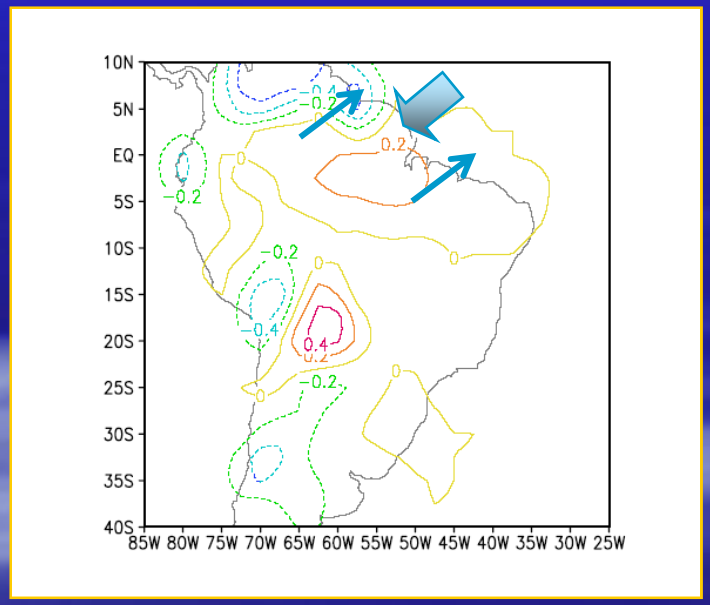
Future work-1:

- ***Investigate the changes of surface fluxes, wind stress, local and remote sea-level height associated with between westerly (easterly) wind anomalies to determine the conditions under which they can trigger the changes between warm and cold phase of the Atlantic Niños.***

  – Need longer data to cover more events!

Future work-3:

- *Investigate the influence of moisture transport on South American rainfall using QuikSCAT moisture flux data working with Tim Liu.*



Rainfall become more intense over the Amazon. (1979-2001) gauge data

Ffield 2006

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

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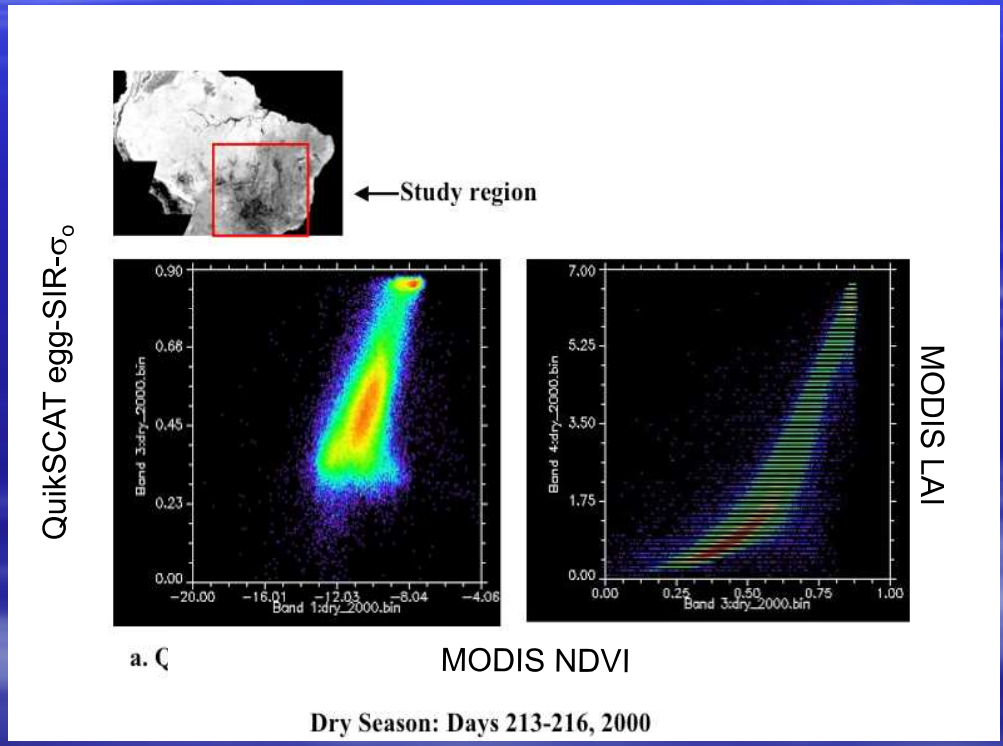
Future work-3:

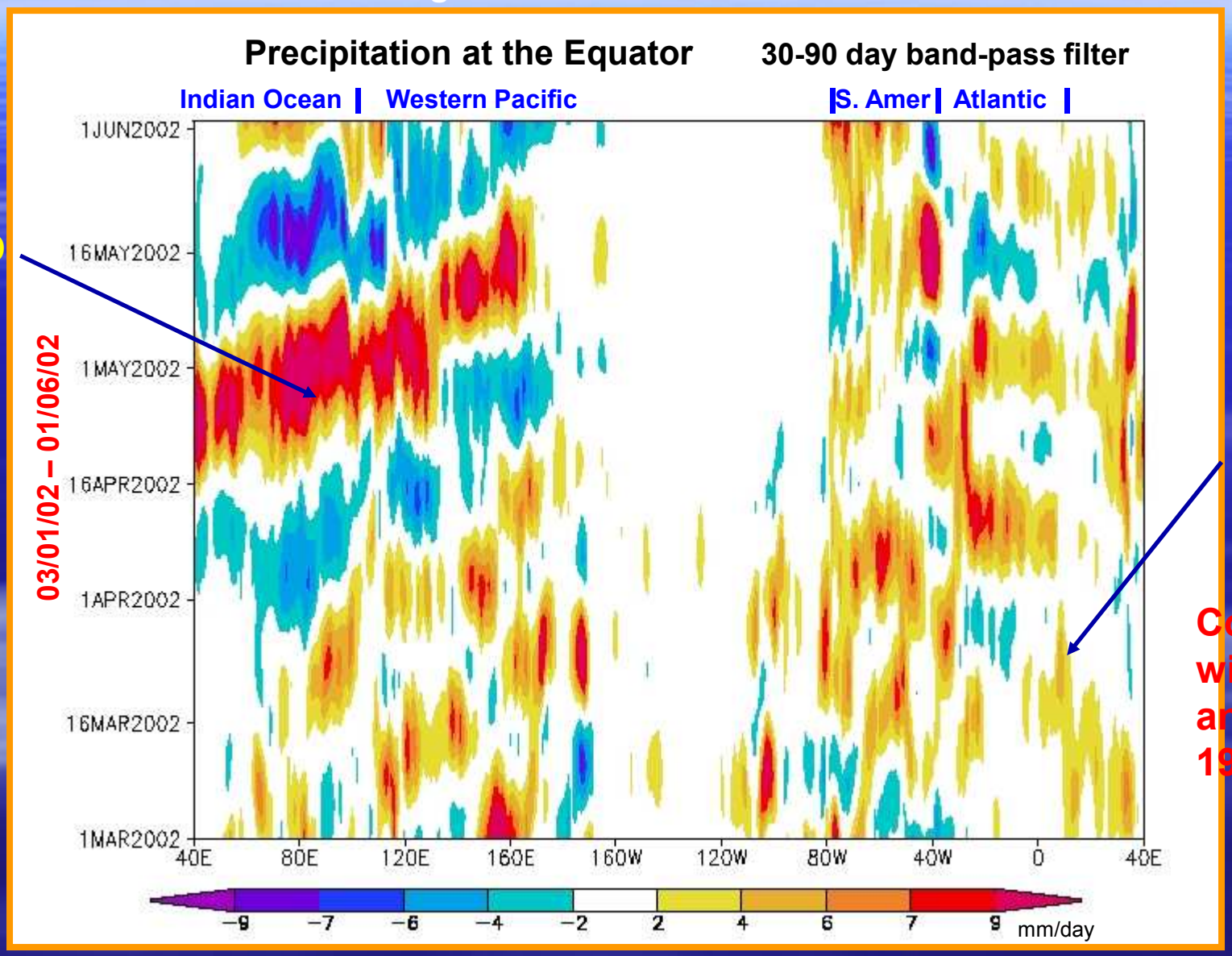
- ***Determining the canopy wetness and vegetation seasonality through joint use of QuikSCAT σ_o and MODIS LAI and EVI over tropical forest.***



Long and Harding 1994

Related to Pacific?

No significant correlation between high frequency (6-7 days) variability of the Atlantic ITCZ and convection (either unfiltered or 30-90 day band-pass filtered data) in other equatorial regions.



MJO

Westward propagation

Consistent with Wheeler and Kiladis 1999.

Easterly wind anomalies may have triggered the transition from the warm to cold phase of the Atlantic Nino in spring of 2005.