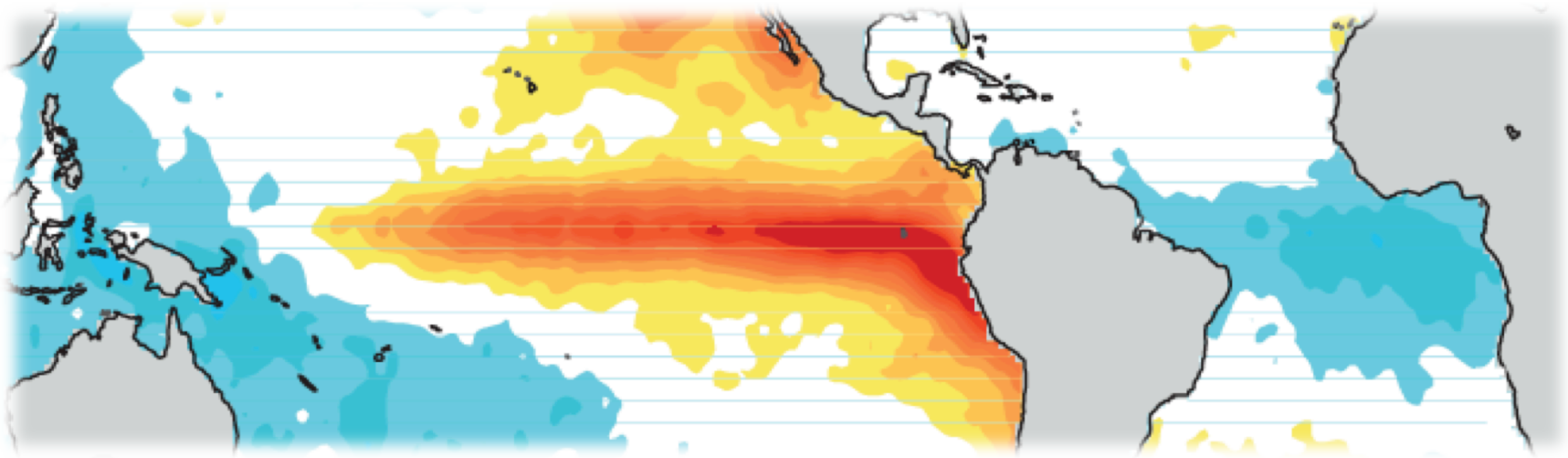


Tropical Atlantic variability and its impact on the Pacific



Marta Martín del Rey

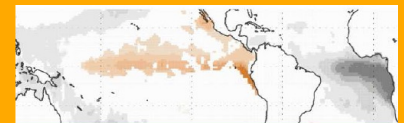
Belén Rodríguez-Fonseca and Irene Polo



Universidad Complutense de Madrid

2010-2015

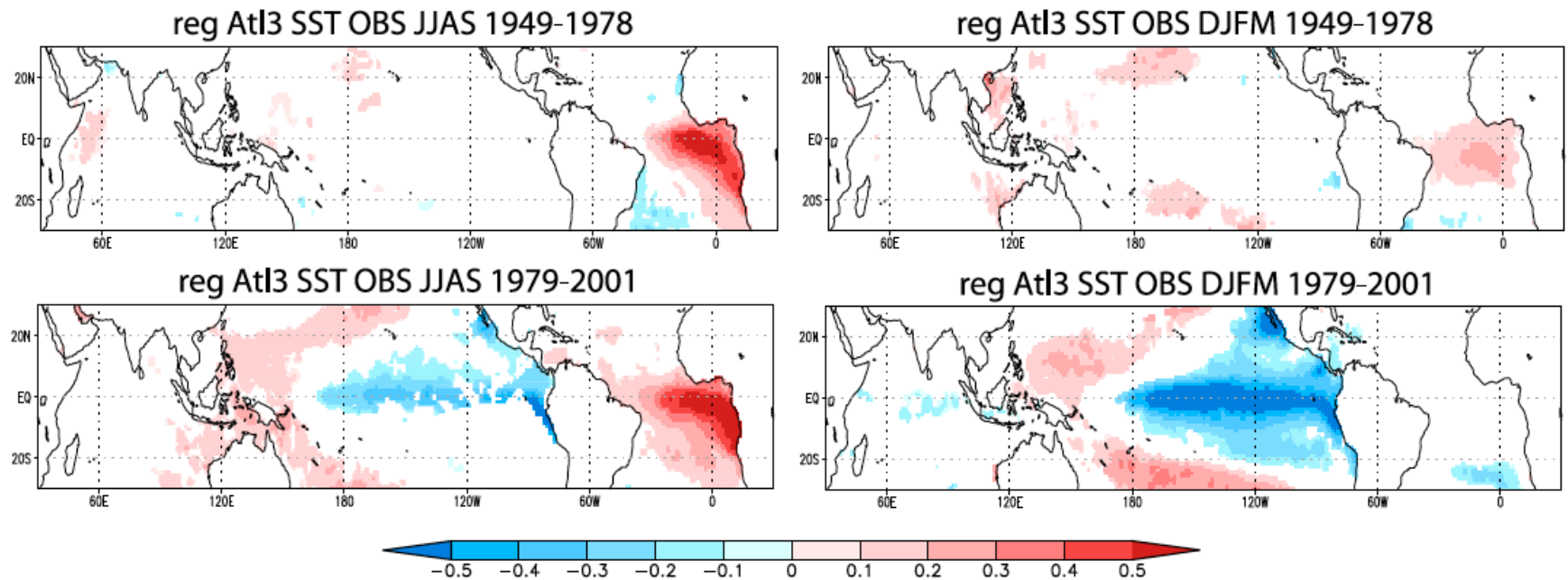
TROPA UCM
researching climate variability



<http://tropla.fis.ucm.es>

MOTIVATION

The Atlantic Niño (Niña) precedes the development of a Pacific La Niña (EL Niño) after the 1970s.

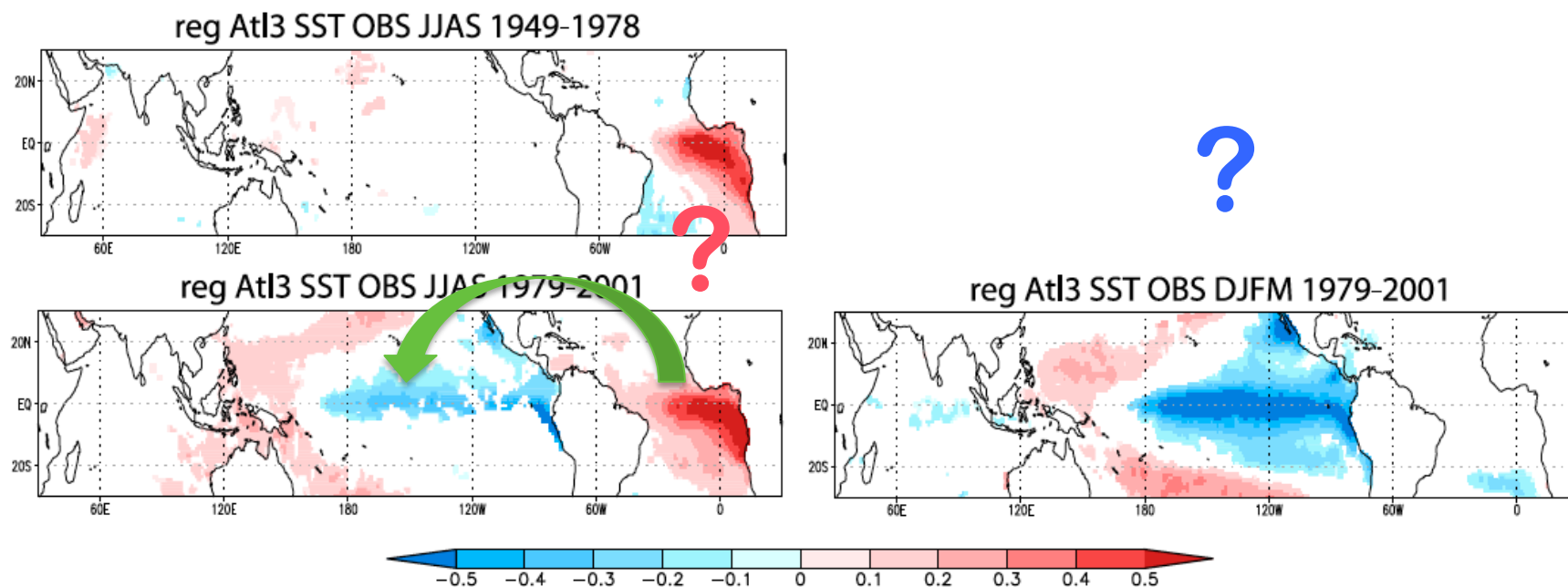


From Rodríguez-Fonseca et al. 2009.

(Polo et al. 2008; Keenlyside and Latif 2007; Ding et al 2012)

MOTIVATION

The Atlantic Niño (Niña) precedes the development of a Pacific La Niña (EL Niño) after the 1970s.



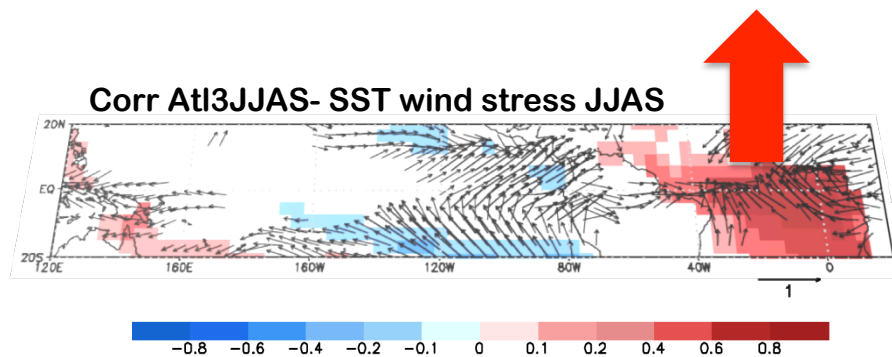
From Rodríguez-Fonseca et al. 2009. (Polo et al. 2008; Keenlyside and Latif 200)

- ✧ Which are the air-sea processes involved in the Atlantic-forced ENSO?
- ✧ When does the Atlantic-Pacific connection take place?
- ✧ How are the Atlantic Niños able to impact on ENSO?

RESULTS

- ✧ Which are the air-sea processes involved in the
- ✧ Atlantic-forced ENSO?

After the 1970s



A summer Atlantic Niño enhances the convection

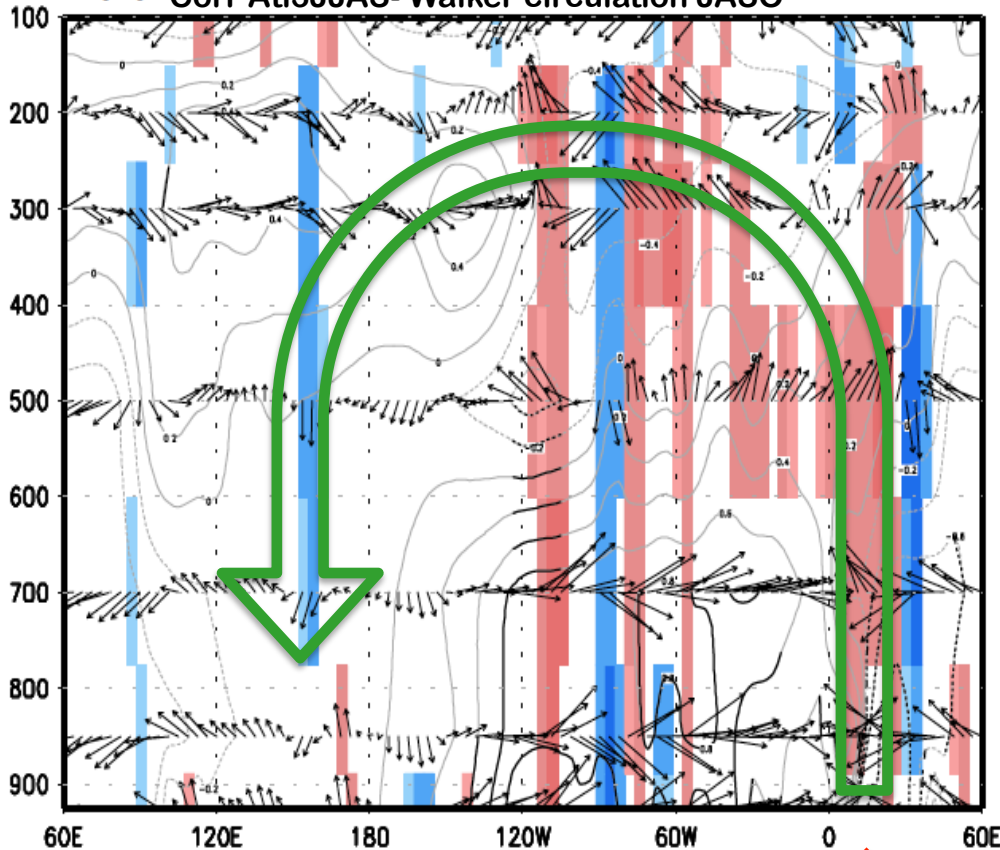
Polo et al. 2015a

RESULTS

- ✧ Which are the air-sea processes involved in the
- ✧ Atlantic-forced ENSO?

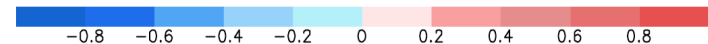
After the 1970s

Corr Atl3JJAS- Walker circulation JASO

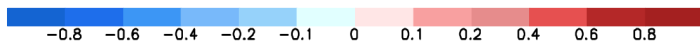
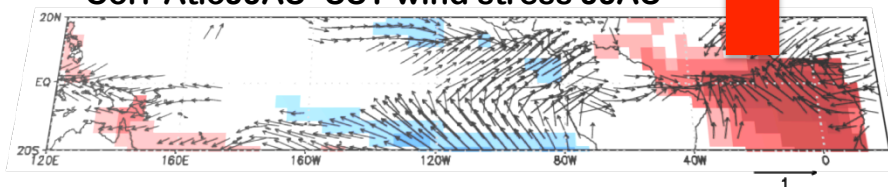


Altering the Walker circulation:

Red: Ascending motions
Blue: Descending motions
Contours: zonal wind
Vectors: zonal and vertical wind



Corr Atl3JJAS- SST wind stress JJAS



A summer Atlantic Niño enhances the convection

Polo et al. 2015

RESULTS

- ✧ Which are the air-sea processes involved in the
- ✧ Atlantic-forced ENSO?

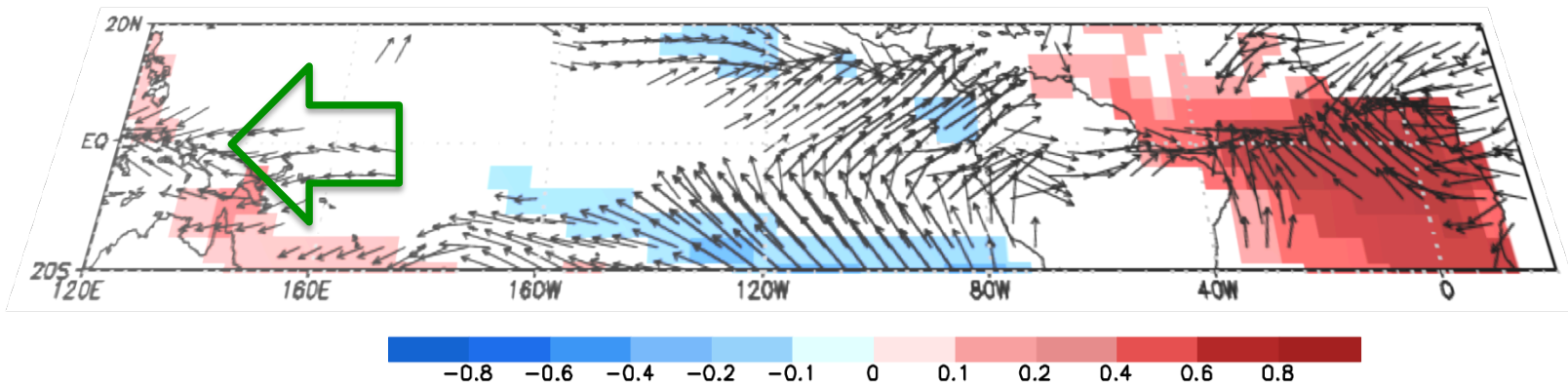
After the 1970s

Altering the Walker circulation:

-Anomalous wind divergence

-Anomalous easterlies in west equatorial Pacific

Corr Atl3JJAS- SST wind stress JJAS



→
1

Polo et al. 2015

RESULTS

- ✧ Which are the air-sea processes involved in the
- ✧ Atlantic-forced ENSO?

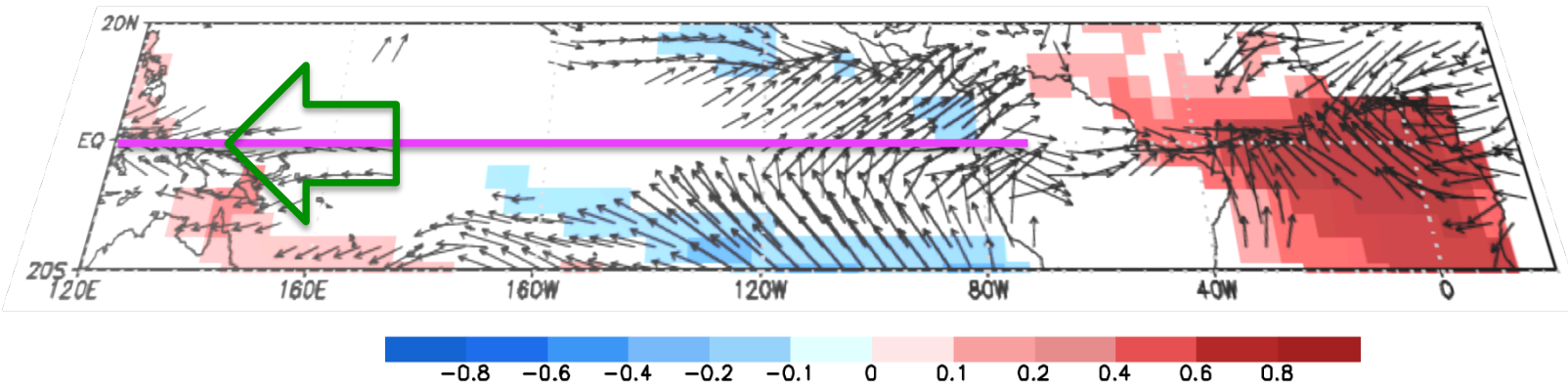
After the 1970s

Altering the Walker circulation:

-Anomalous wind divergence

-Anomalous easterlies in west equatorial Pacific

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→
1

Polo et al. 2015

RESULTS

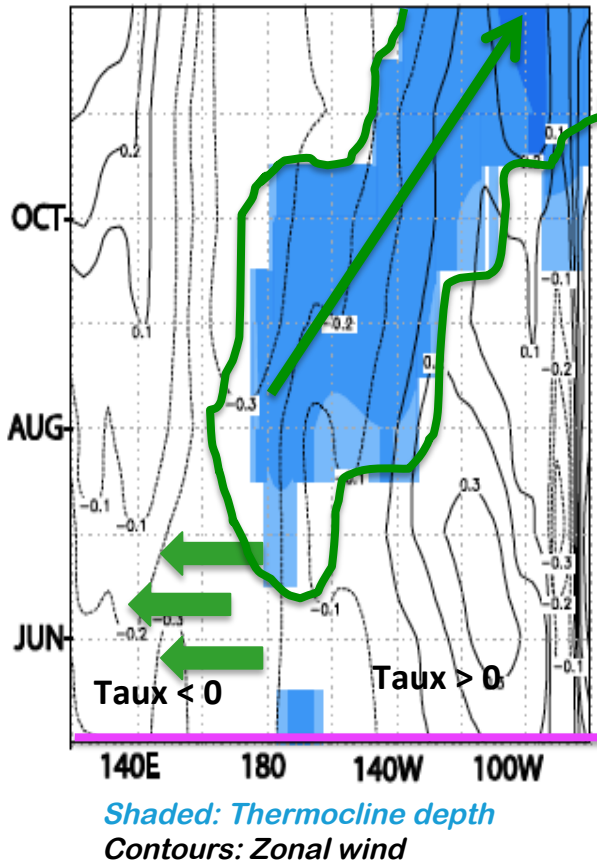
- ✧ Which are the air-sea processes involved in the
- ✧ Atlantic-forced ENSO?

After the 1970s

AT THE EQUATOR

Easterlies in Wpacific → Kelvin wave

(d) D20 & TAUX SPEEDY-RGO EQ



RESULTS

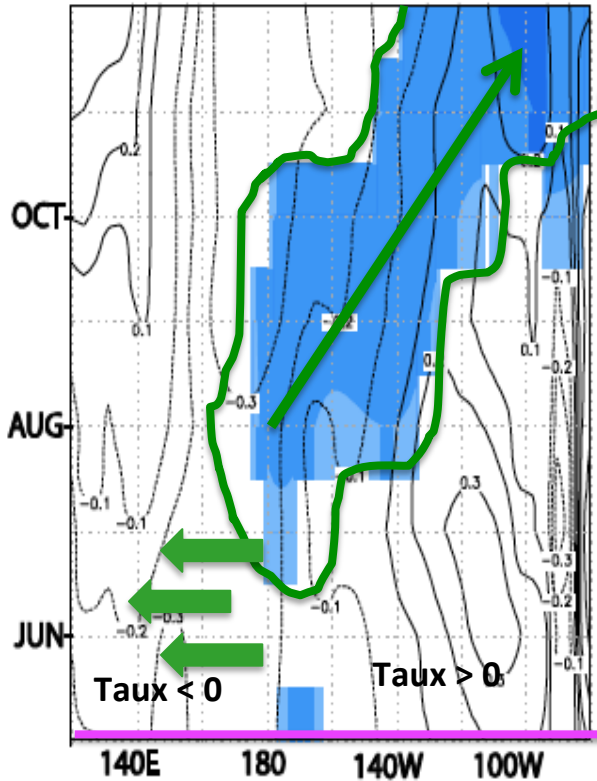
- ✧ Which are the air-sea processes involved in the
- ✧ Atlantic-forced ENSO?

After the 1970s

AT THE EQUATOR

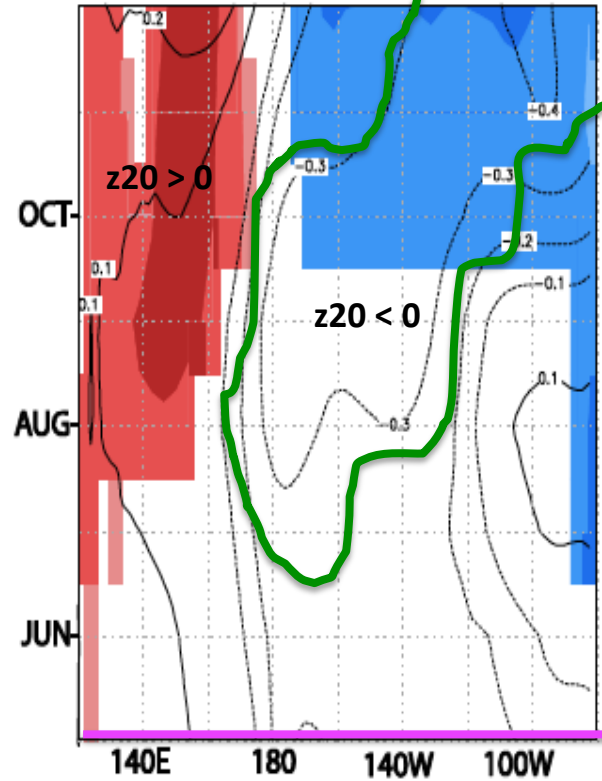
Kelvin wave → La Niña pattern

(d) D20 & TAUX SPEEDY-RGO EQ



Blue: Shallower thermocline depth
Contours: Zonal wind

(e) SST & D20 SPEEDY-RGO EQ



Red: Warmer SST
Blue: Cooler SST
Contour: Thermocline depth

Polo et al. 2015a

RESULTS

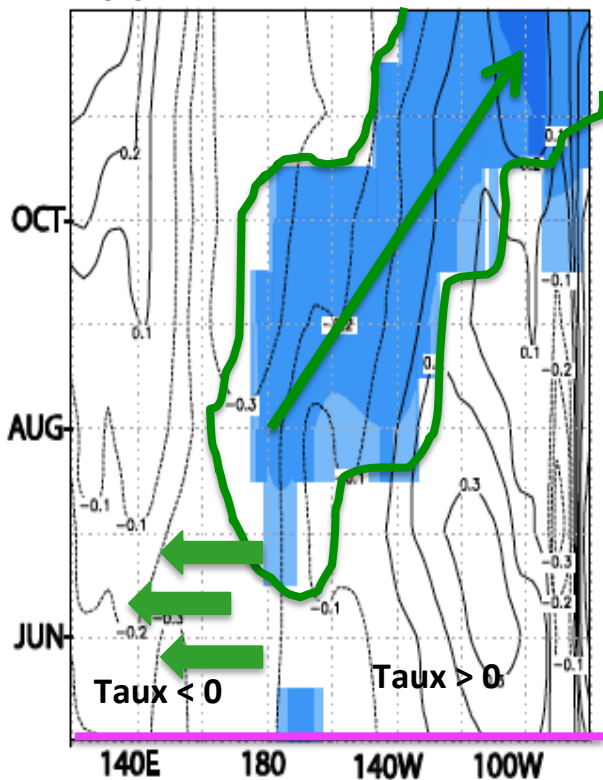
- ✧ Which are the air-sea processes involved in the
- ✧ Atlantic-forced ENSO?

After the 1970s

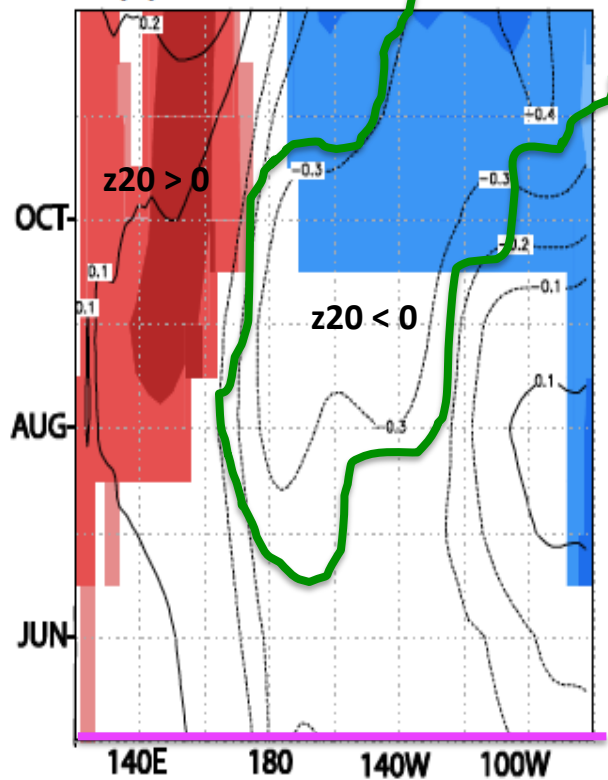
AT THE EQUATOR

La Niña pattern → Bjerknes feedback

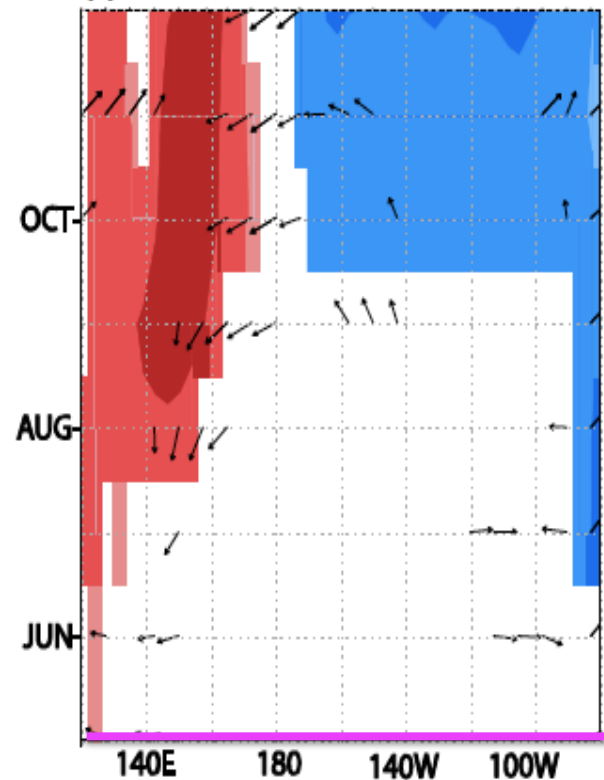
(d) D20 & TAUX SPEEDY-RGO EQ



(e) SST & D20 SPEEDY-RGO EQ



(f) SST & wind stress SPEEDY-RGO EQ



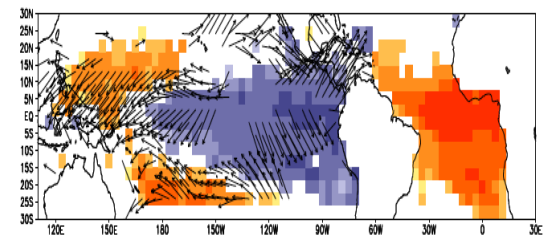
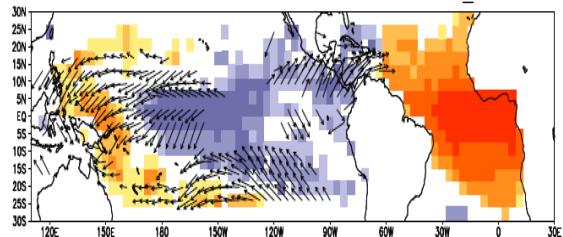
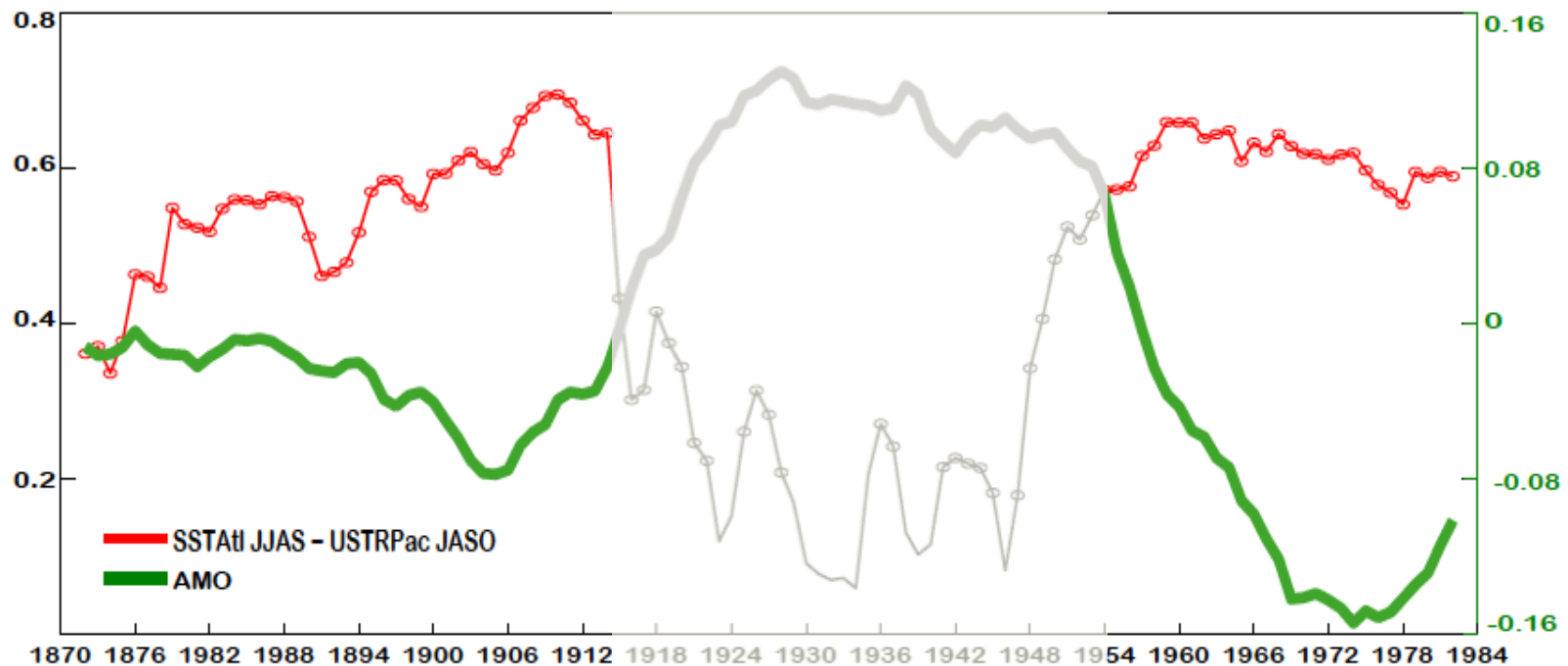
Polo et al. 2015a

Key processes: Winds in western Pacific and oceanic waves
(Recharge-oscillator (Suarez and Schopf 1988), Delayed-oscillator (Jin 1997ab; Wyrтки 1975, 1985))

RESULTS ✧ When does the Atlantic-Pacific connection take place?

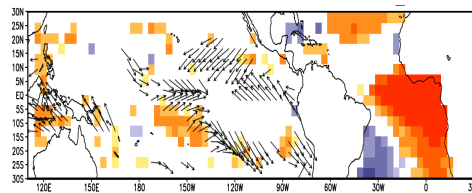
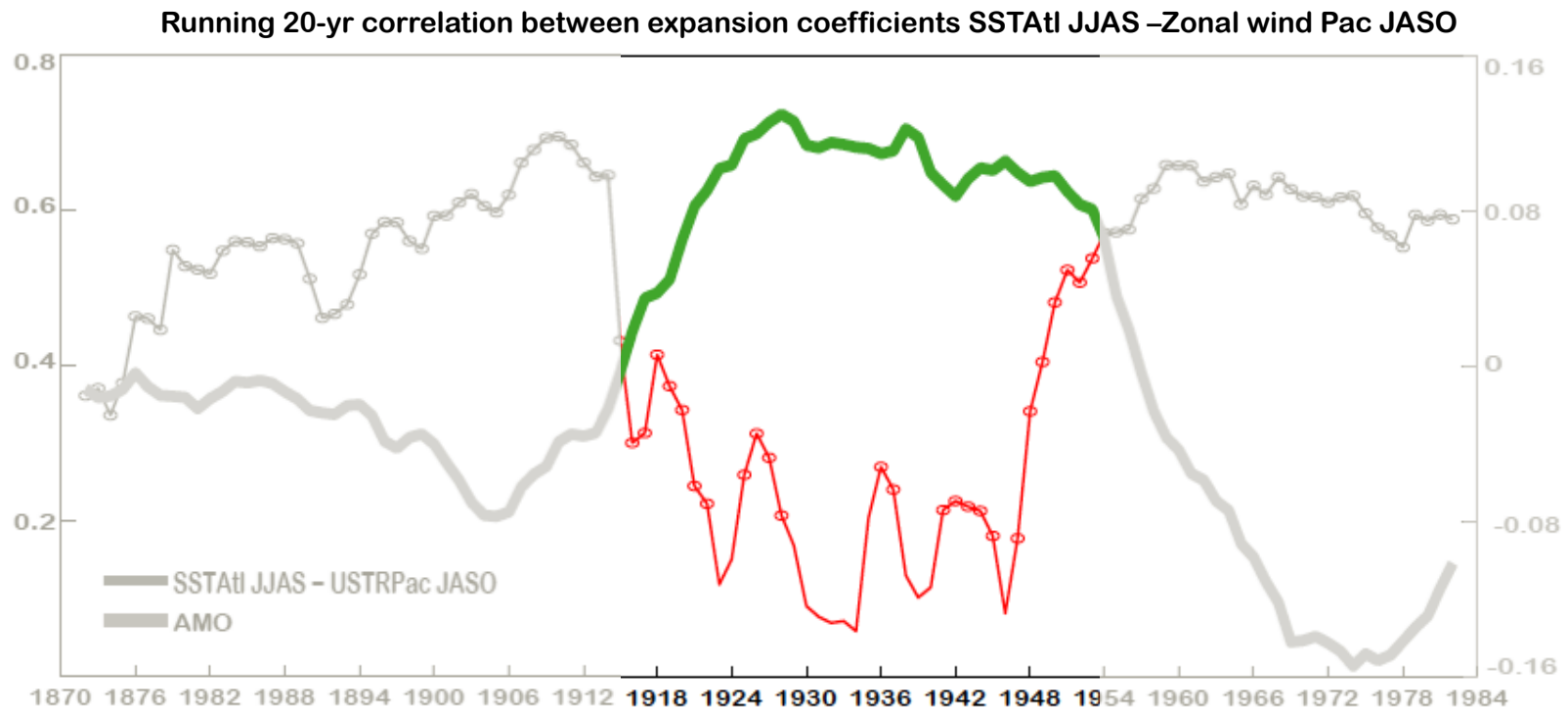
The Atlantic-Pacific connection is an air-sea coupled mode that emerges at multidecadal time scales (coinciding with negative AMO phases)

Running 20-yr correlation between expansion coefficients SSTAtl JJAS - Zonal wind Pac JASO



RESULTS ✧ When does the Atlantic-Pacific connection take place?

For a positive AMO phase, the Atlantic Niño appears alone



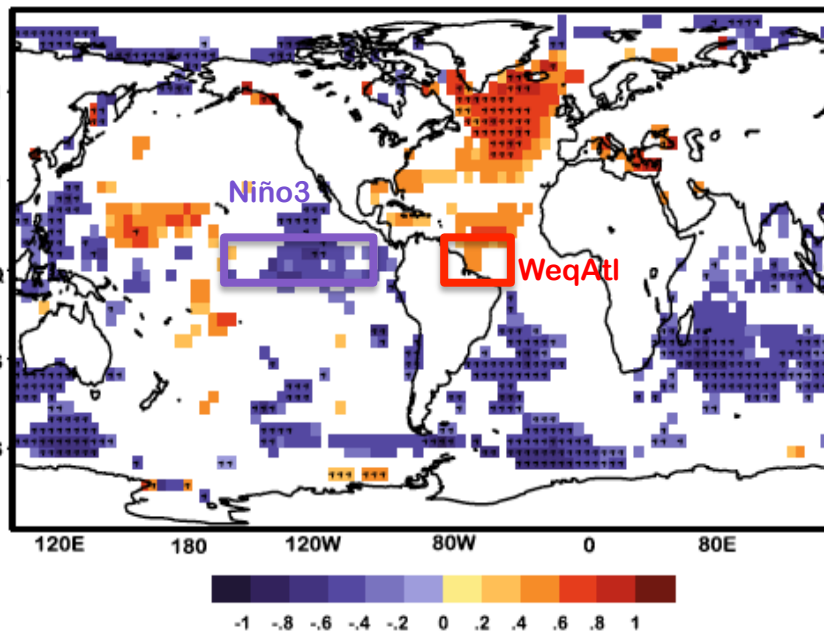
Martín-Rey et al. 2014

Does the Multidecadal variability modulate the Atlantic-Pacific connection?

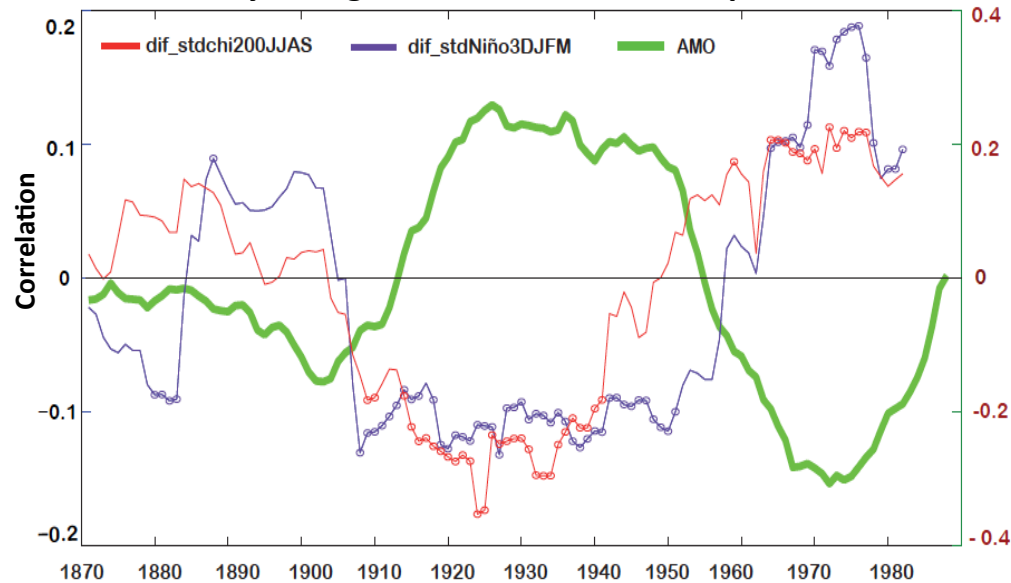
RESULTS ✧ When does the Atlantic-Pacific connection take place?

The AMO could modulate the Atlantic-Pacific connection at multidecadal time scales through changes in the variability of the equatorial Atlantic convection and eastern Pacific SST.

(b) CORRELATION MAP AMO index - SST GLOB 1871-2001



Variability changes Niño3 SST & west-equatorial Atl chi200



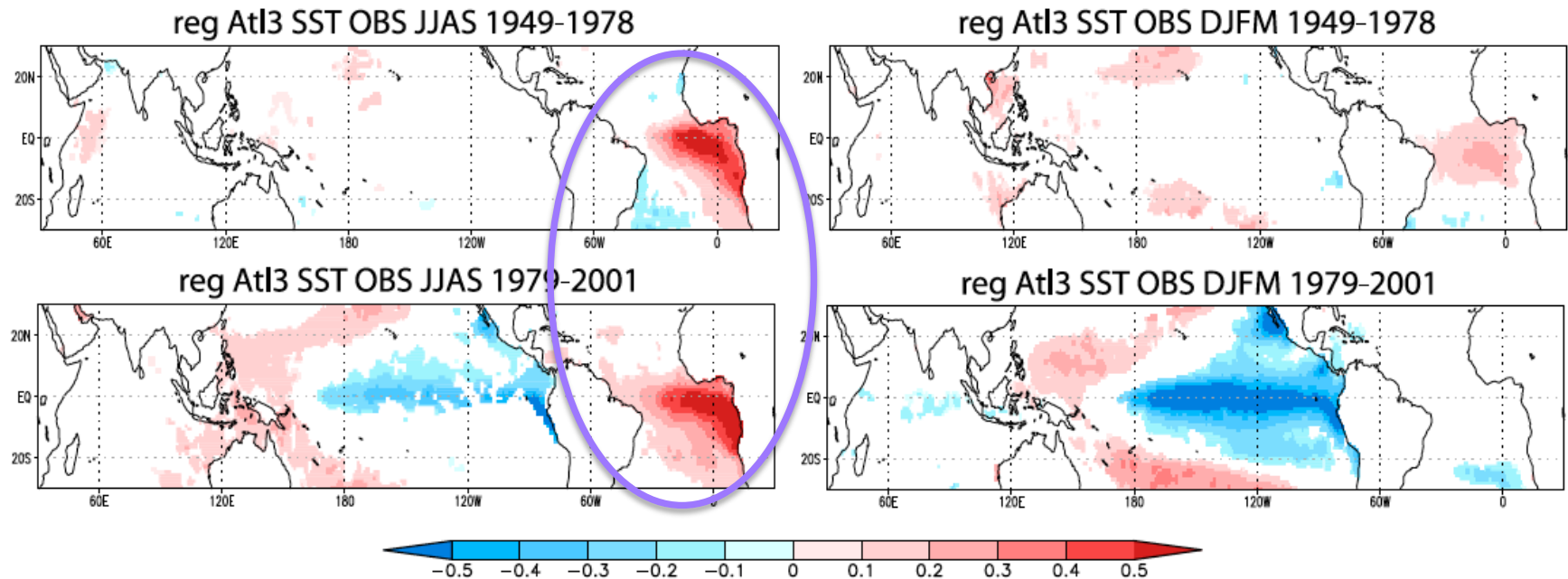
Martín-Rey et al. 2014

The multidecadal modulation of the Atlantic influence on ENSO opens additional opportunities to predict ENSO episodes (Martín-Rey et al. 2015).

RESULTS

✧ How are the Atlantic Niños able to impact on ENSO?

Different spatial structure before and after the 1970s



From Rodríguez-Fonseca et al. 2009. (Polo et al. 2008; Keenlyside and Latif 200)

The spatial structure before and after the 1970s coincide with different teleconnections (Polo et al. 2008; Rodríguez-Fonseca et al. 2009; Mohino et al. 2011; Losada et al. 2012b; Losada and Rodríguez-Fonseca 2015).

✧ Which are the air-sea processes involved in the development of these Atlantic Niños?

RESULTS

✧ How are the Atlantic Niños able to impact on ENSO?

AMO neg 1971-1989

2 Atlantic Niños:

Basin-Wide (BW)

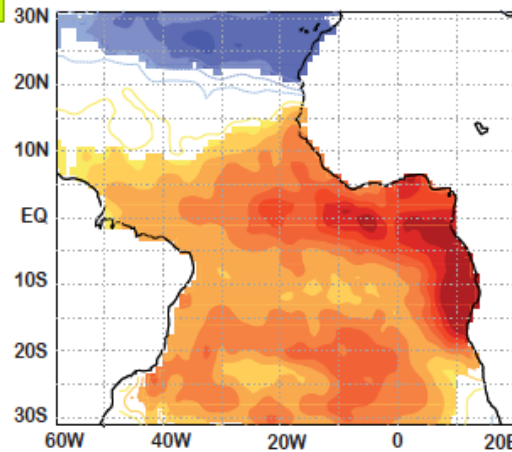
Dipolar (D)

AMO pos 1995-2013

1 Atlantic Niño

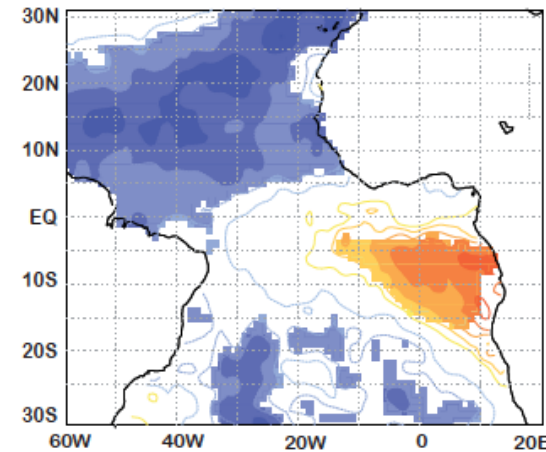
Basin -Wide

(a) EOF1 42.93 % OBS AMO neg

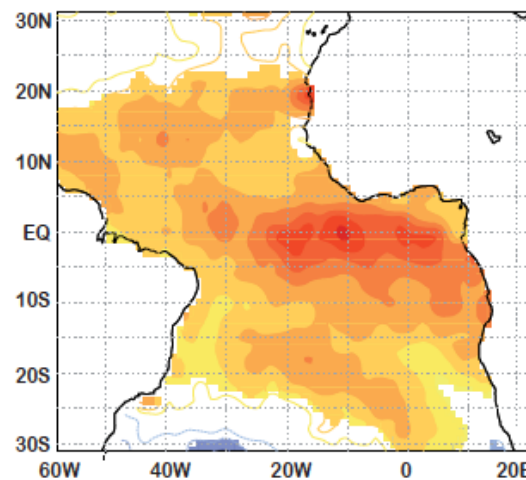


Dipolar

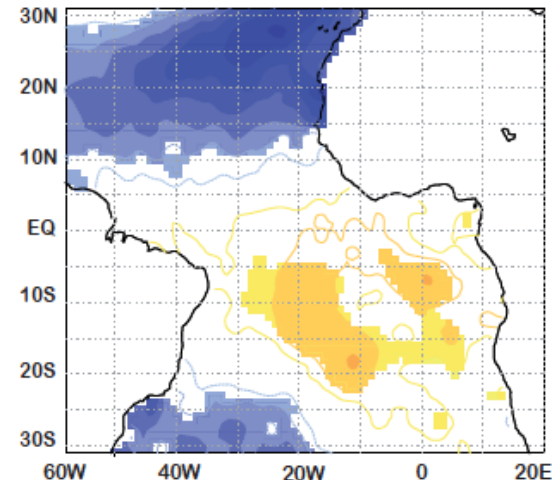
(b) EOF2 17.2 % OBS AMO neg



(c) EOF1 34.4 % OBS AMO pos



(d) EOF2 24.4 % OBS AMO pos



Martín-Rey et al. 2016a

RESULTS

✧ How are the Atlantic Niños able to impact on ENSO?

AMO neg 1971-1989

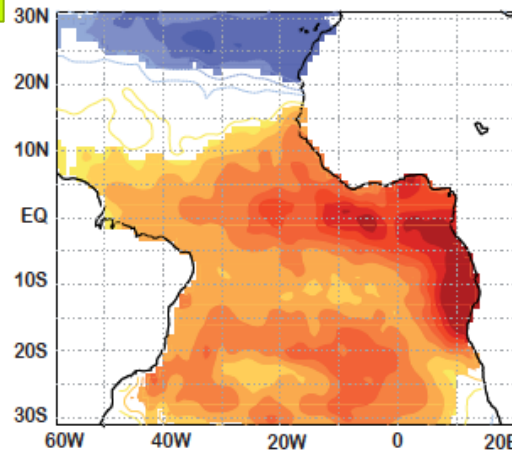
2 Atlantic Niños:

Basin-Wide (BW)

Dipolar (D)

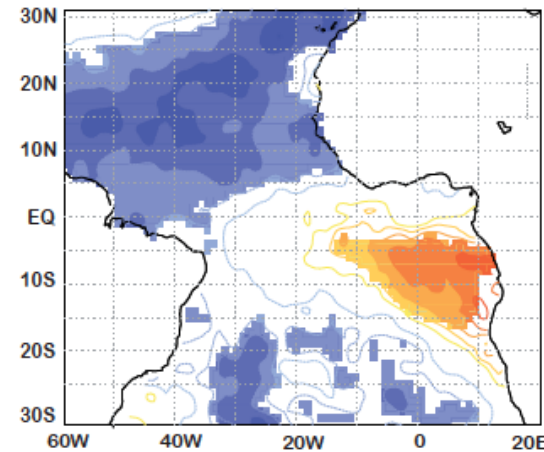
Basin -Wide

(a) EOF1 42.93 % OBS AMO neg



Dipolar

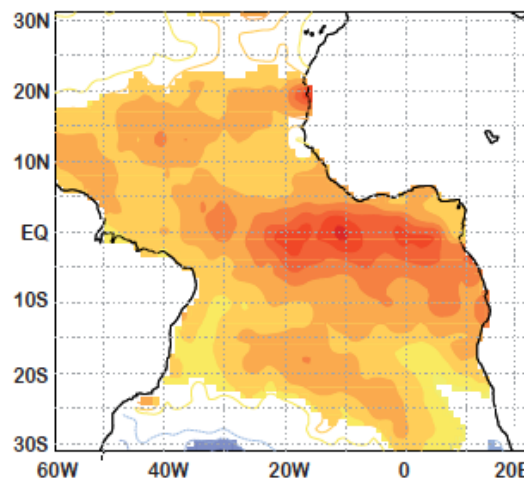
(b) EOF2 17.2 % OBS AMO neg



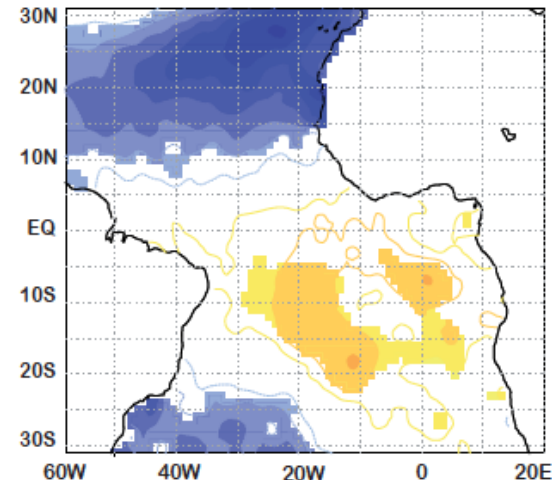
AMO pos 1995-2013

1 Atlantic Niño

(c) EOF1 34.4 % OBS AMO pos



(d) EOF2 24.4 % OBS AMO pos



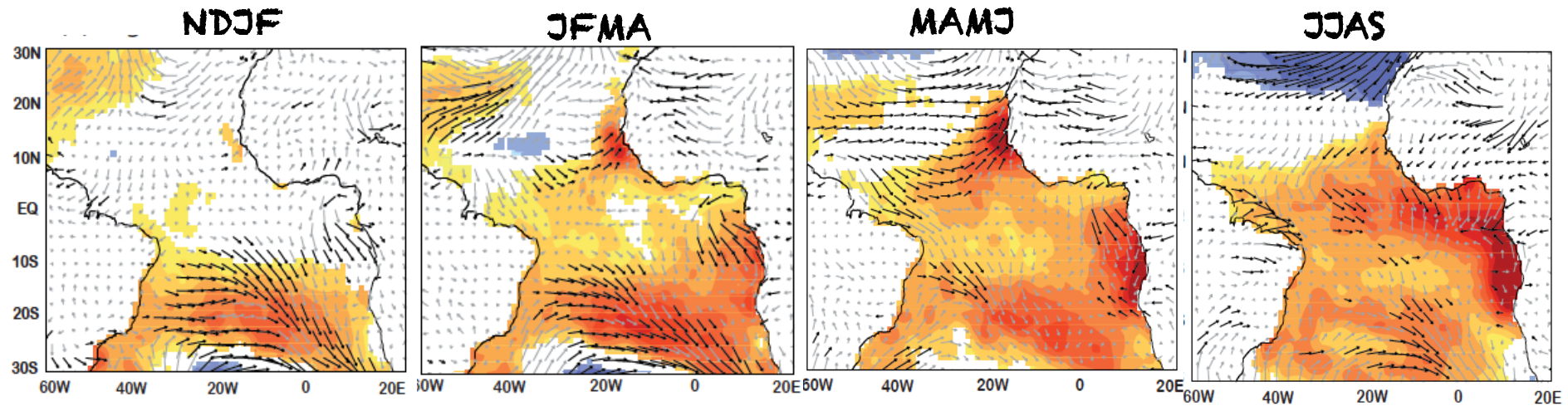
Martín-Rey et al. 2016a

RESULTS

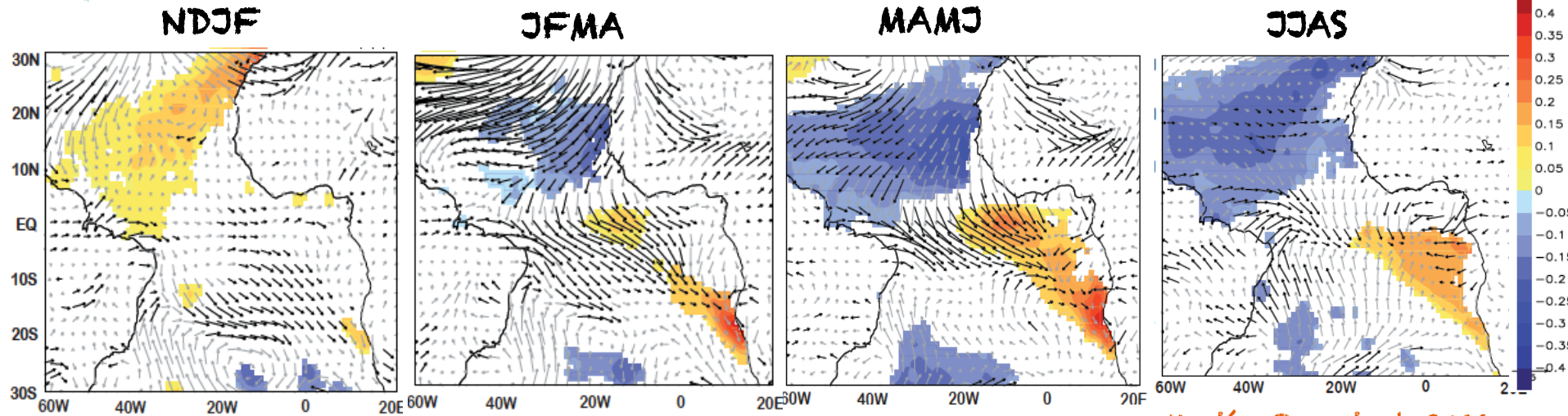
✧ How are the Atlantic Niños able to impact on ENSO?

AMO neg

BW-ATLANTIC NIÑO: Reduction of the south-eastern and north-eastern trades



D-ATLANTIC NIÑO: Intensification north-eastern trades and reduction of the equatorial and southern trade winds

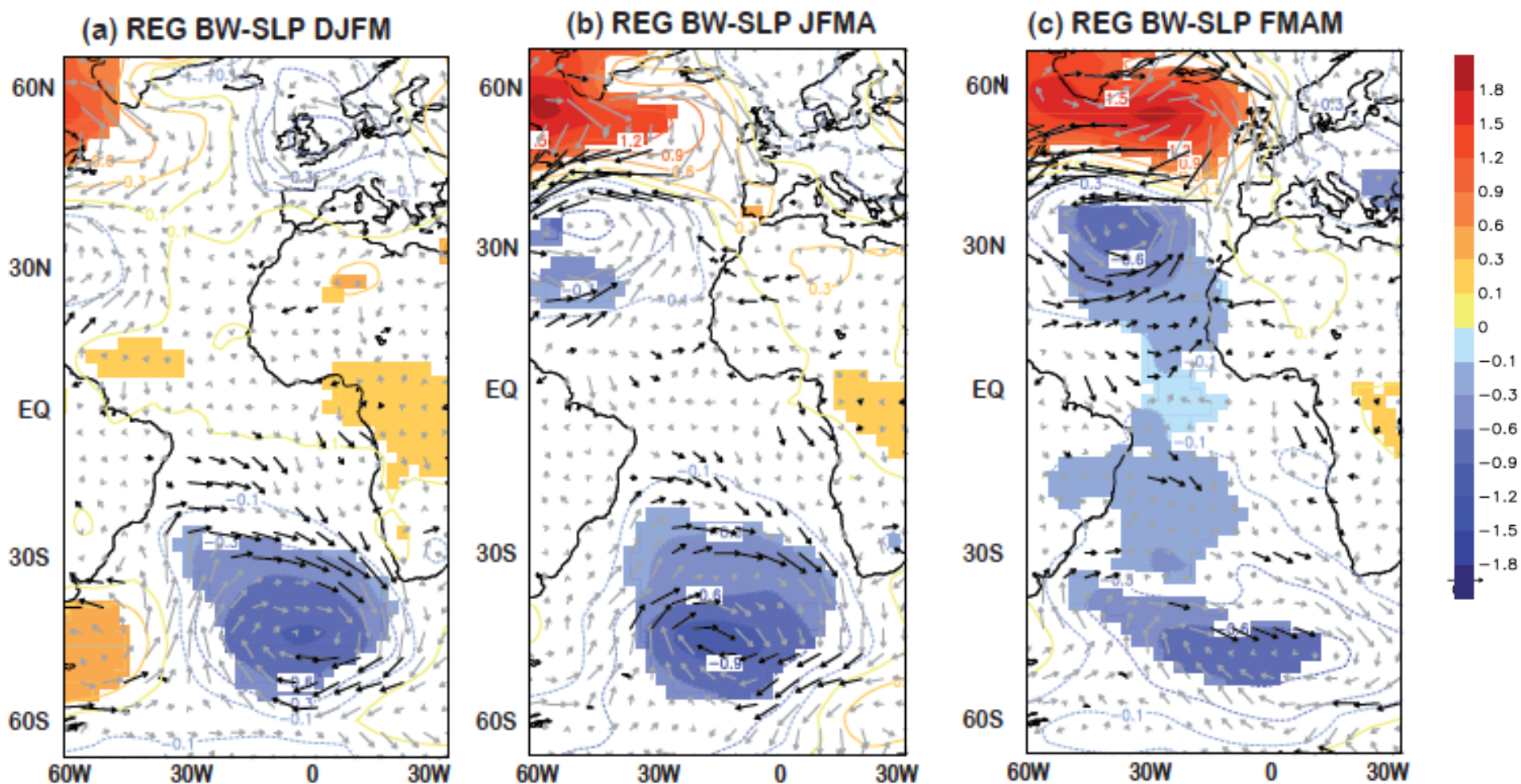


Martín-Rey et al. 2016a

RESULTS Why are two different Atlantic Niño configurations?

BW-ATLANTIC NIÑO:

Weakening of both Azores and Sta Helena Highs



RESULTS Why are two different Atlantic Niño configurations?

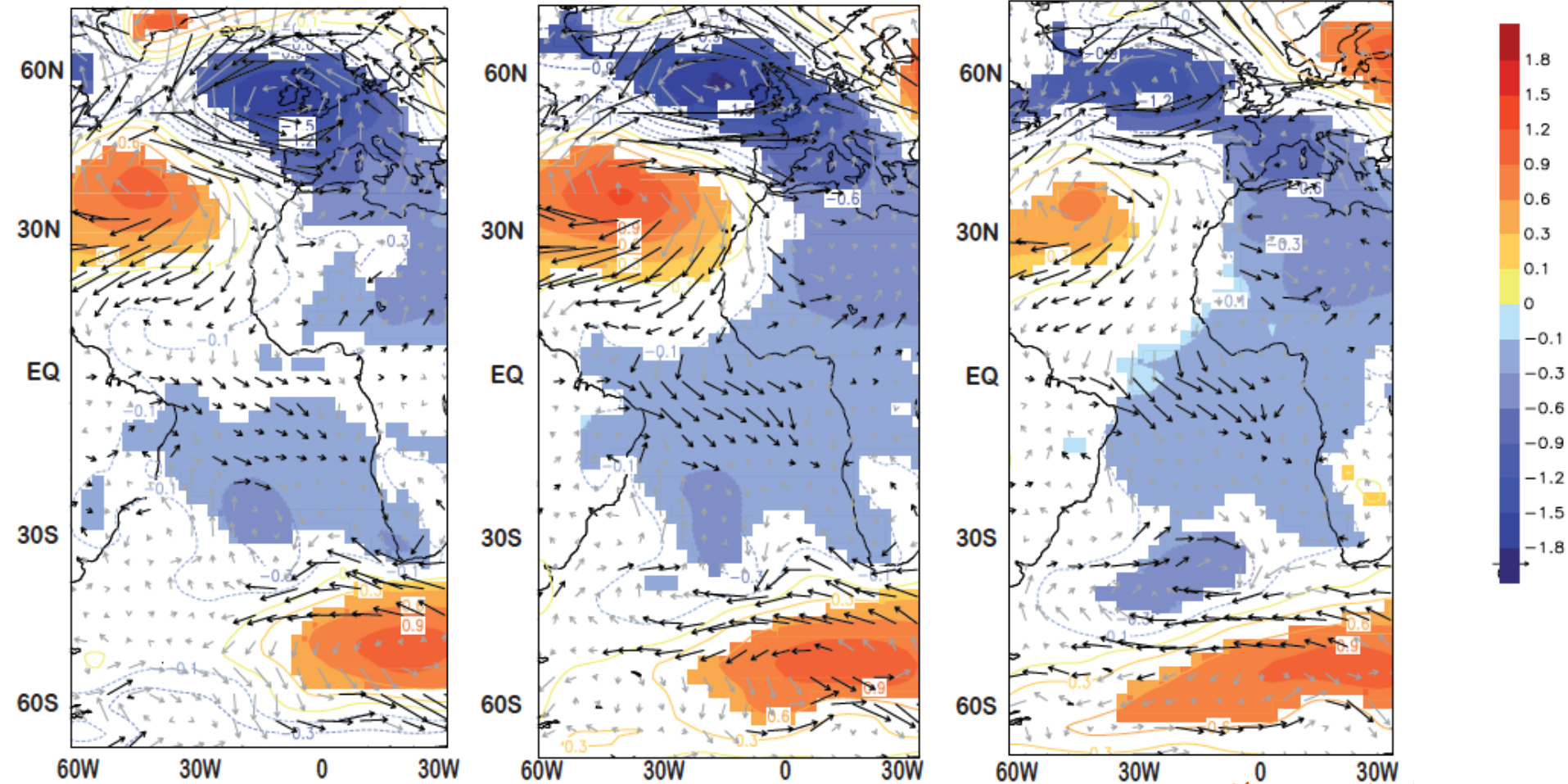
D-ATLANTIC NIÑO:

Intensification of Azores and negative SLP anomalies in EQ and STA

(g) REG D-SLP DJFM

(h) REG D-SLP JFMA

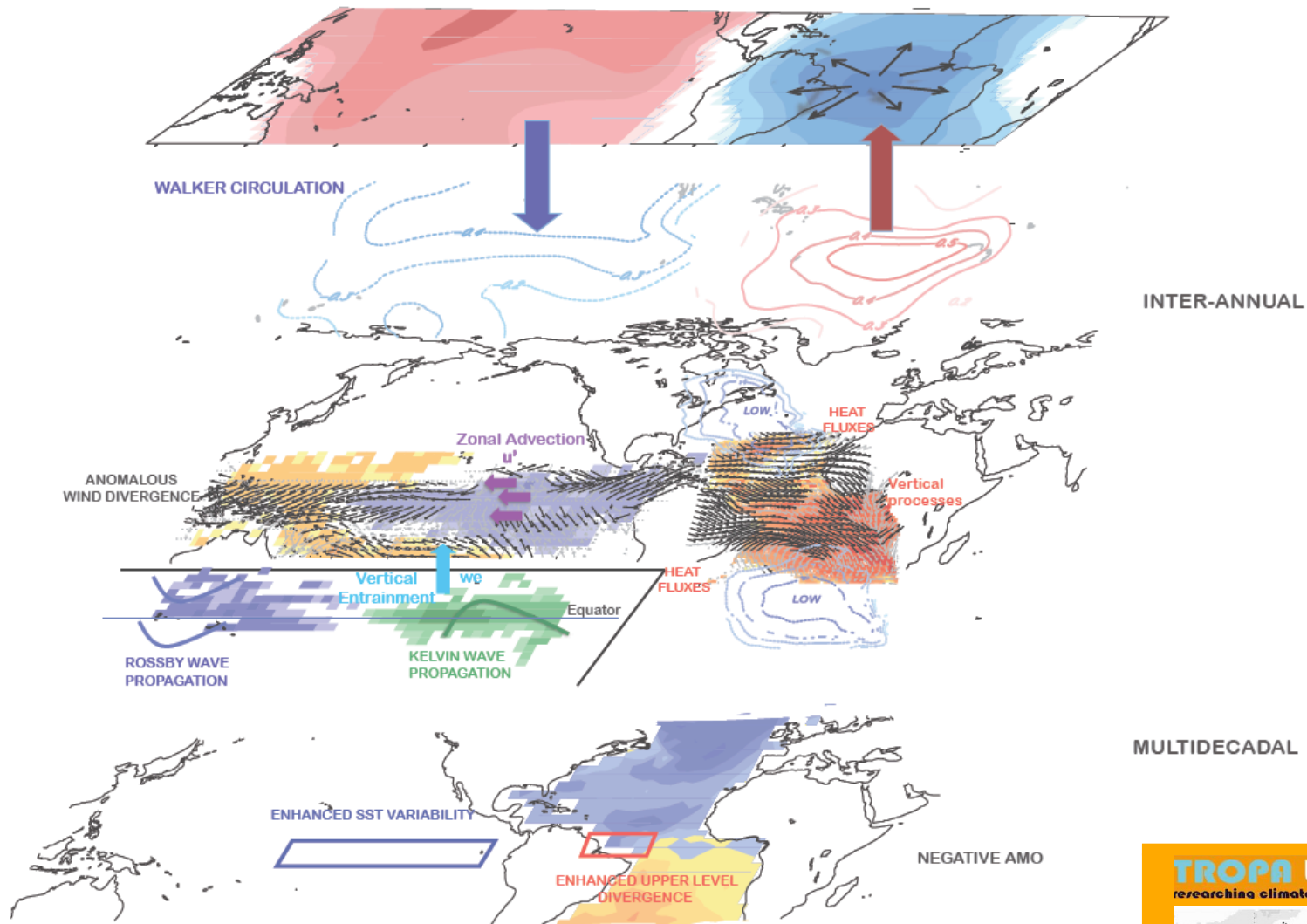
(i) REG D-SLP FMAM



CONCLUSIONS

- The Atlantic-Pacific connection is an air-sea coupled mode of inter-annual tropical variability.
- The Atlantic-Pacific mode emerges at multidecadal time scales, possibly modulated by the Atlantic Multidecadal Oscillation
- The Atlantic-Pacific connection oppens additional opportunities for ENSO prediction during certain decades.
- Two different Atlantic Niños co-exist in the TA during negative AMO phases: Basin-Wide and Dipolar
- A different contribution of the subtropical Highs drives the development of BW and D Atlantic Niño

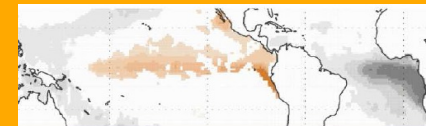
THANK YOU FOR YOUR ATTENTION



MERCI POUR VOTRE ATTENTION

Martín-Rey et al. 2016a

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ONGOING WORK

- Analysis of the oceanic processes involved in the development of the BW and D Atlantic Niño:
(Inter-annual NEMO-ATLTROP simulation)
 - * Heat Budget
 - * Oceanic waves
- Investigate the causes of the different contribution of the subtropical Highs
- Study the different Atlantic Niño pattern in AMO positive and its dependence of the time period.

RESULTS

Are the Subtropical Highs Pressure Systems externally forced?

BW-ATLANTIC NIÑO:

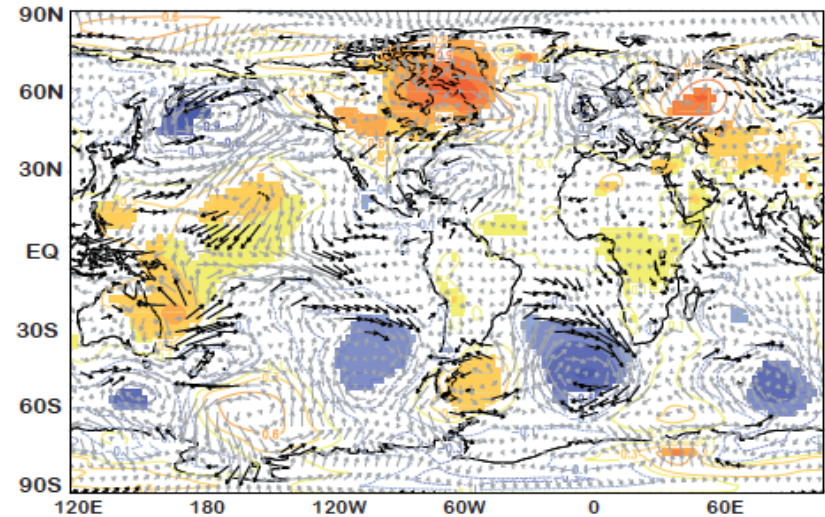
- Rossby wave train in Southern Ocean

Both are forced by an atmospheric signal emanating from the Pacific!!

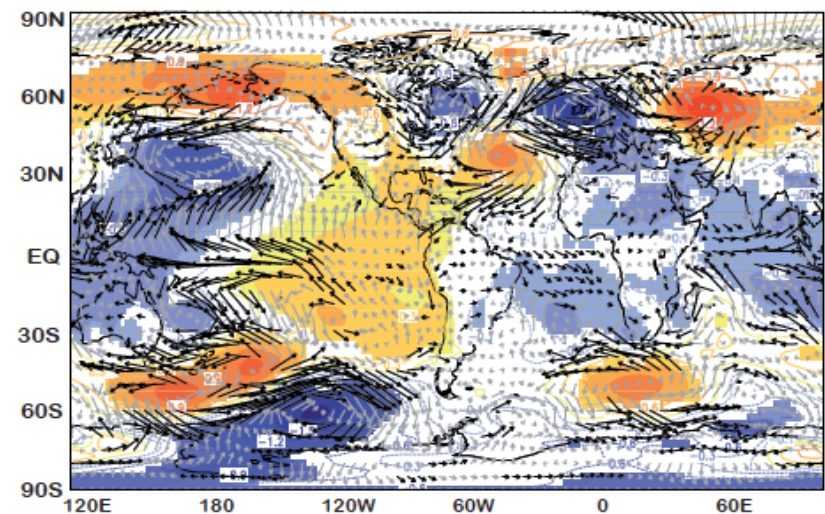
D-ATLANTIC NIÑO:

- Rossby wave train in the Northern and Southern Oceans

(b) REG BW-SLPWIND DJFM year -1 AMO neg



(e) REG D-SLPWIND DJFM year -1 AMO neg



RESULTS

Are the Subtropical Highs Pressure Systems externally forced?

BW-ATLANTIC NIÑO:

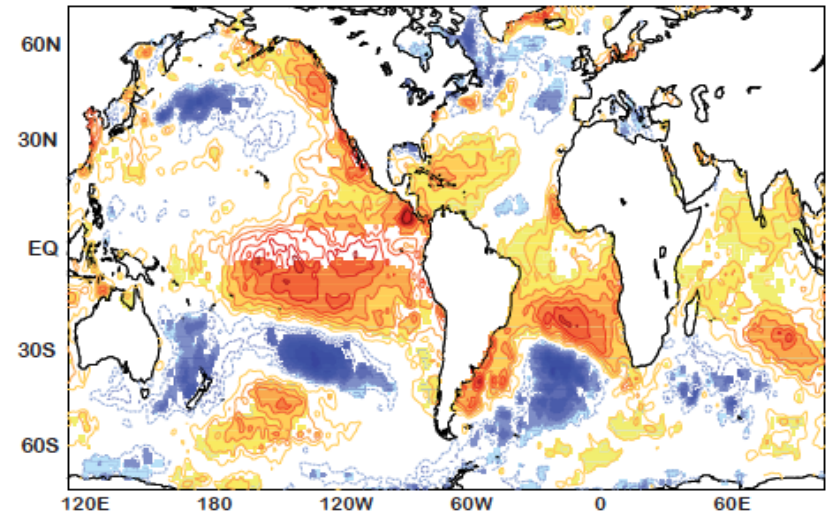
- Preceded by an El Niño pattern

ENSO signal is propagated in both cases with different impact over the Atlantic.

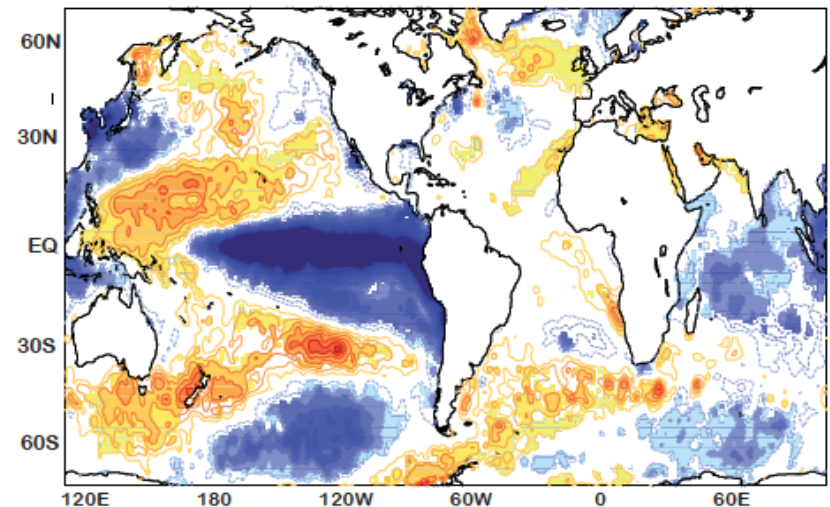
D-ATLANTIC NIÑO:

- Preceded by La Niña pattern

(a) REG BW-SST DJFM year -1 AMO neg

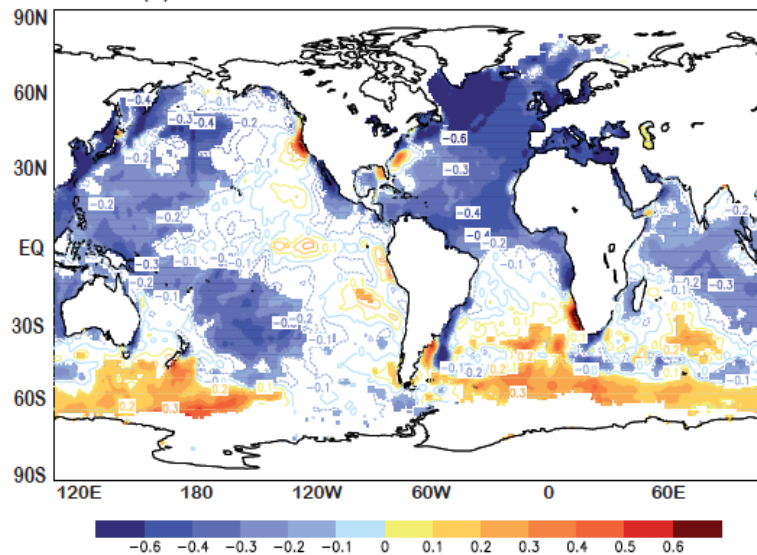


(d) REG D-SST DJFM year -1 AMO neg

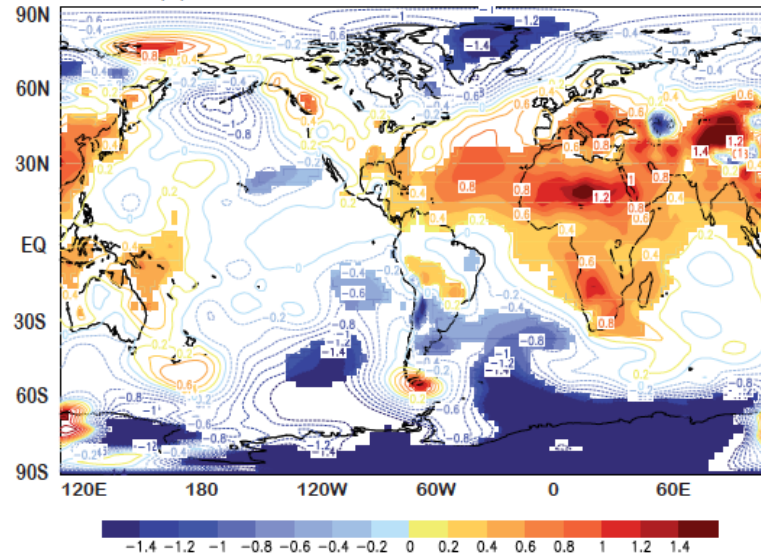


Different ENSO impact under negative AMO phase

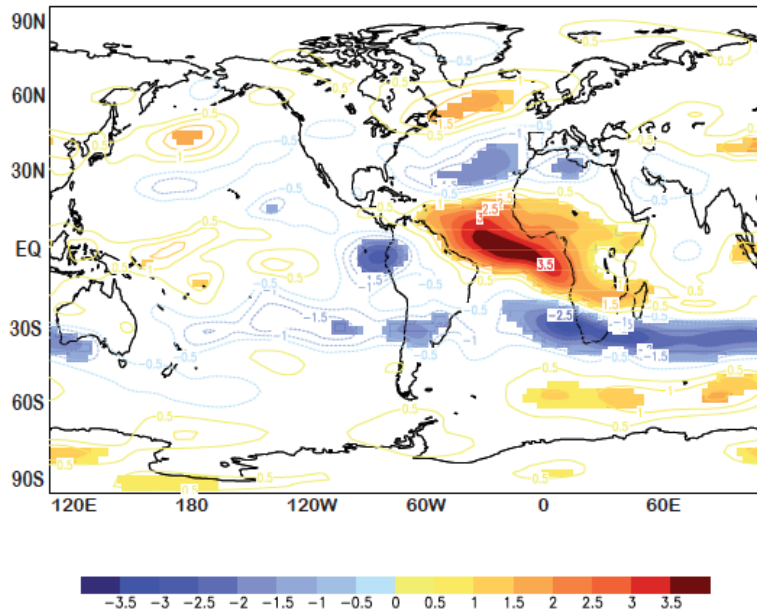
(a) CHANGES MEAN SST AMONEG - AMOPOS



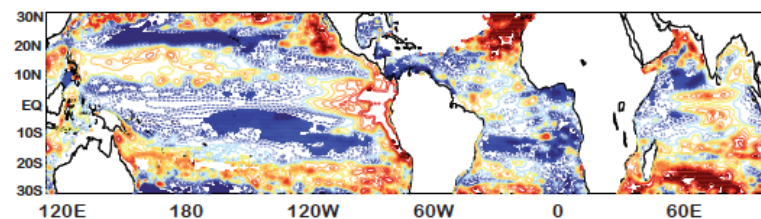
(b) CHANGES MEAN SLP AMONEG - AMOPOS



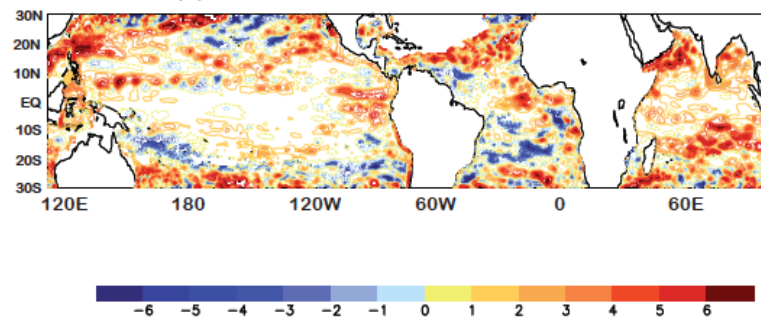
(c) CHANGES MEAN ZONAL WIND 200hPa AMONEG - AMOPOS



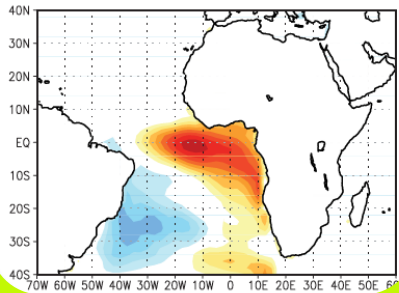
(d) CHANGES MEAN D16 AMONEG - AMOPOS



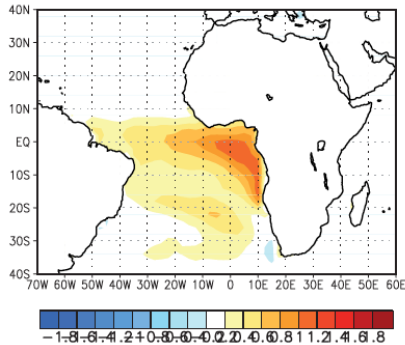
(e) CHANGES STD D16 AMONEG - AMOPOS



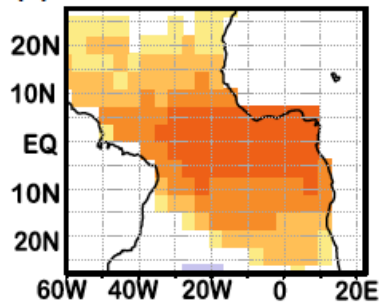
sst JAS 5069



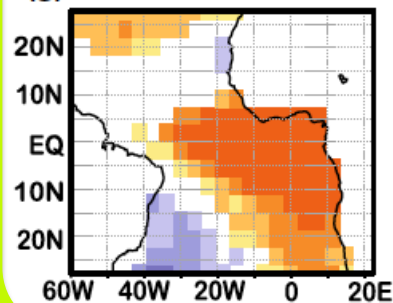
sst JAS 7594



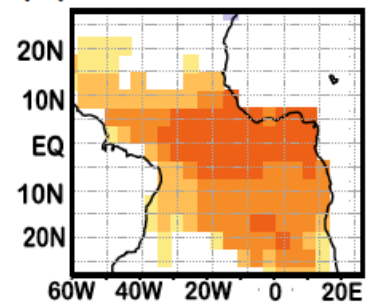
(a) SST JJAS HADISST 1872-1933



(g) SST JJAS HADISST 1934-1969



(m) SST JJAS HADISST 1970-2001



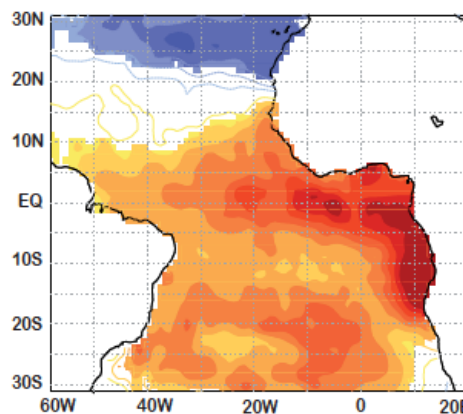
Martín-Rey et al. 2014

Before the 1970s

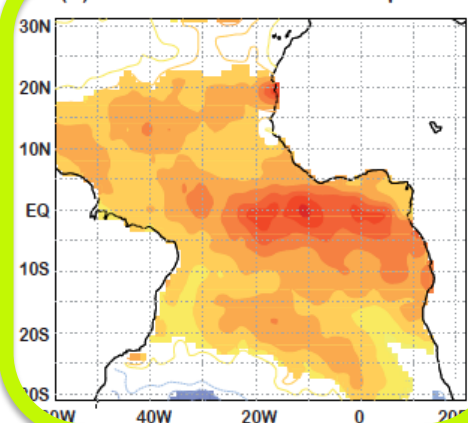
Different Atlantic Niño pattern in positive AMO phase

After the 2000s

(a) EOF1 42.93 % OBS AMO neg



(c) EOF1 34.4 % OBS AMO pos



Martín-Rey et al. 2016a

Losada and Rodríguez-Fonseca 2015

Role of the mean state (GW, AMO, IPO)!!!