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Barcelona Supercomputing Center
Centro Nacional de Supercomputación

EXCELENCIA SEVERO OCHOA

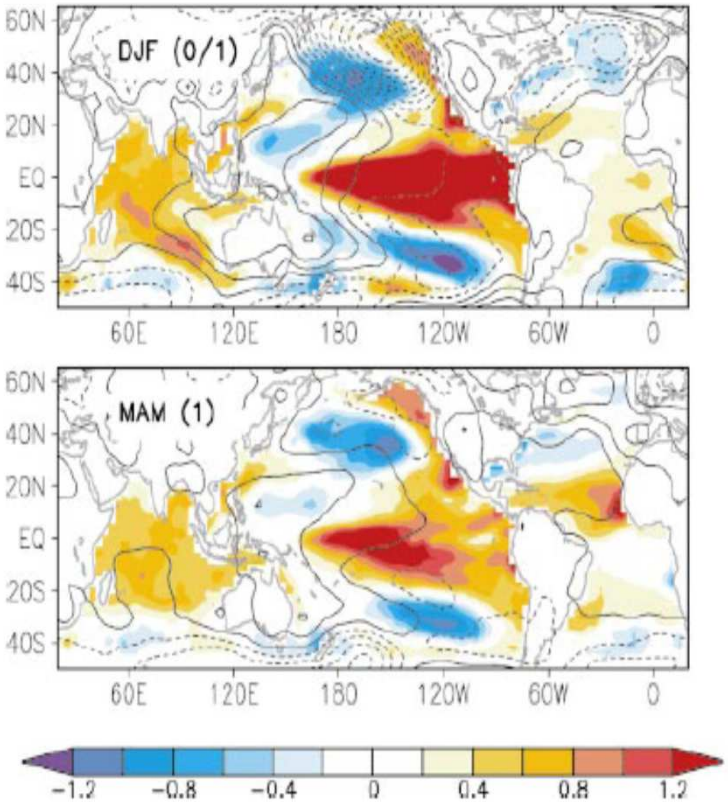
"DPETNA"

Dynamics and **P**redictability of the **E**NSO teleconnection to the **T**ropical **N**orth **A**tlantic

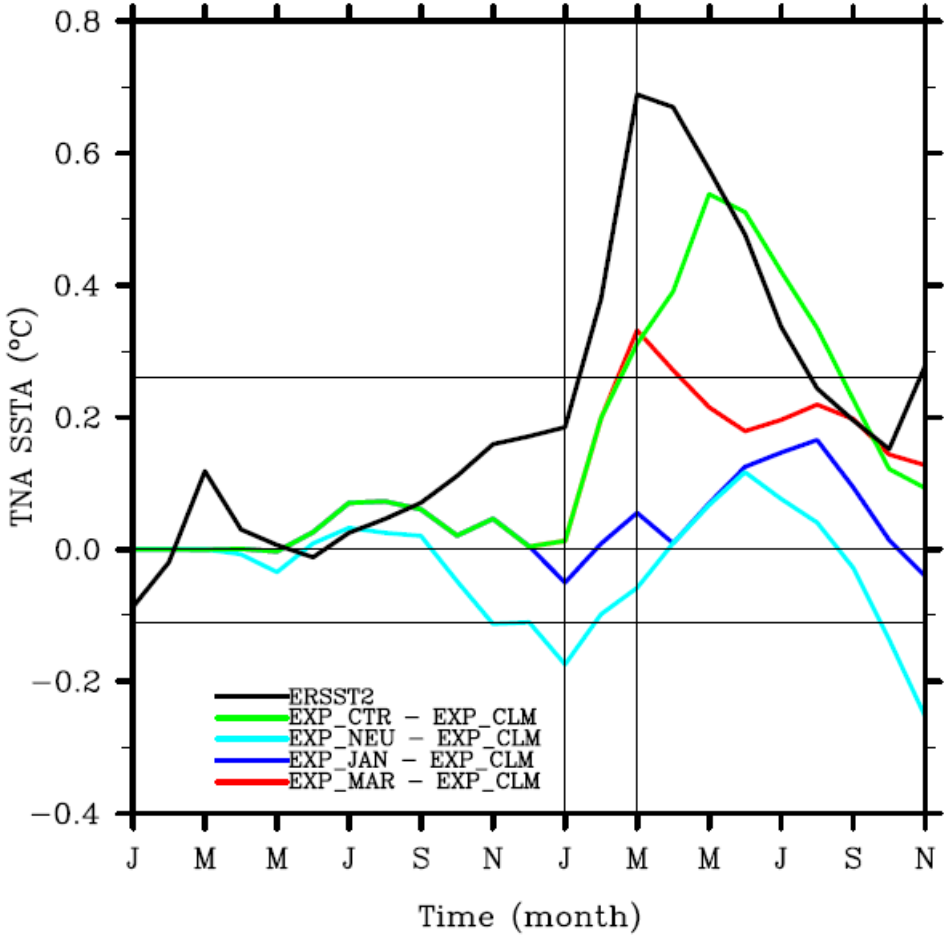
MSCA-IF-EF 655339

Revisiting the ENSO teleconnection to the tropical North Atlantic: observations and CNRM-CM5 simulations

ENSO-TNA teleconnection

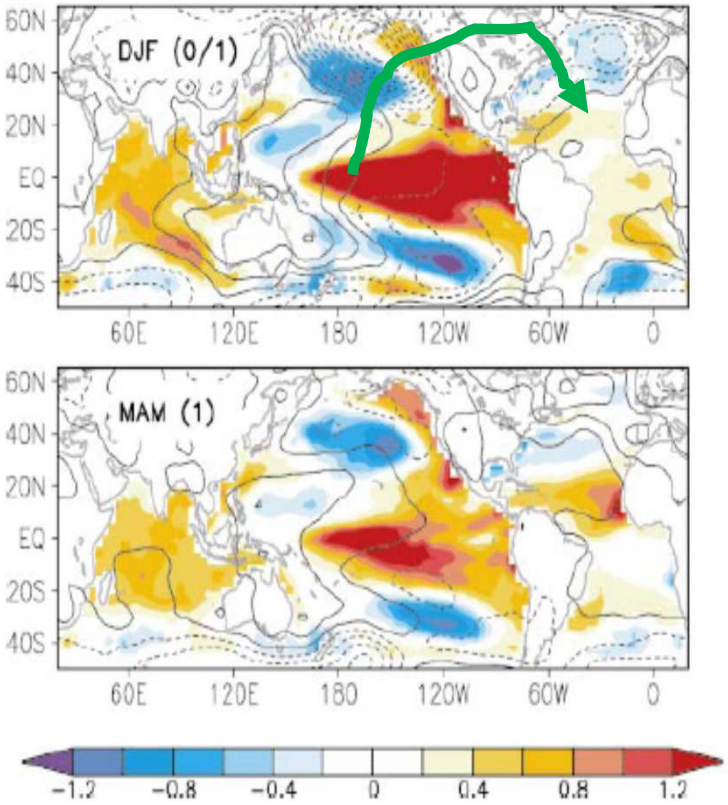


Alexander et al. (2002 JCLIM)



Lee et al. (2008 GRL)

ENSO-TNA teleconnection



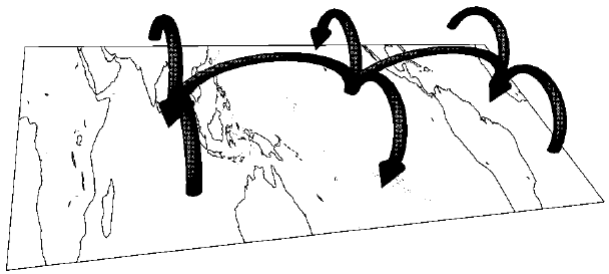
Alexander et al. (2002 JCLIM)

surface processes (AGCM-ML model ok!): weakened trades -> reduced evaporation -> positive SST [*WES feedback*]

- extratropical wavetrain, weakening trades

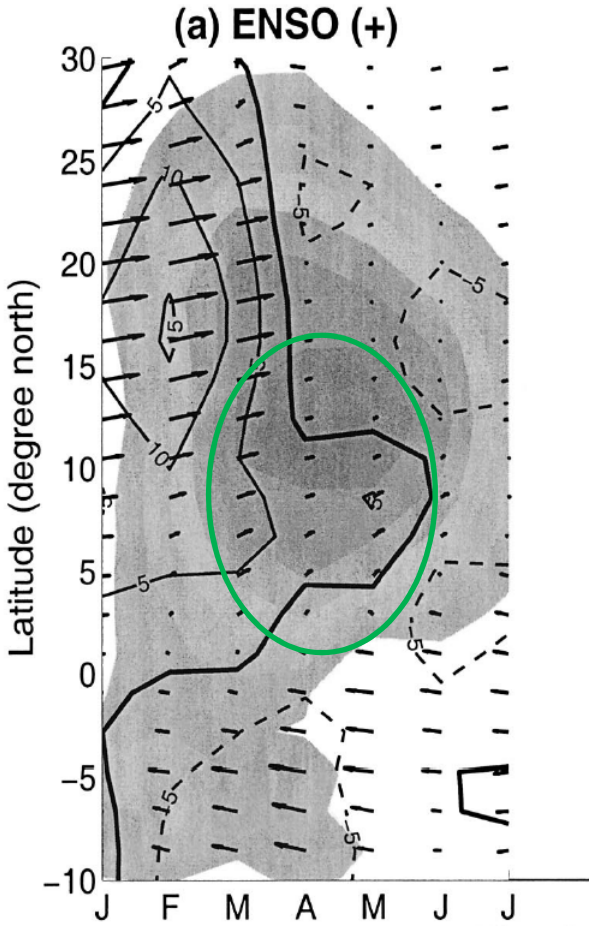
  e.g. Enfield and Mayer (1997 JGR)

- atmospheric bridge, weakening trades



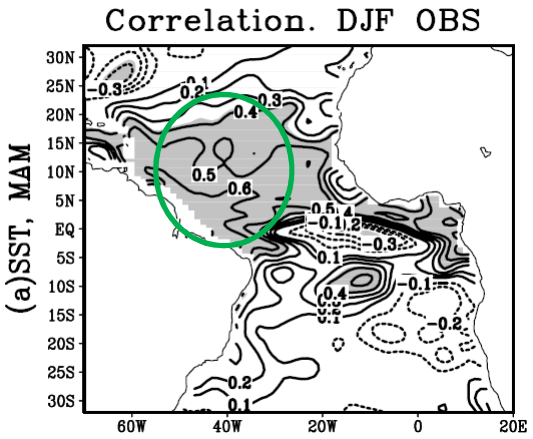
e.g. Klein et al. (1999 JCLIM)

ENSO-TNA teleconnection

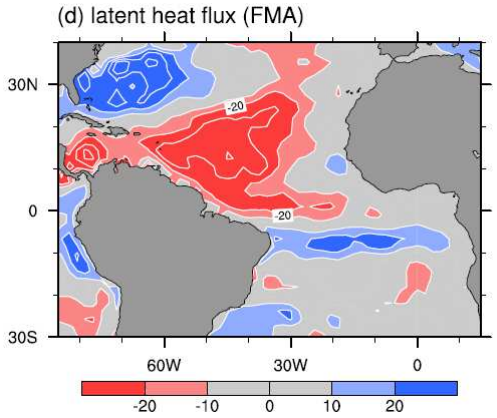


Czaja et al. (2002 JCLIM)

most significant ENSO impact: **deep TNA** (5ºN to 15ºN); **central part of TNA**



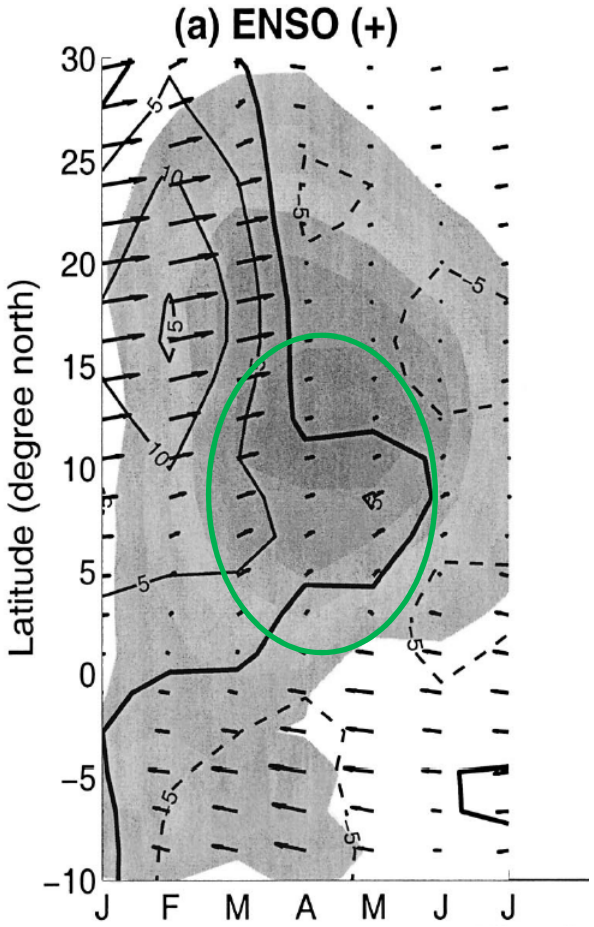
Huang et al. (2002 GRL)



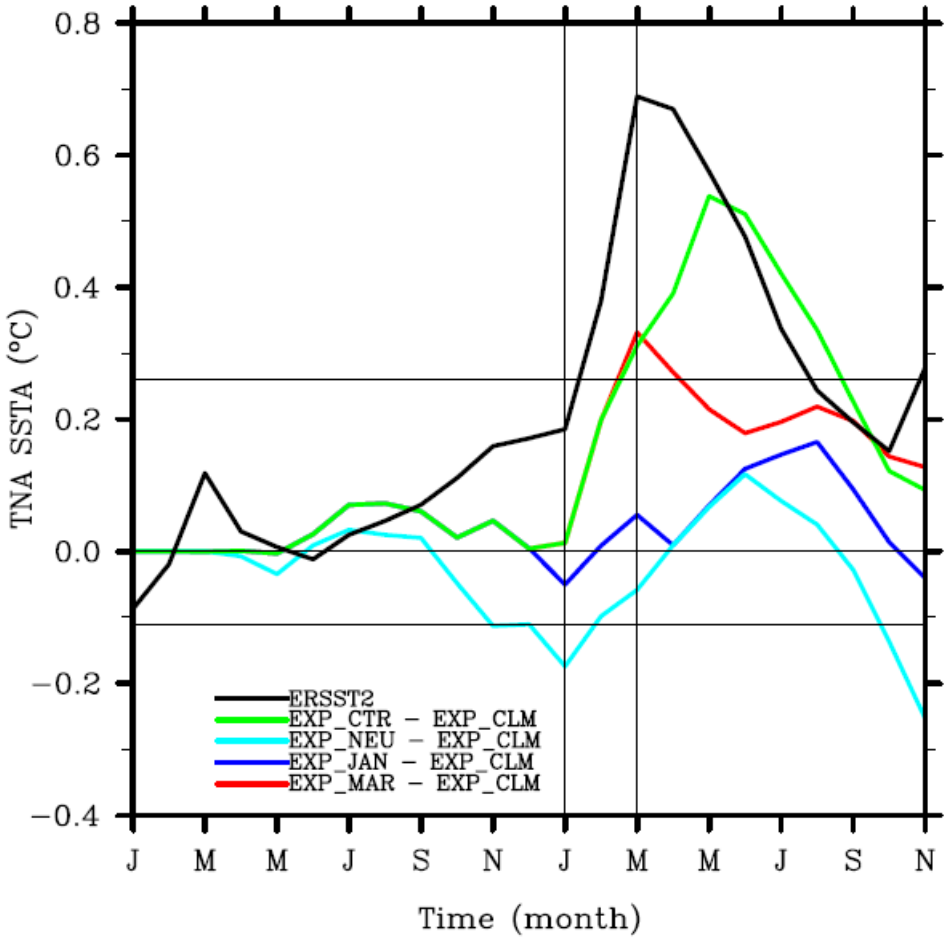
Chikamoto and Tanimoto (2006 GRL)

ENSO-TNA teleconnection

only **persisting ENSO events** impact TNA-SST



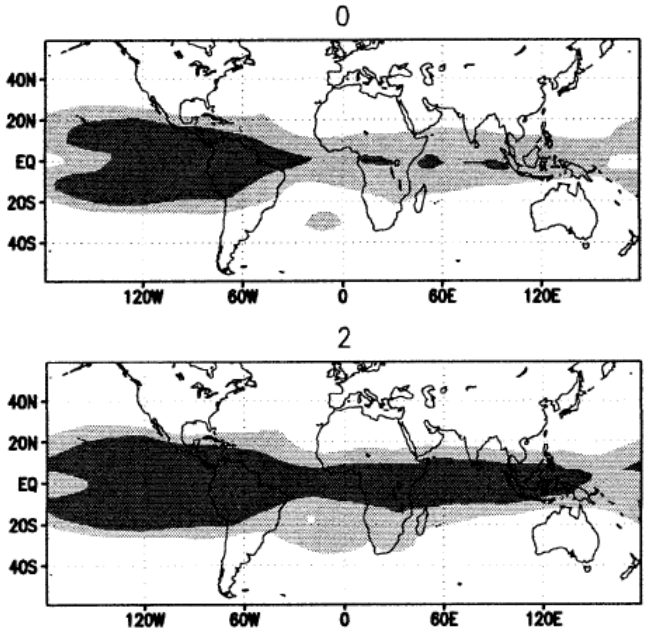
Czaja et al. (2002 JCLIM)



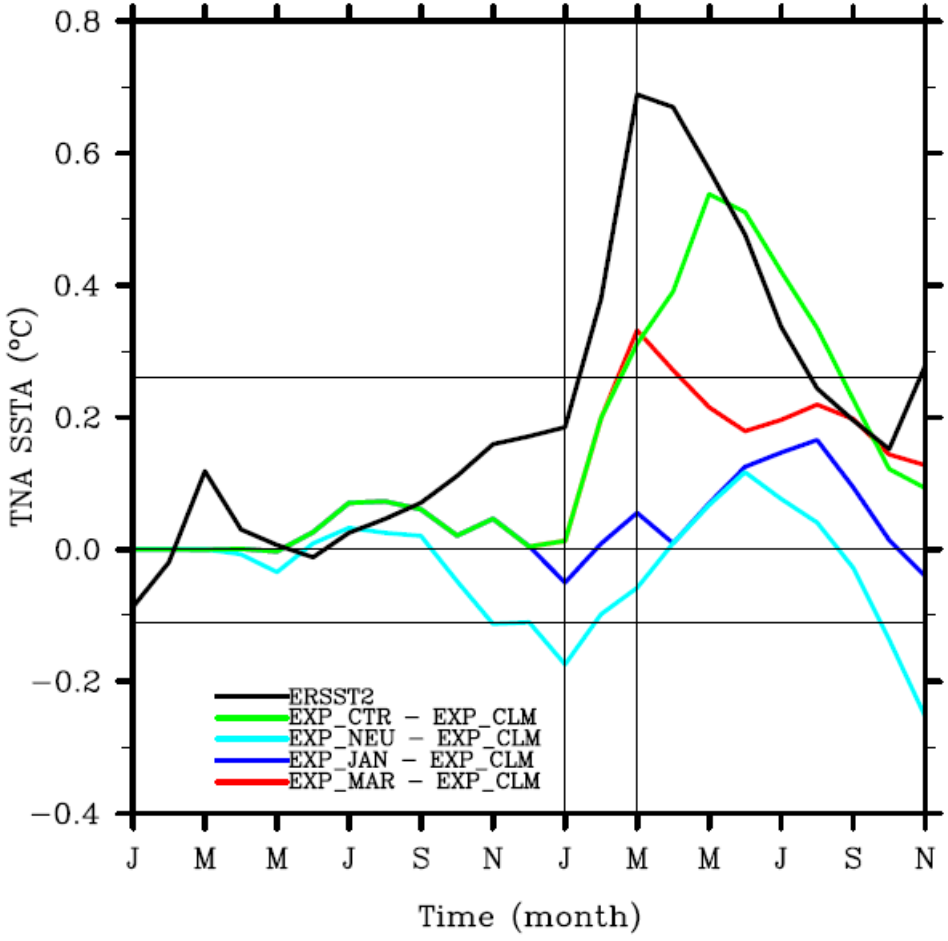
Lee et al. (2008 GRL)

ENSO-TNA teleconnection only **persisting ENSO events** impact TNA-SST

- tropospheric temperature mechanism, no weakening trades but stability/moist convection processes

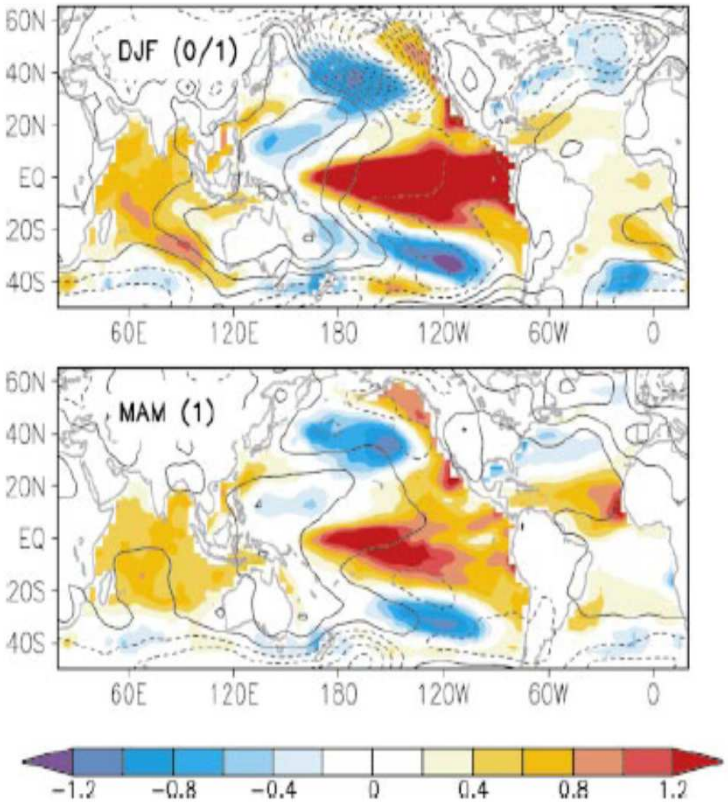


Chiang and Sobel (2002 JCLIM)
Chiang and Lintner (2005 JCLIM)



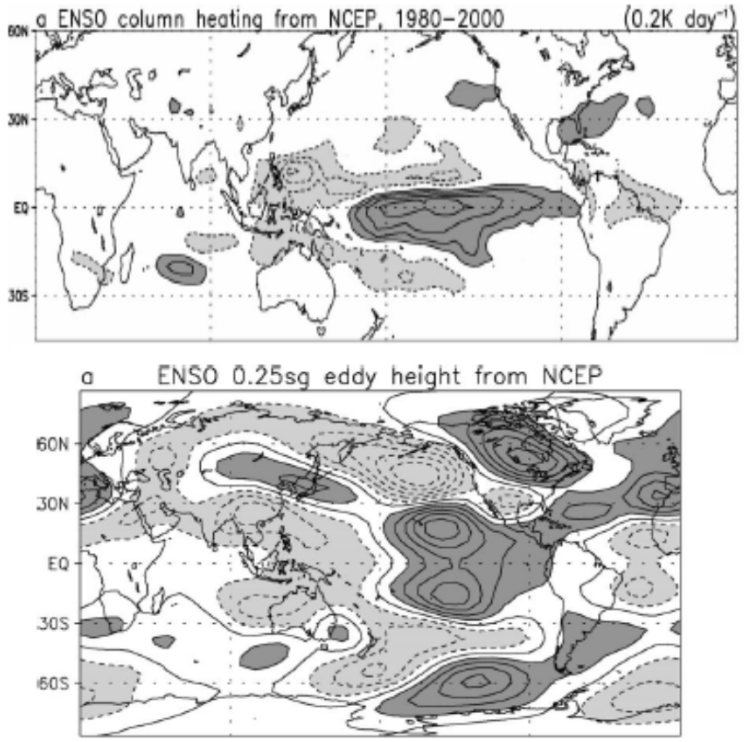
Lee et al. (2008 GRL)

ENSO-TNA teleconnection



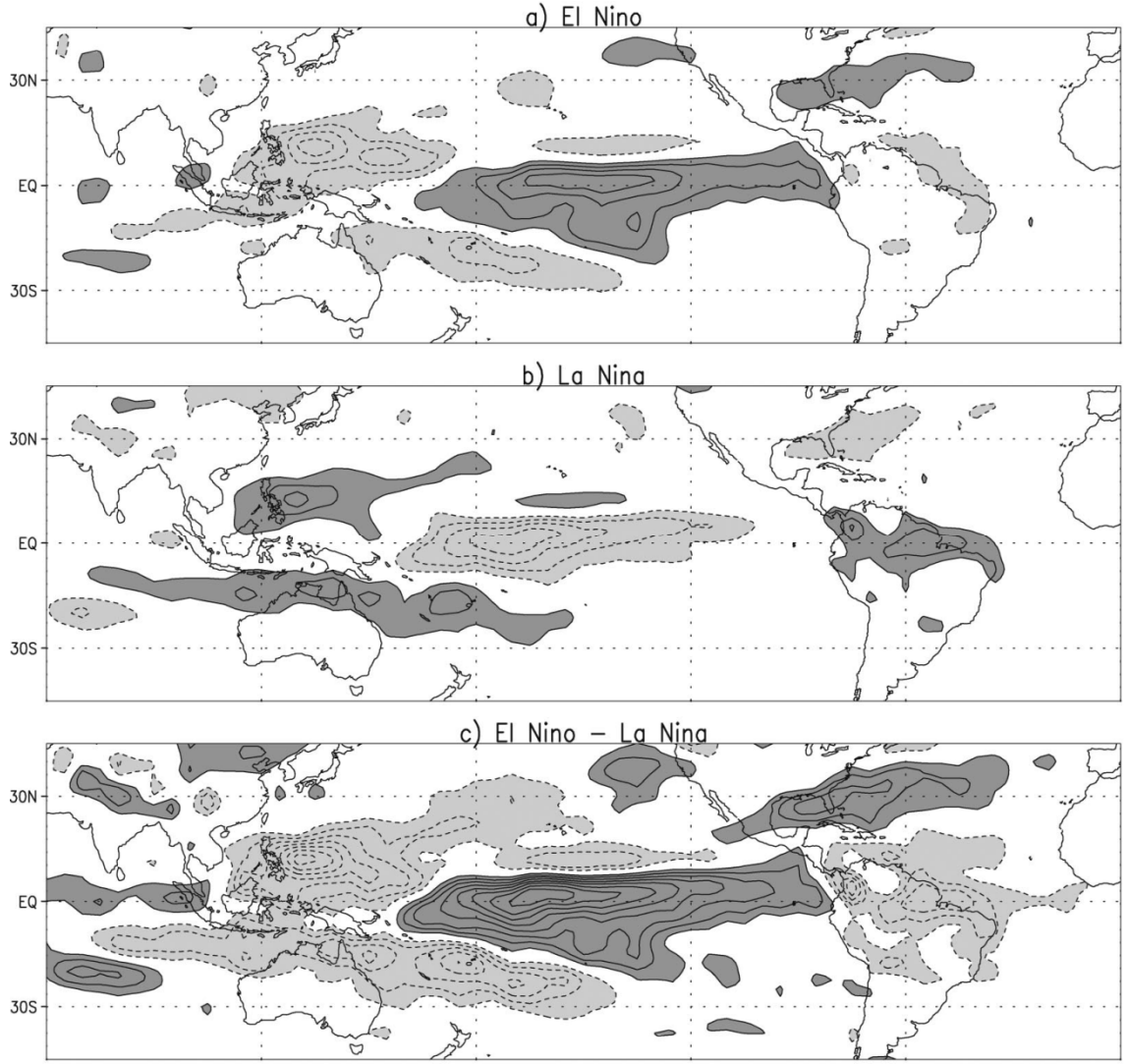
Alexander et al. (2002 JCLIM)

- **4th potential mechanism**: remote Gill-type response in the tropical Atlantic, which is baroclinic with height, whereby modulating the strength of the trade winds

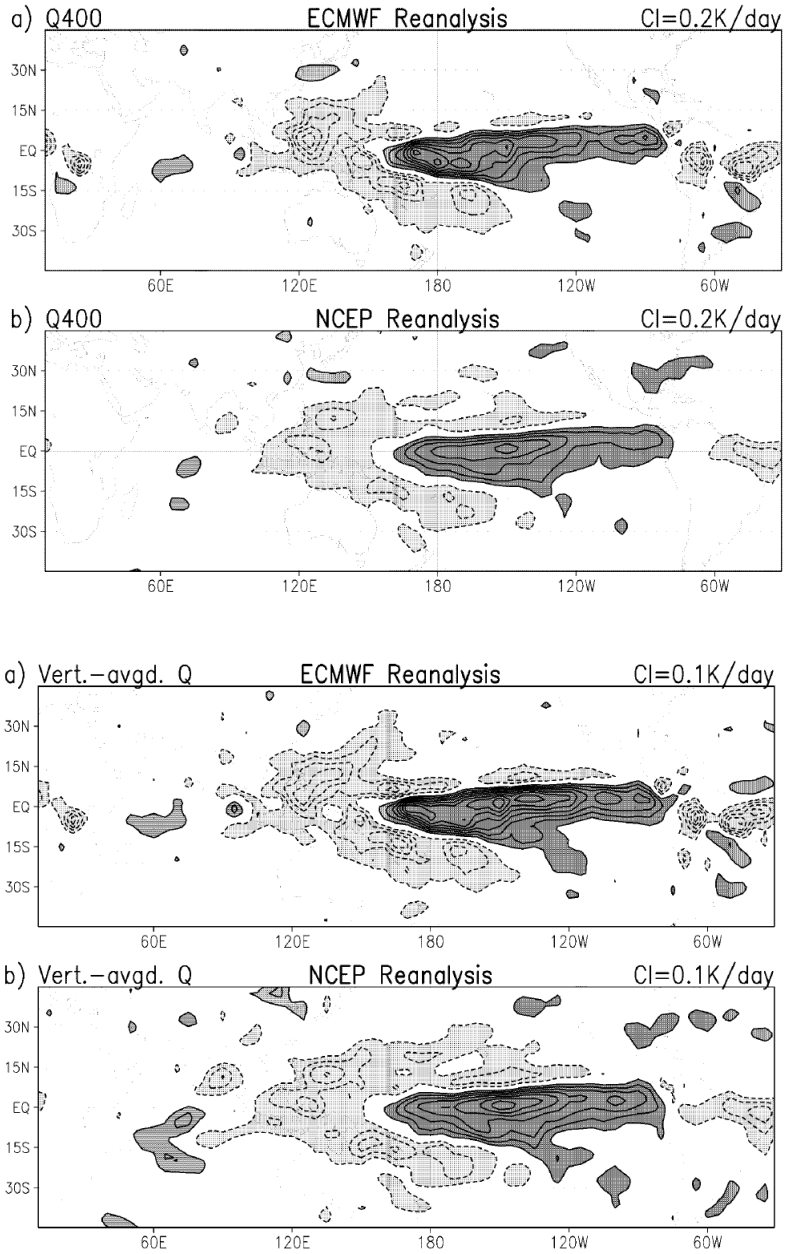


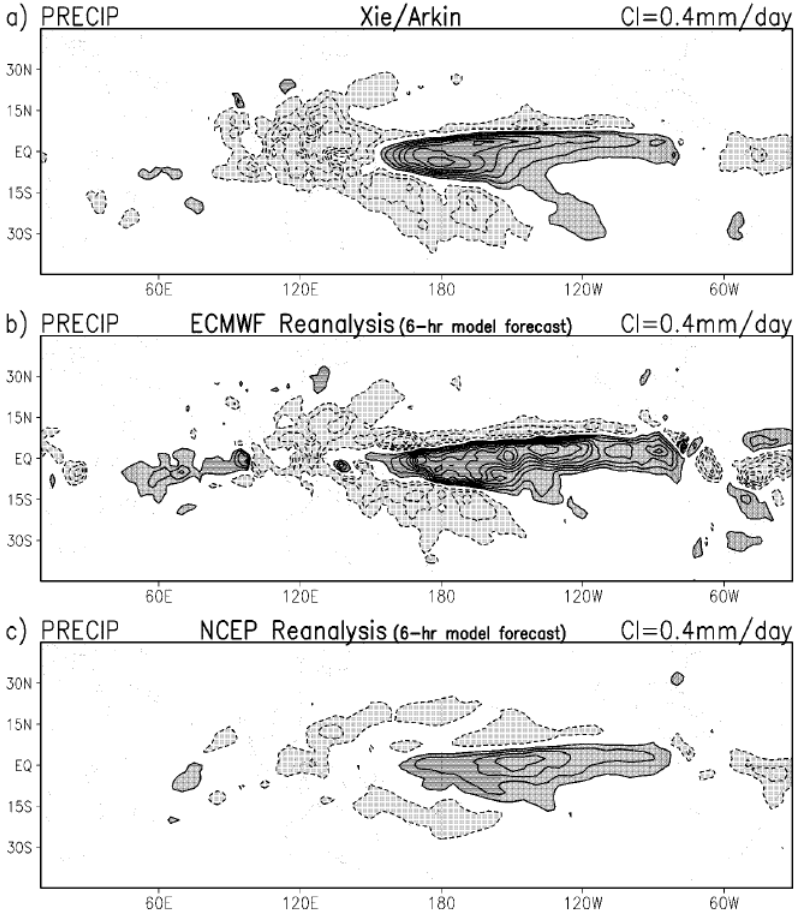
DeWeaver and Nigam (2002, 2004 JCLIM)

FIG. 7. Mass-weighted vertical average of residually diagnosed diabatic heating anomalies



DeWeaver and Nigam (2002 JCLIM)





Nigam et al. (2000 JCLIM)

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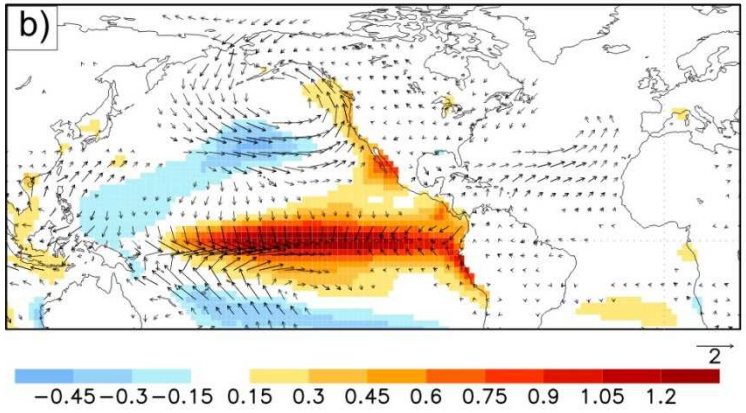
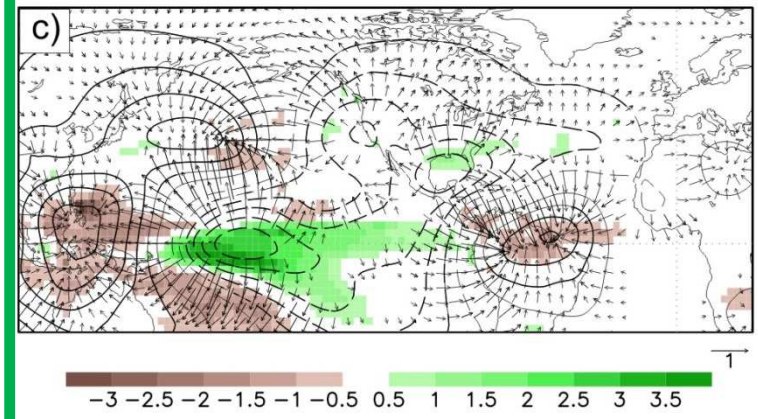
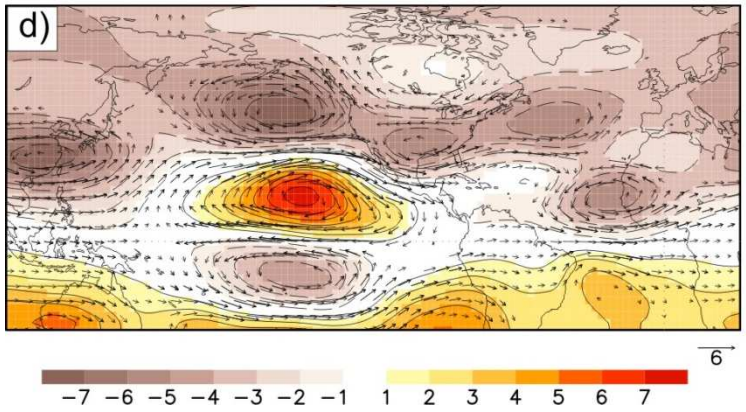
Niño3.4 (djf) x SST/wind-10m (djf)



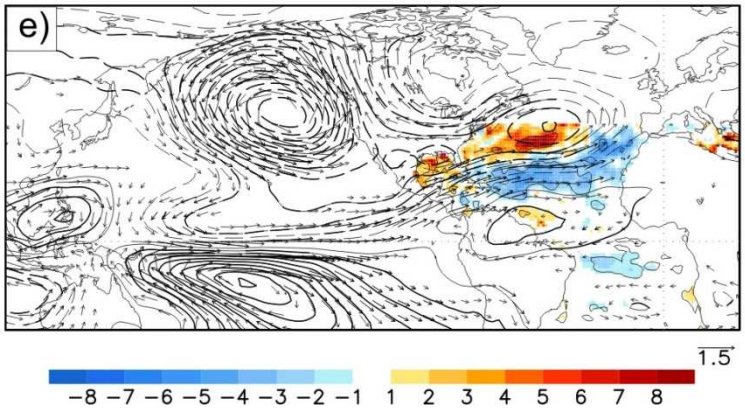
Niño3.4 (djf) x GPCP/divergent-0.21 (djf)



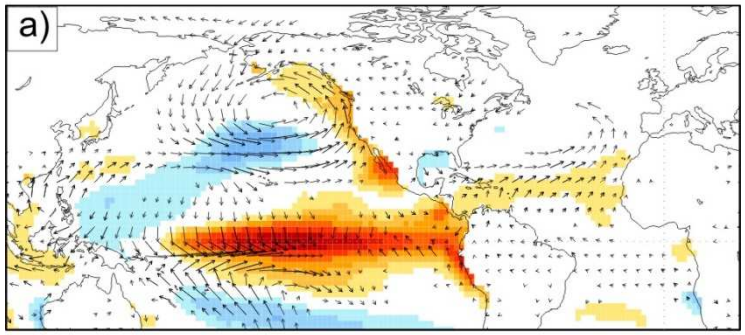
Niño3.4 (djf) x rotational-0.21 (djf)



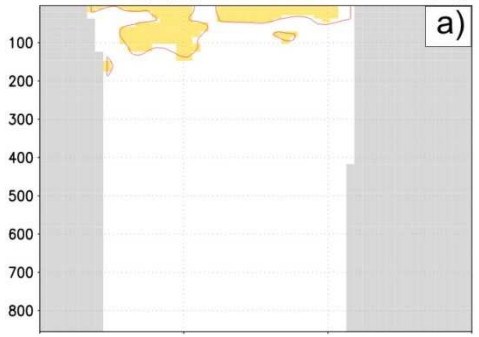
Niño3.4 (djf) x MLD/rot.-0.85 (djf)



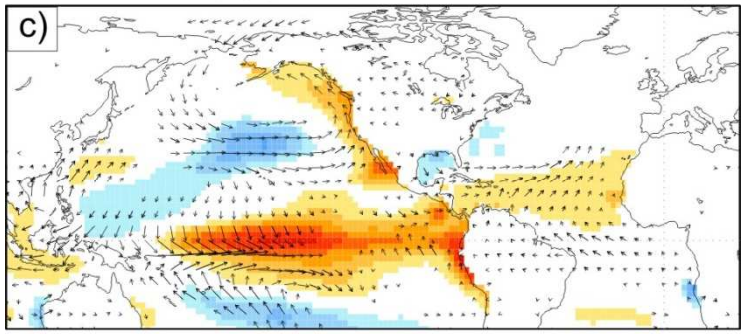
Niño3.4 (djf) x SST/wind-10m (jfm)



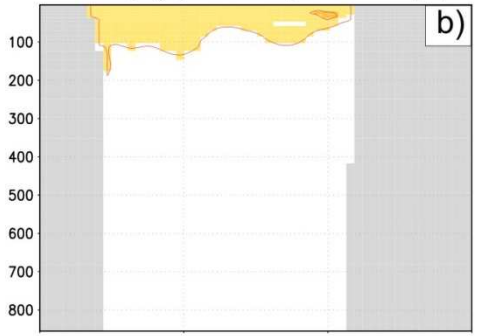
Niño3.4 (djf) x OT[5N25N] (jfm)



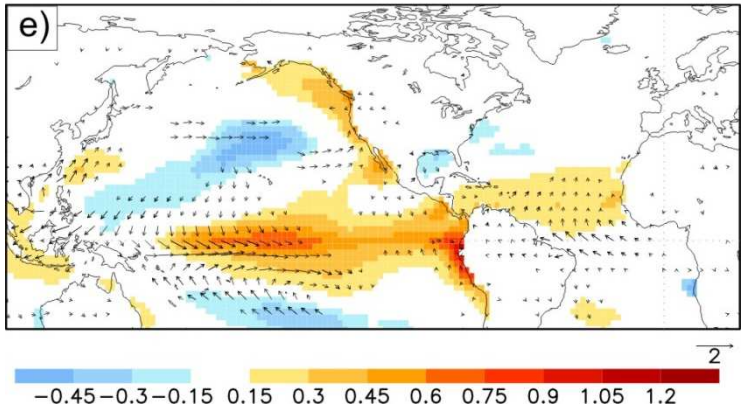
Niño3.4 (djf) x SST/wind-10m (fma)



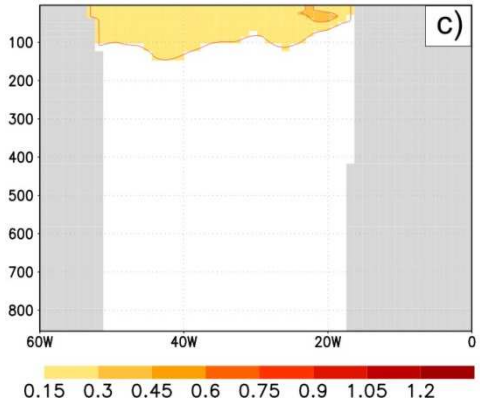
Niño3.4 (djf) x OT[5N25N] (fma)



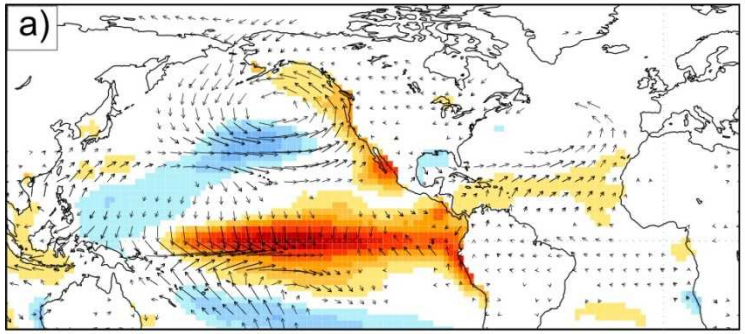
Niño3.4 (djf) x SST/wind-10m (mam)



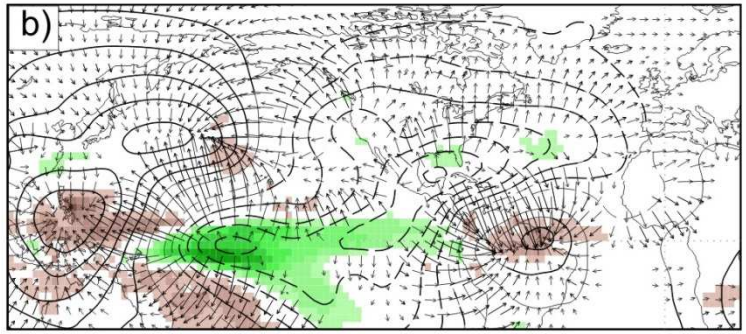
Niño3.4 (djf) x OT[5N25N] (mam)



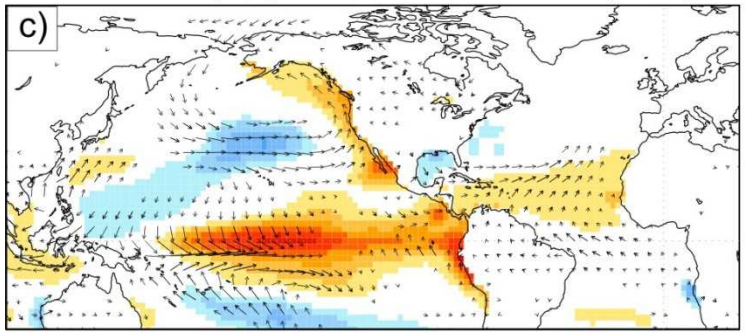
Niño3.4 (djf) x SST/wind-10m (jfm)



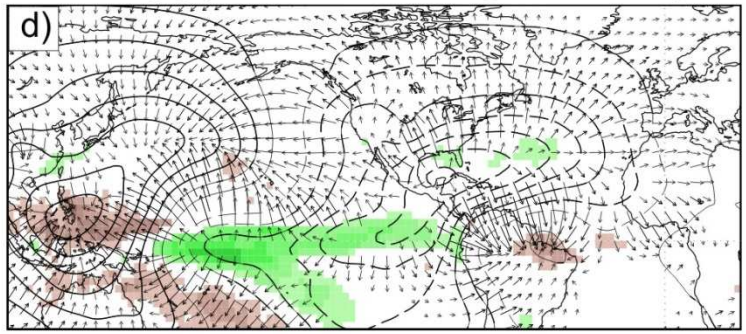
Niño3.4 (djf) x GPCP/divergent-0.21 (jfm)



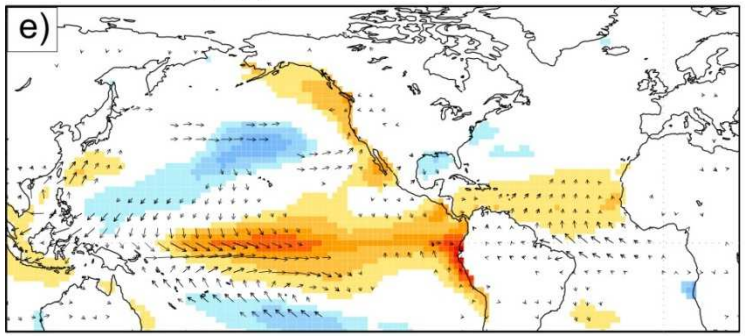
Niño3.4 (djf) x SST/wind-10m (fma)



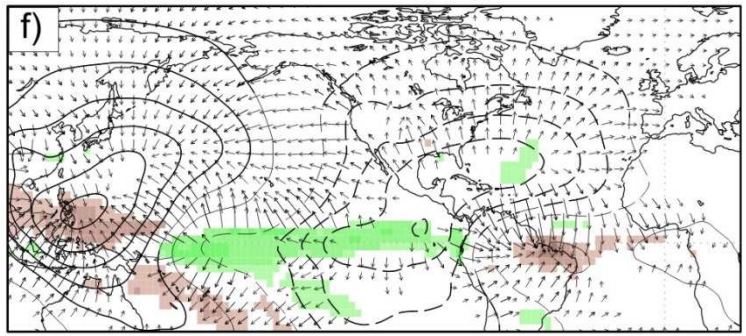
Niño3.4 (djf) x GPCP/divergent-0.21 (fma)



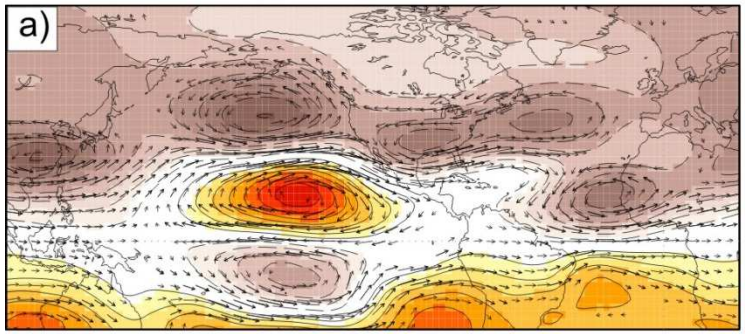
Niño3.4 (djf) x SST/wind-10m (mam)



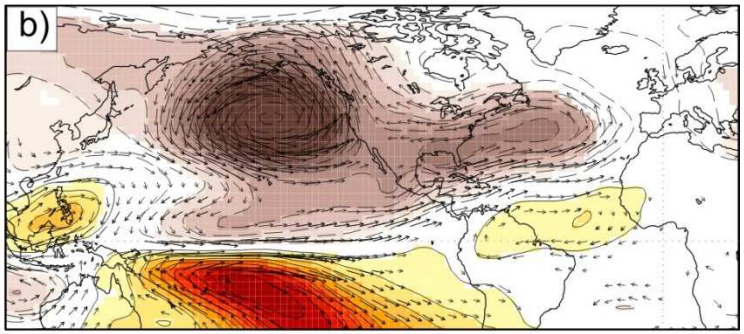
Niño3.4 (djf) x GPCP/divergent-0.21 (mam)



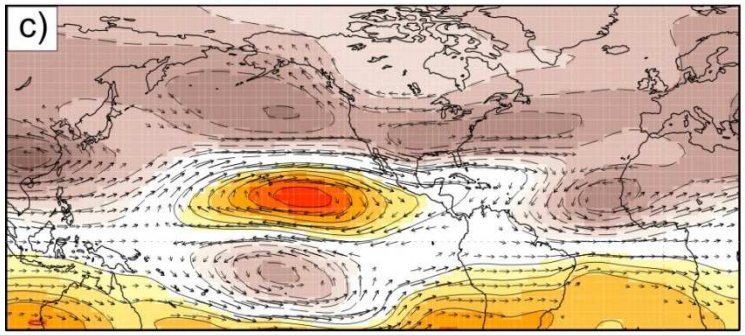
Niño3.4 (djf) x rotational-0.21 (jfm)



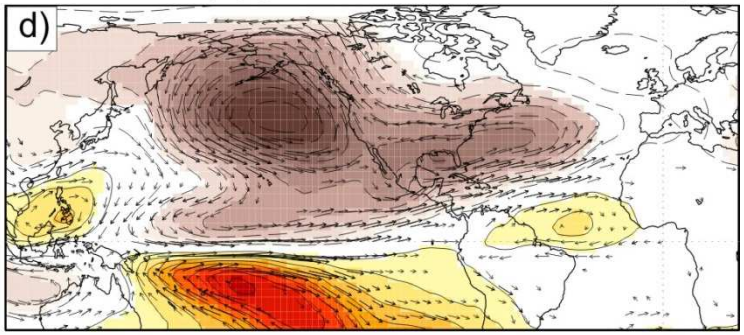
Niño3.4 (djf) x rotational-0.85 (jfm)



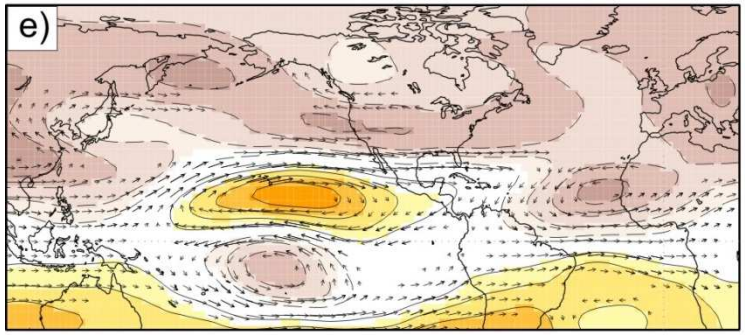
Niño3.4 (djf) x rotational-0.21 (fma)



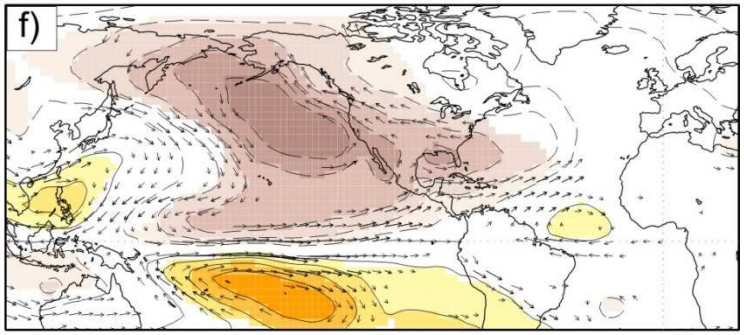
Niño3.4 (djf) x rotational-0.85 (fma)



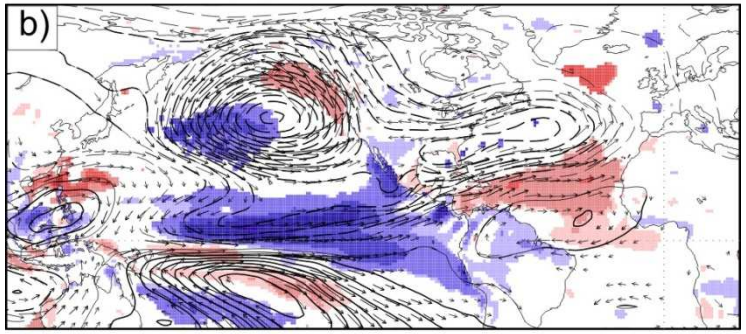
Niño3.4 (djf) x rotational-0.21 (mam)



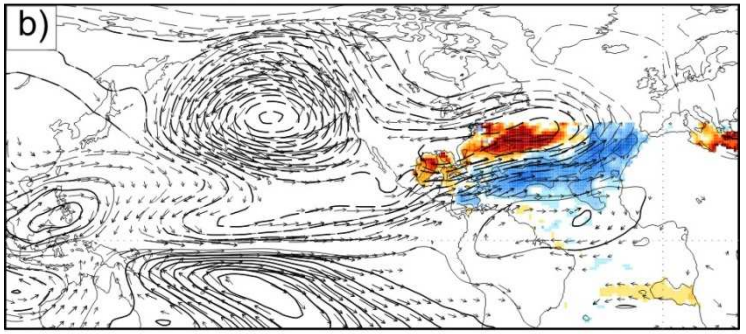
Niño3.4 (djf) x rotational-0.85 (mam)



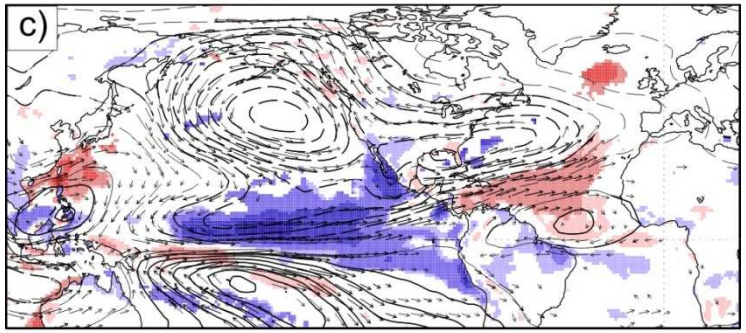
Niño3.4 (djf) x THF/rot.-0.85 (jfm)



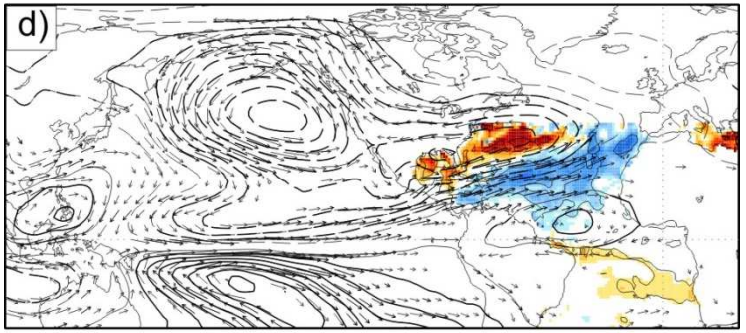
Niño3.4 (djf) x MLD/rot.-0.85 (jfm)



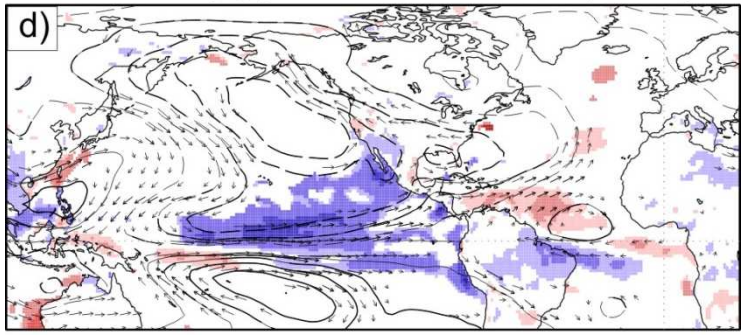
Niño3.4 (djf) x THF/rot.-0.85 (fma)



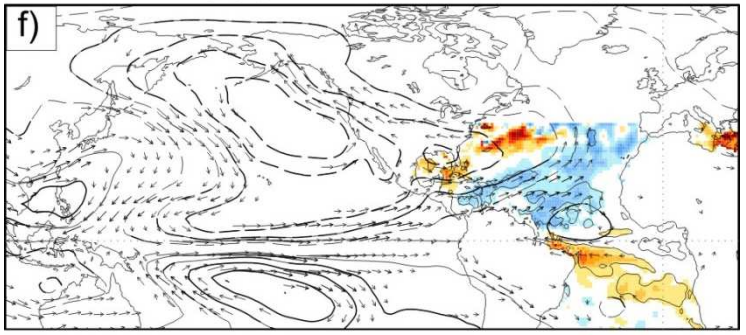
Niño3.4 (djf) x MLD/rot.-0.85 (fma)

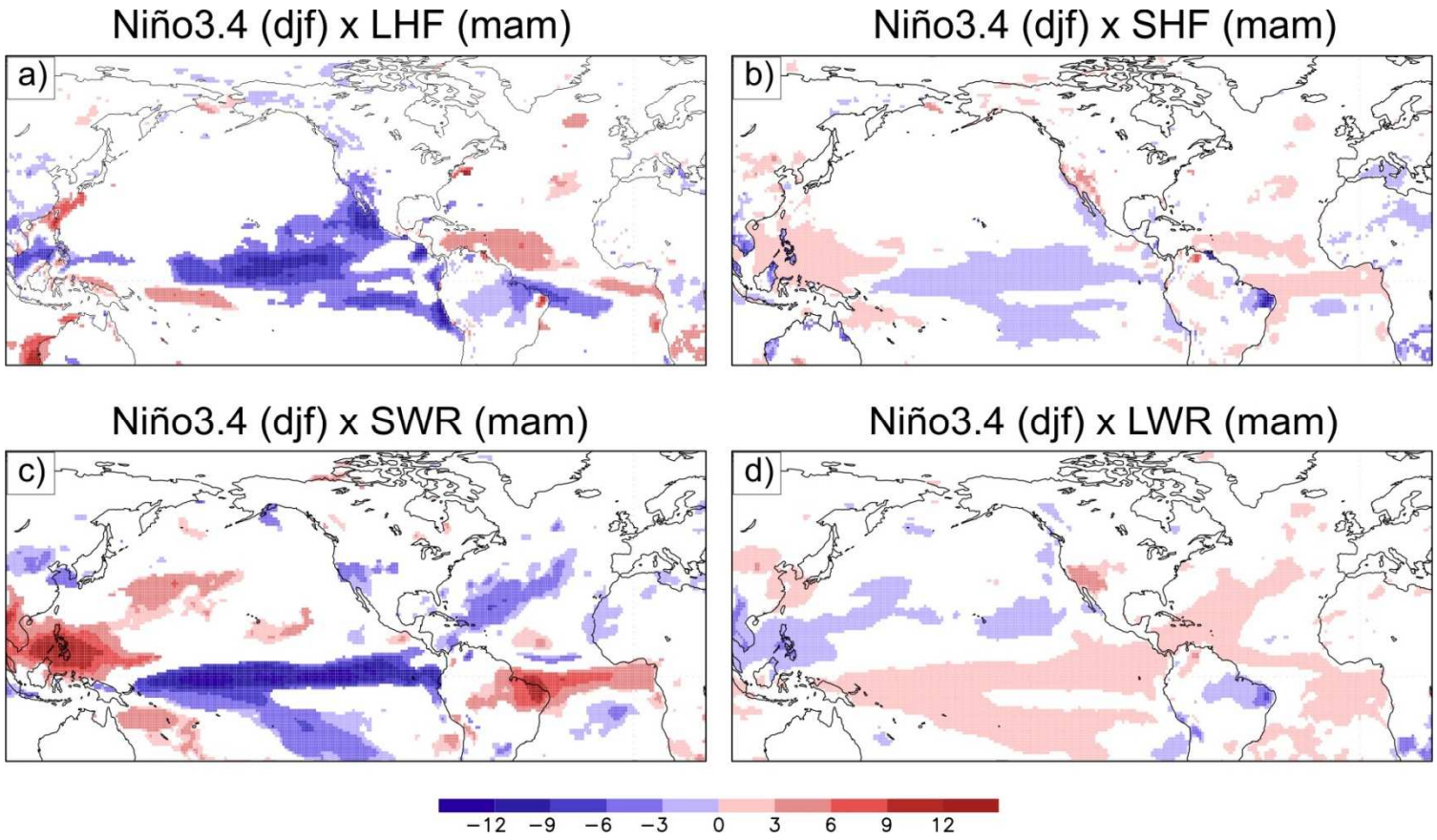


Niño3.4 (djf) x THF/rot.-0.85 (mam)

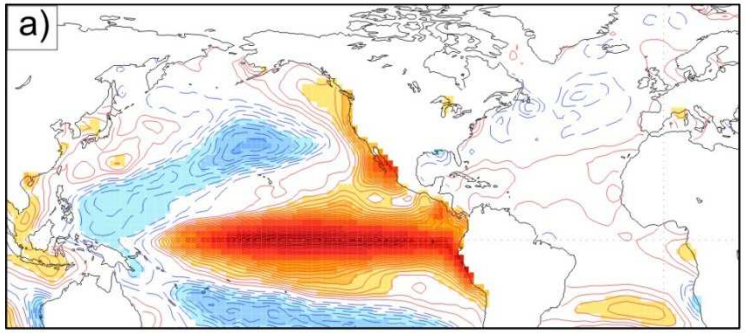


Niño3.4 (djf) x MLD/rot.-0.85 (mam)

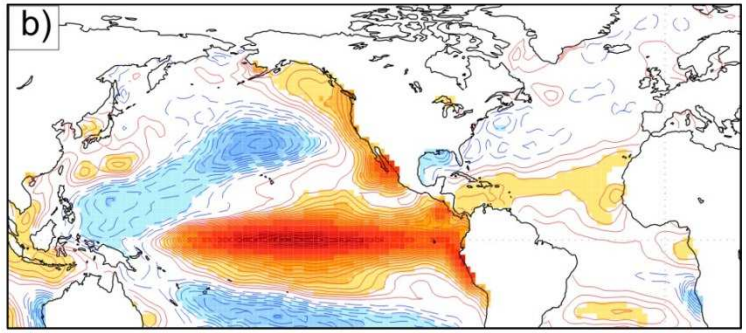



Niño3.4 (djf) x LHF (mam)
a)
Niño3.4 (djf) x SHF (mam)
b)
Niño3.4 (djf) x SWR (mam)
c)
Niño3.4 (djf) x LWR (mam)
d)
−12 −9 −6 −3 0 3 6 9 12

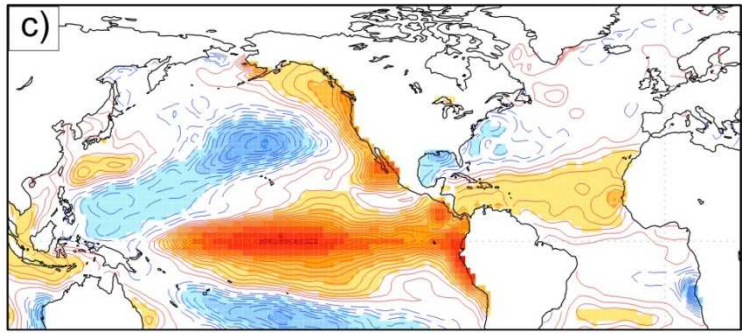
Niño3.4 (djf) x SST (djf)



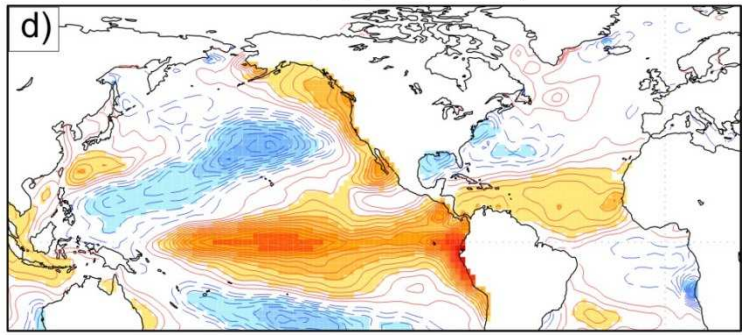
Niño3.4 (djf) x SST (jfm)



Niño3.4 (djf) x SST (fma)



Niño3.4 (djf) x SST (mam)



(i) continuous atmospheric forcing due to the remote Gill-type response

(ii) but, why the remote impact on SSTs is largest in MAM vs DJF ?

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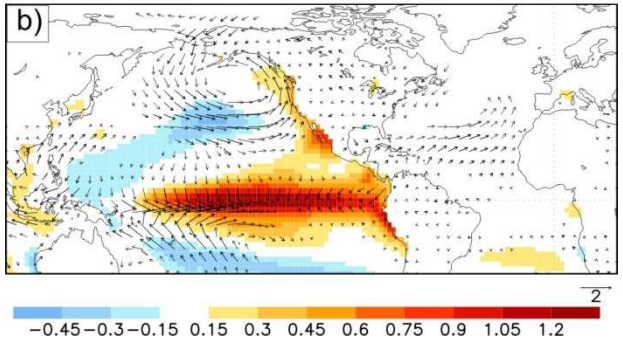
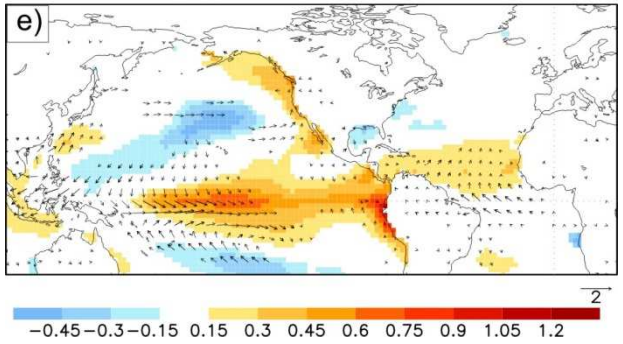
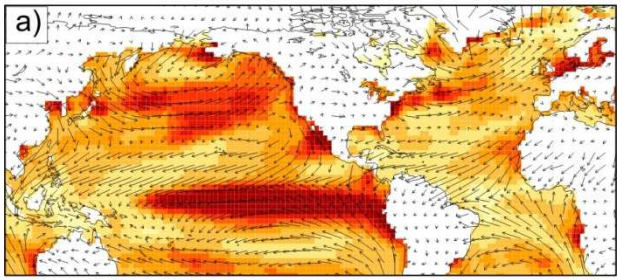
Niño3.4 (djf) x SST/wind-10m (djf)



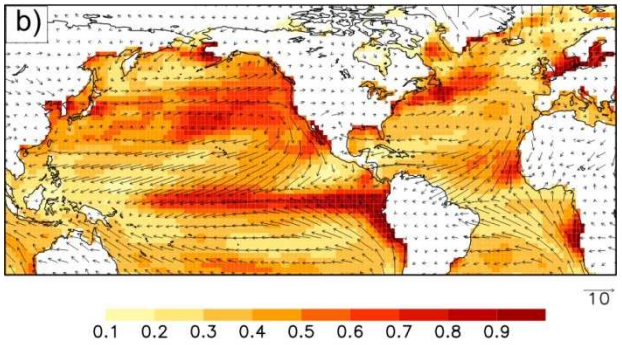
Niño3.4 (djf) x SST/wind-10m (mam)



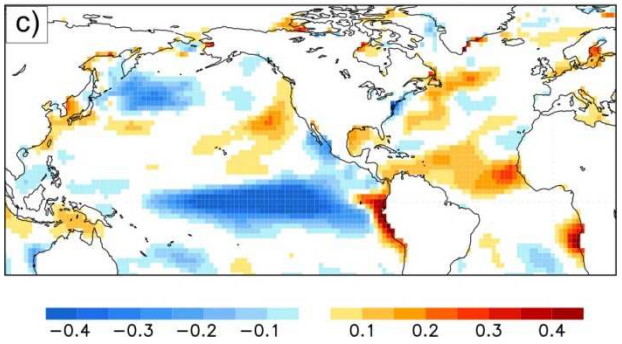
clim wind-10m / stdev SST (djf)



clim wind-10m / stdev SST (mam)

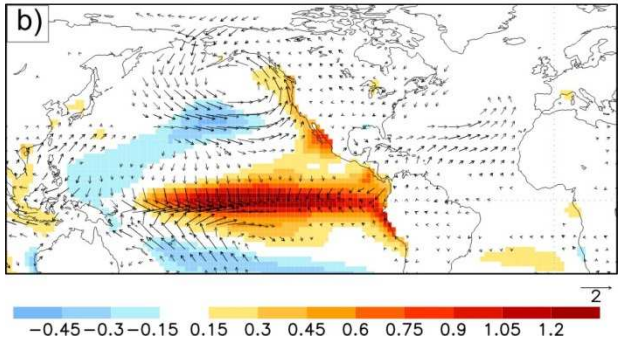


stdev SST (mam-djf)

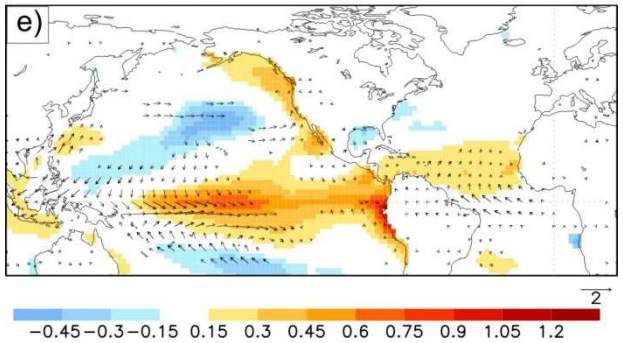


HadISST

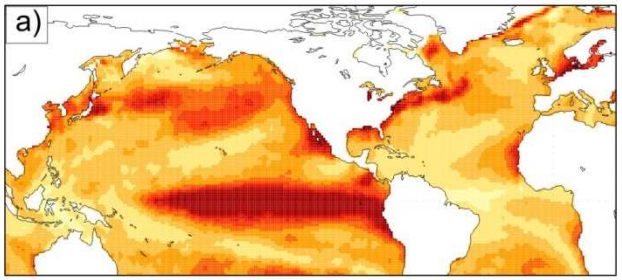
Niño3.4 (djf) x SST/wind-10m (djf)



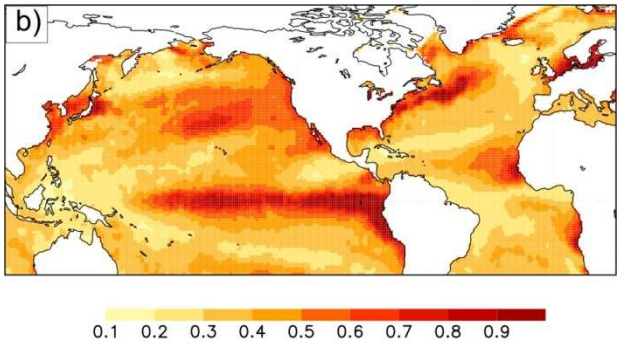
Niño3.4 (djf) x SST/wind-10m (mam)



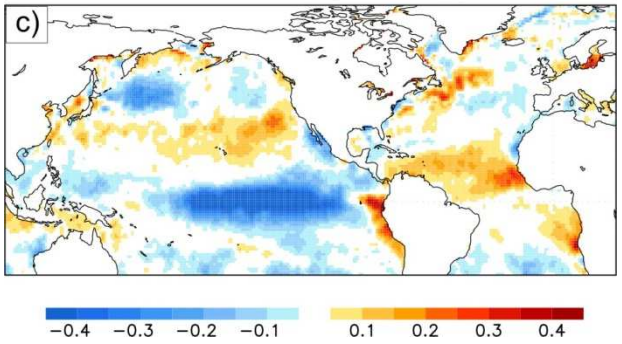
clim wind-10m / stdev SST (djf)



clim wind-10m / stdev SST (mam)

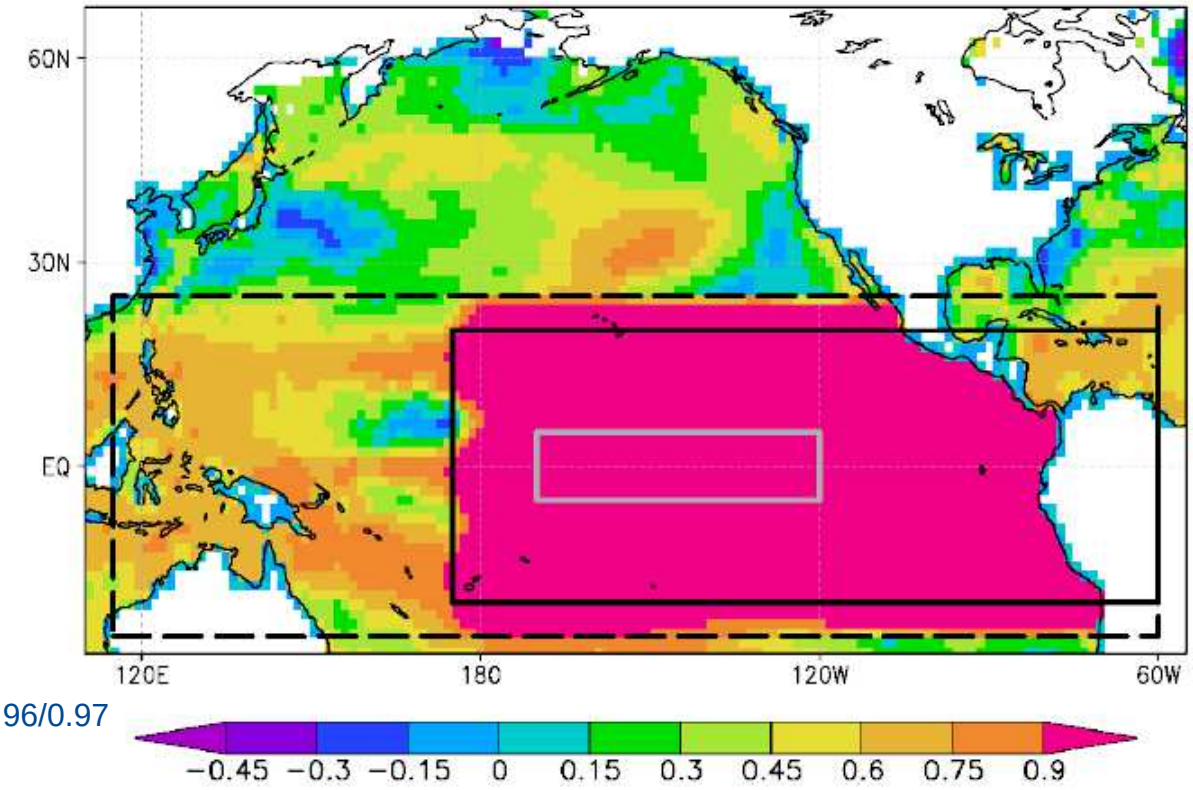


stdev SST (mam-djf)



5-member ensemble sensitivity experiment with CNRM-CM5 prescribing HadISST anomalies over the tropical Pacific (CNRM-NUDG);

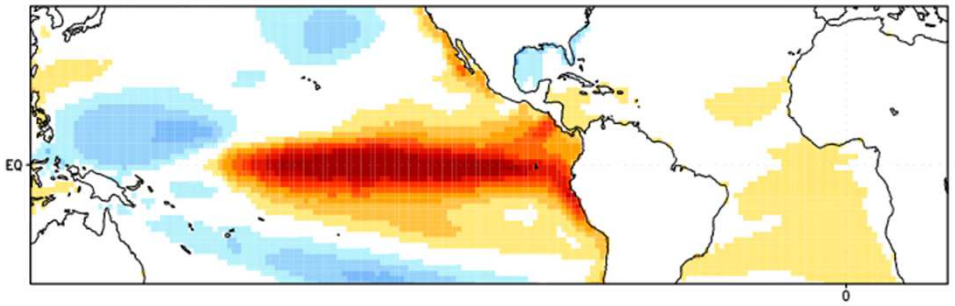
compared to 5 members from the historical+rcp4.5 simulations (CNRM-HIST)



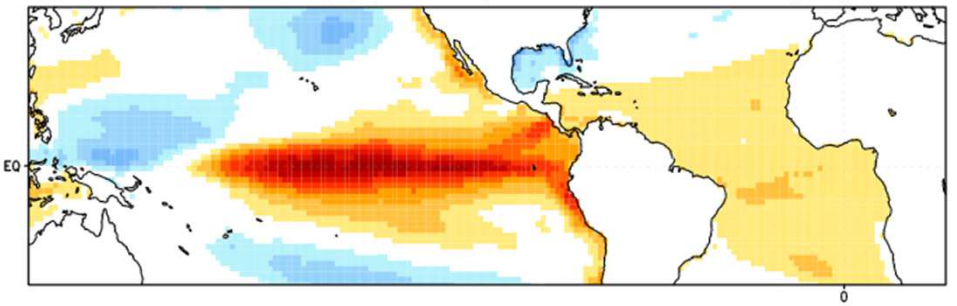
r(Niño3.4, Niño3)=0.96/0.97

Douville et al. (2015 GRL)

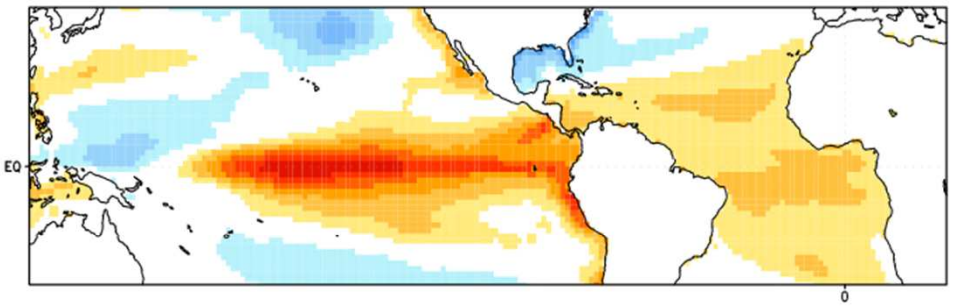
obs–Nino3.4 (djf) x SST/wind CNRM–NUDG (djf)



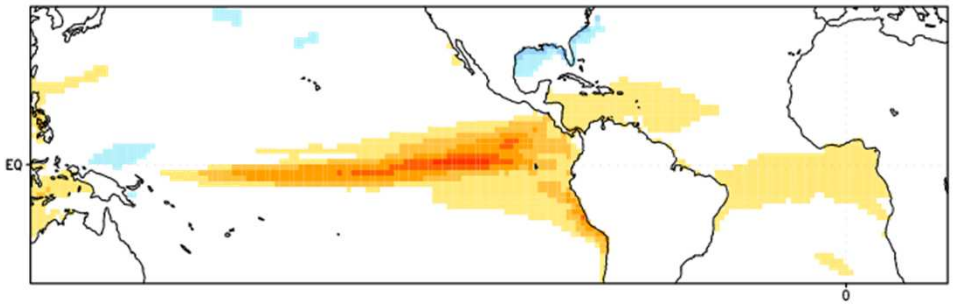
obs–Nino3.4 (djf) x SST/wind CNRM–NUDG (jfm)



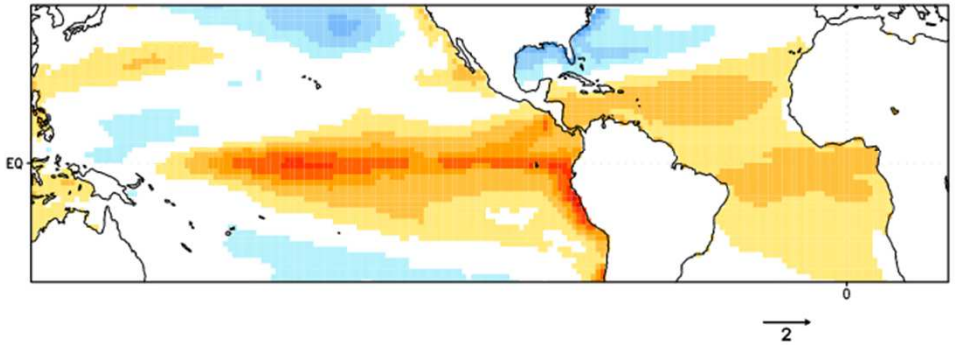
obs–Nino3.4 (djf) x SST/wind CNRM–NUDG (fma)



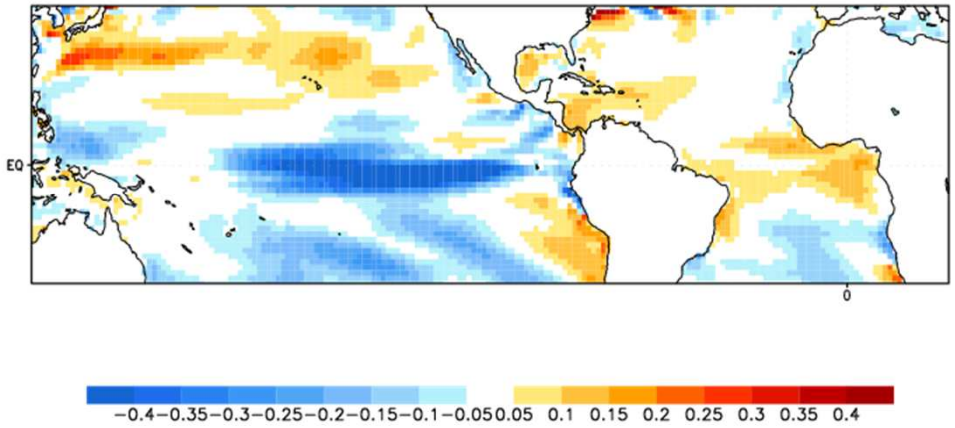
mod–Nino3.4 (djf) x SST CNRM–HIST (mam)



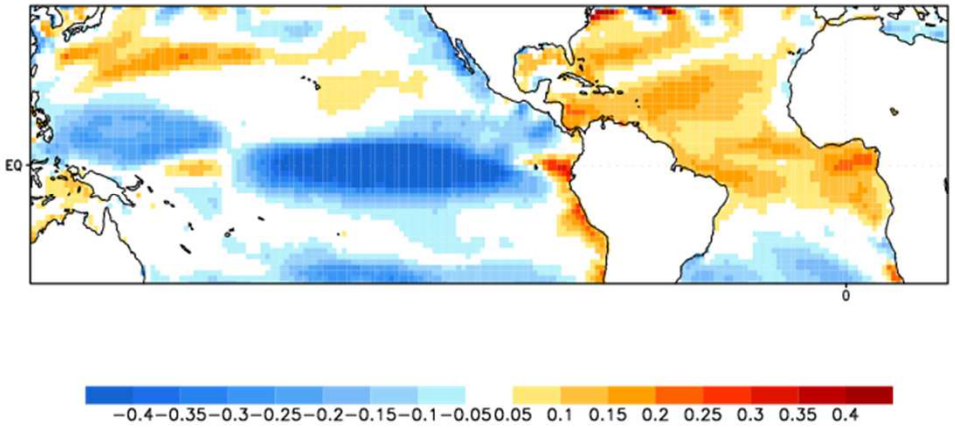
obs–Nino3.4 (djf) x SST/wind CNRM–NUDG (mam)



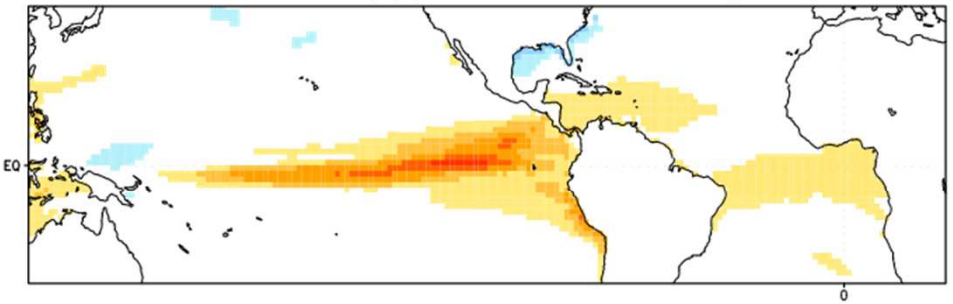
st.dev SST CNRM−HIST (mam−djf)



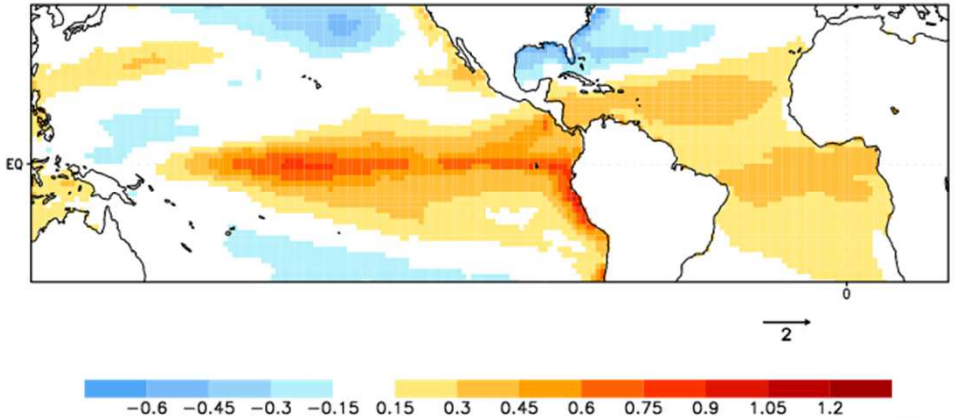
st.dev SST CNRM−NUDG (mam−djf)



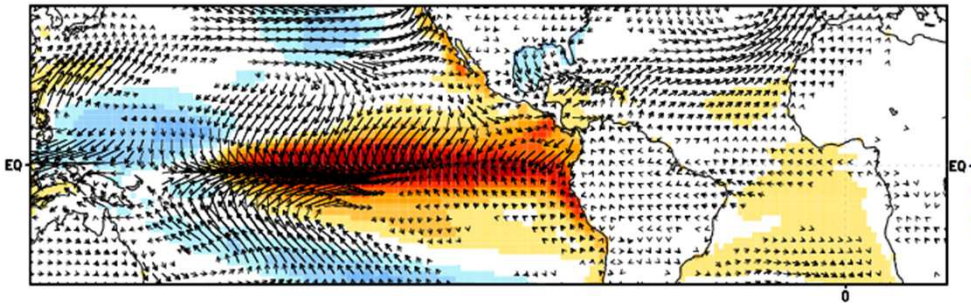
mod−Nino3.4 (djf) x SST CNRM−HIST (mam)



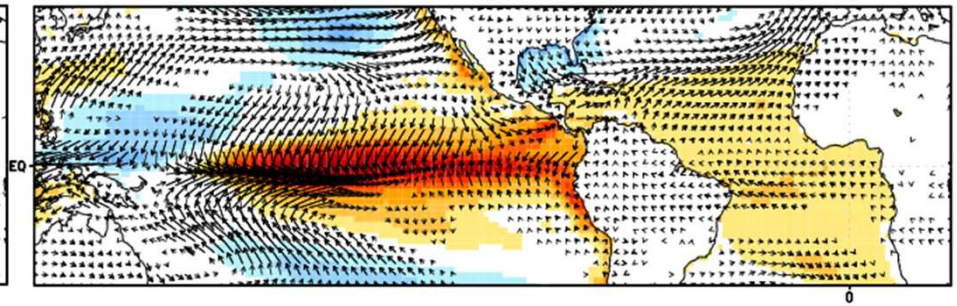
obs−Nino3.4 (djf) x SST/wind CNRM−NUDG (mam)



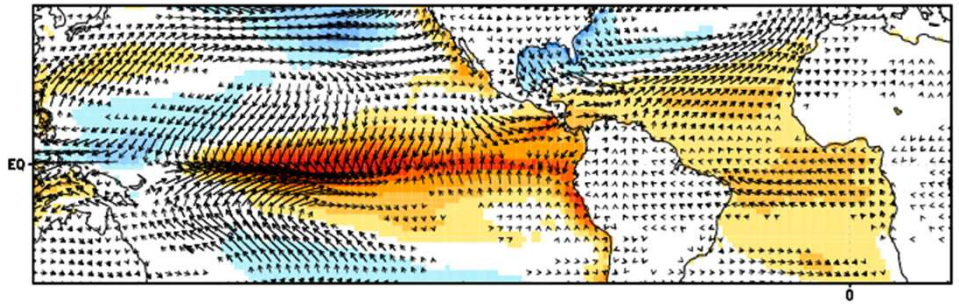
obs–Nino3.4 (djf) x SST/wind CNRM–NUDG (djf)



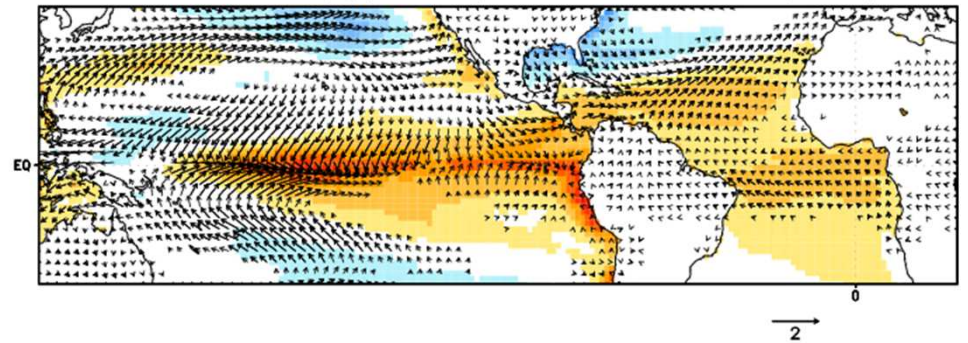
obs–Nino3.4 (djf) x SST/wind CNRM–NUDG (jfm)



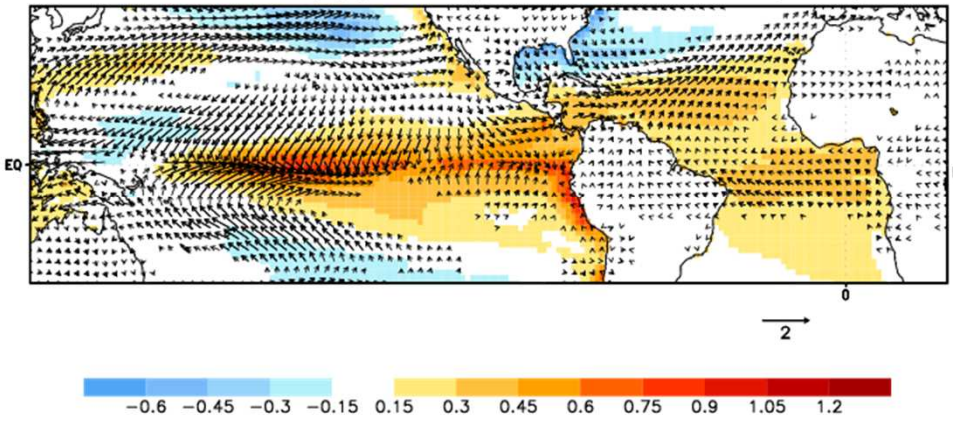
obs–Nino3.4 (djf) x SST/wind CNRM–NUDG (fma)



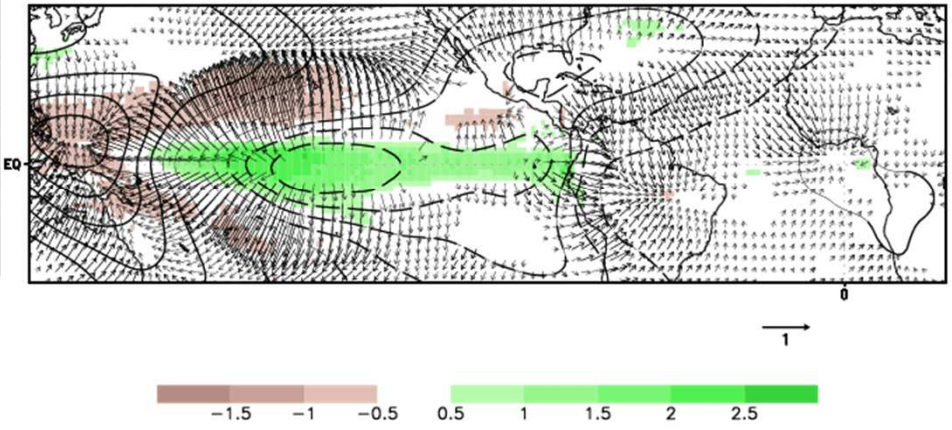
obs–Nino3.4 (djf) x SST/wind CNRM–NUDG (mam)



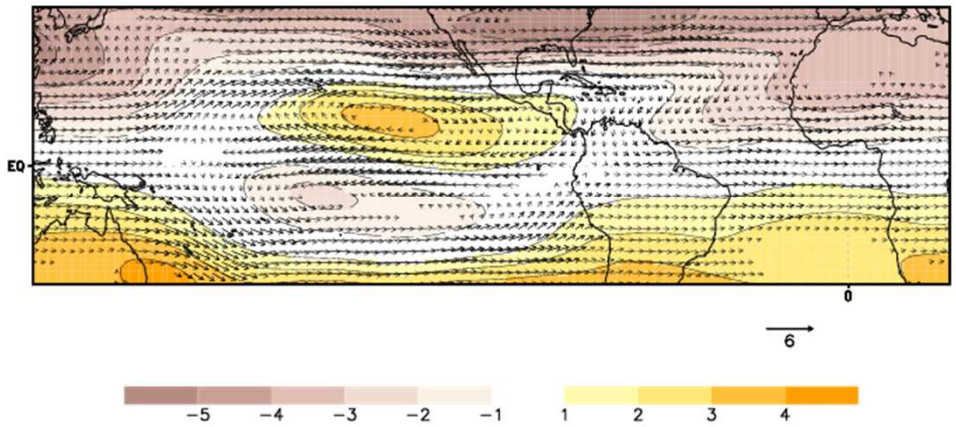
obs–Nino3.4 (djf) x SST/wind CNRM–NUDG (mam)



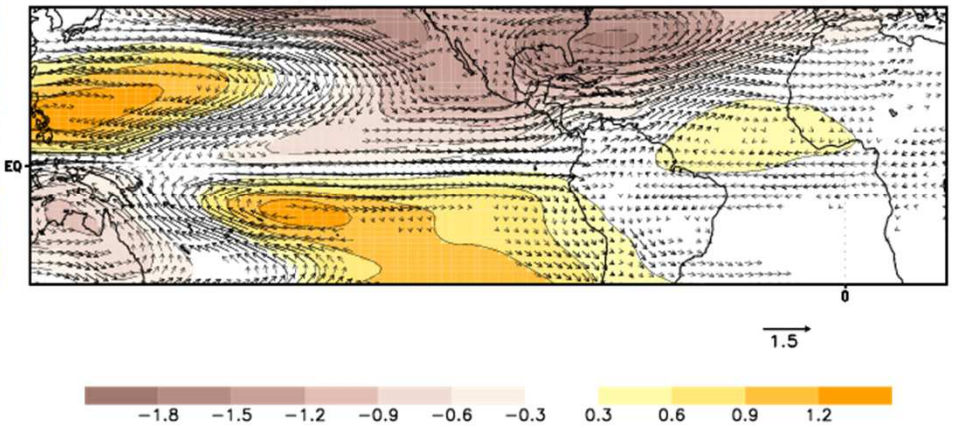
obs–Nino3.4 (djf) x pcp & divergent–200 CNRM–NUDG (mam)



obs–Nino3.4 (djf) x rotational–200 CNRM–NUDG (mam)



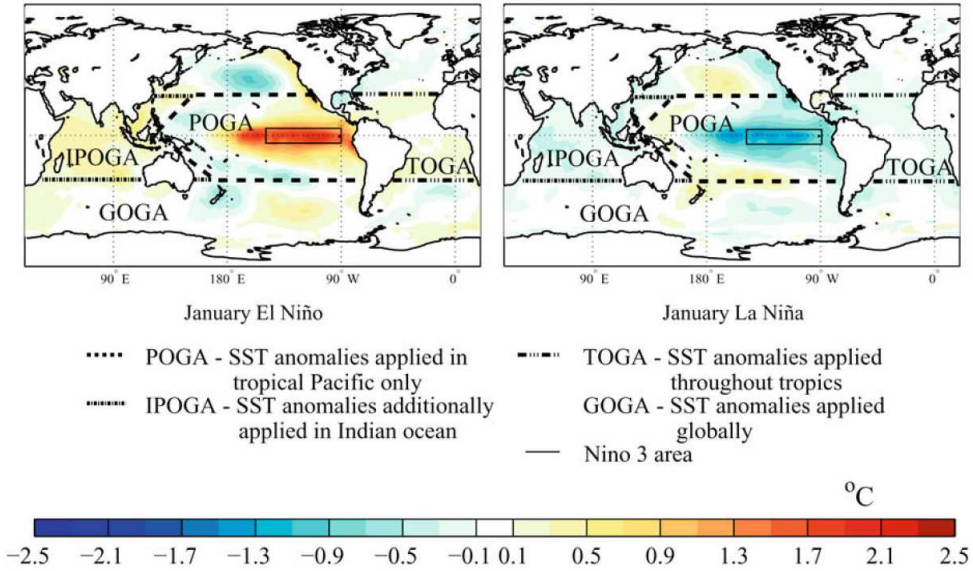
obs–Nino3.4 (djf) x rotational–850 CNRM–NUDG (mam)

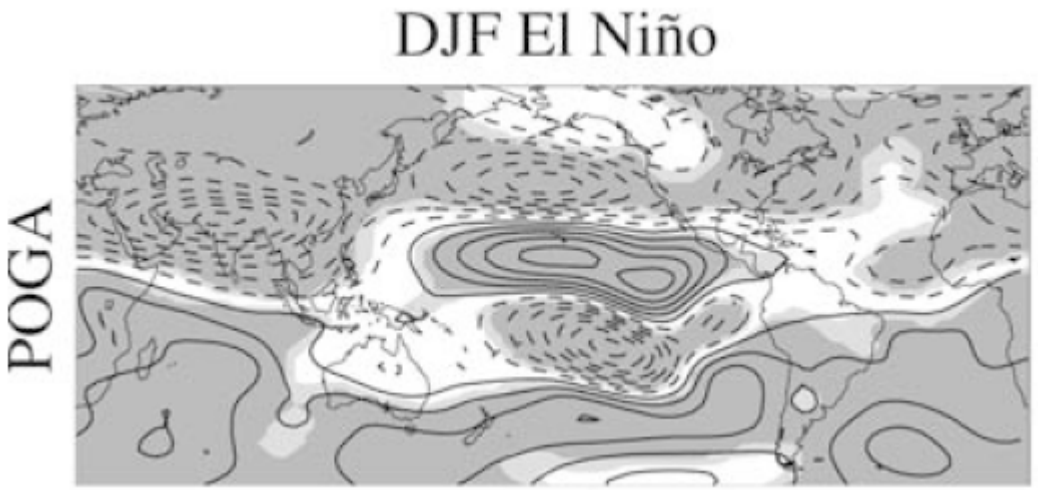


- The observational study describes a fourth potential mechanism to explain the ENSO teleconnection to the tropical North Atlantic in boreal spring. The continuous ENSO-induced atmospheric forcing in the tropical Atlantic via the remote Gill-type response plus the springtime increase in SST variance over the TNA region may conceivably be underlying the apparent one-season lagged ENSO-TNA teleconnection.

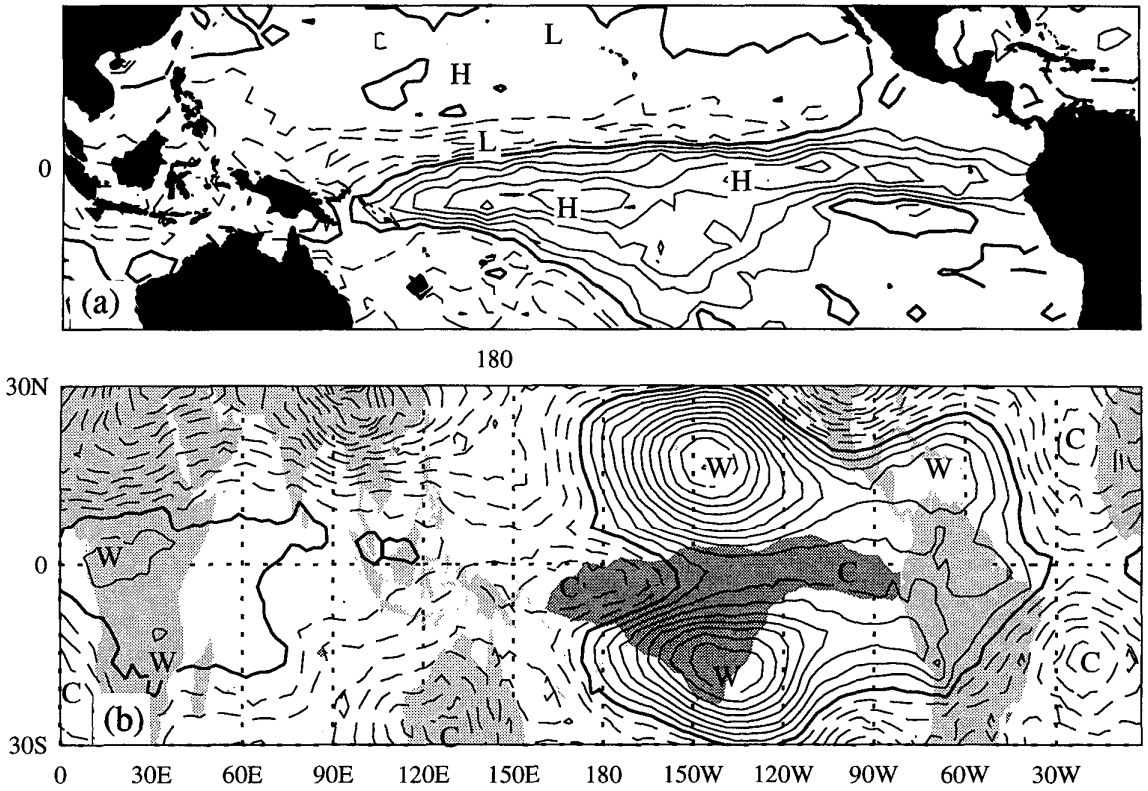
- Both processes appear to be at play in CNRM-NUDG, which also shows the ENSO-TNA teleconnection peaking in boreal spring. The contribution of the (overestimated) subtropical atmospheric forcing still to be quantified. Prescribing the observed timing of ENSO (CNRM-NUDG) increase model SST variance in the equatorial Atlantic, which is unrealistic, and over the TNA region – getting closer to observations.

supplementary slides

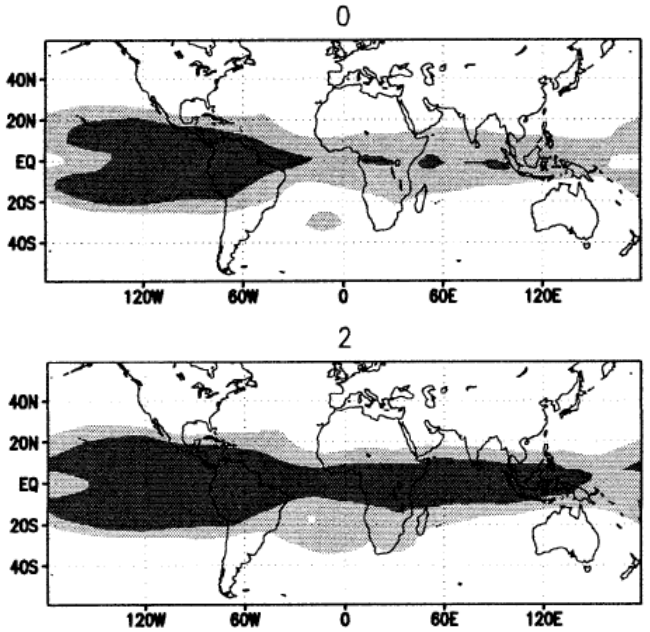




Spencer et al. (2004 ClimDyn)

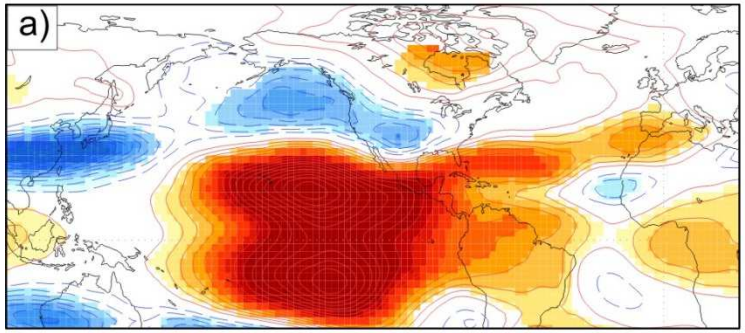


Yulaeva and Wallace (1994 JCLIM)

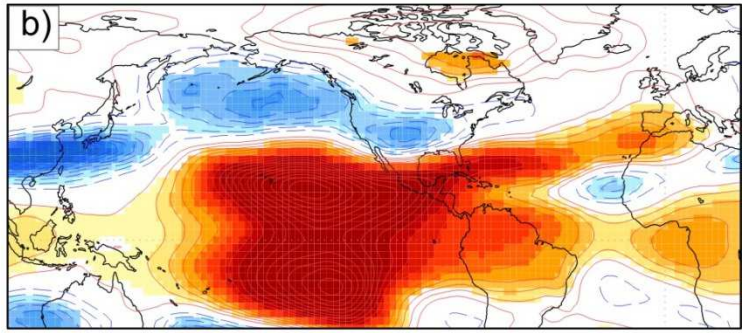


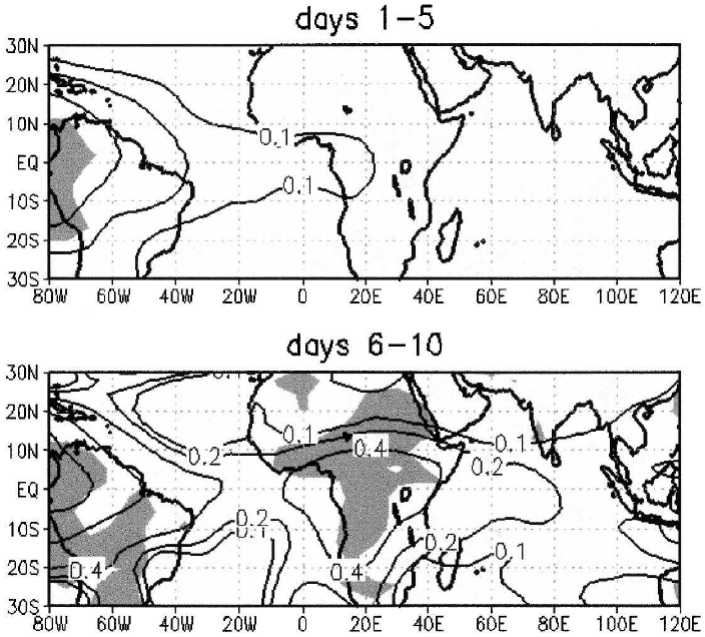
Chiang and Sobel (2002 JCLIM)

Niño3.4 (djf) x T300 (djf)



Niño3.4 (djf) x T300 (jfm)

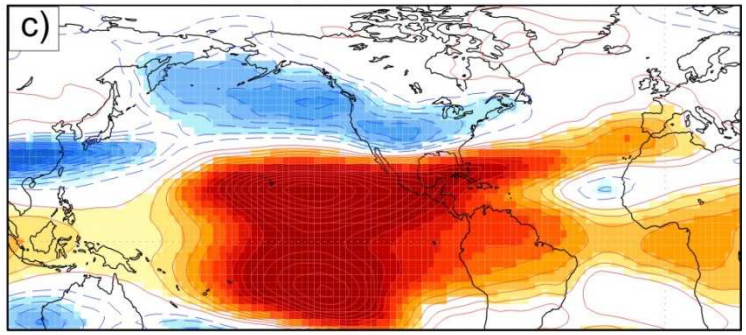




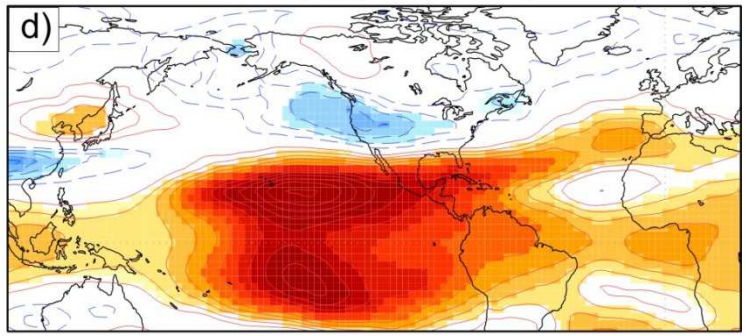
Chiang and Lintner (2005 JCLIM)

[consistent with Kelvin wave]

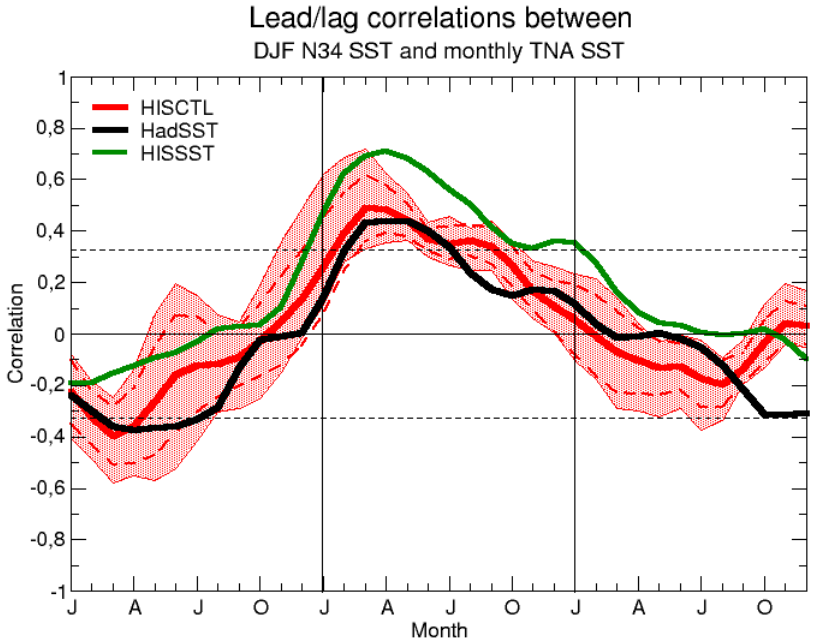
Niño3.4 (djf) x T300 (fma)

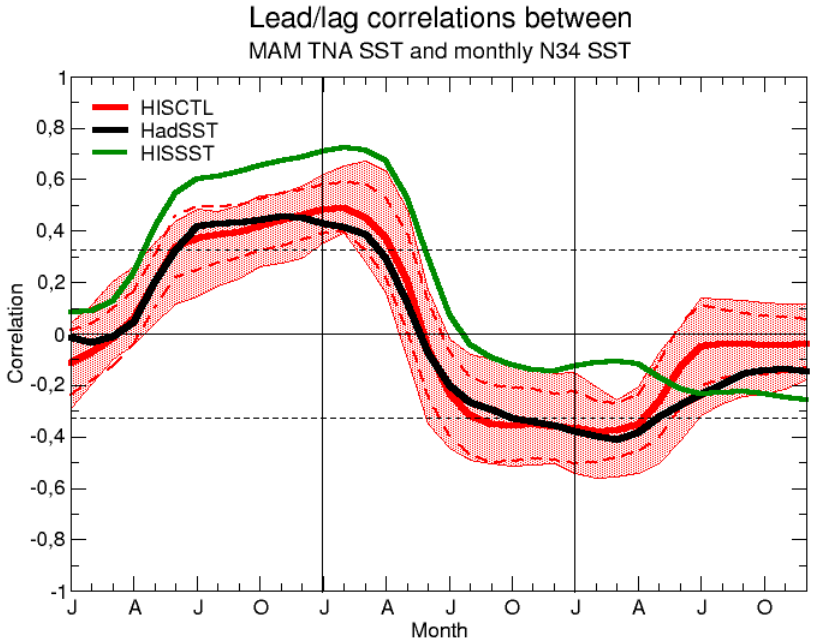


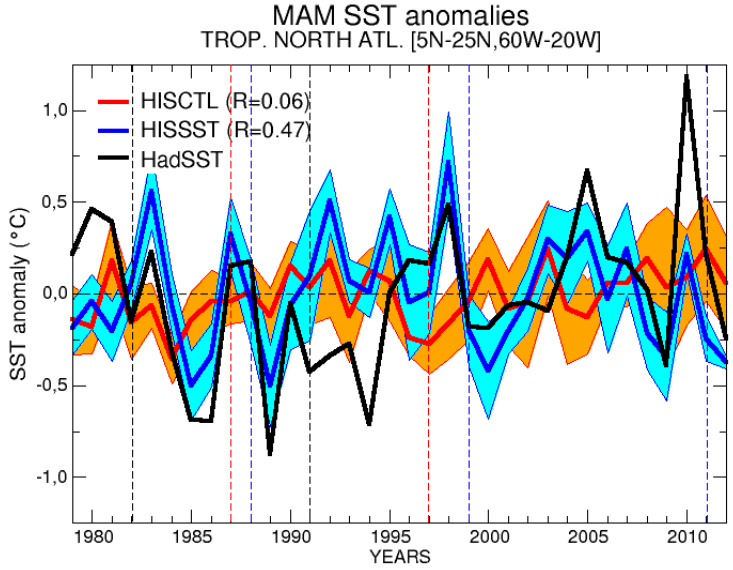
Niño3.4 (djf) x T300 (mam)

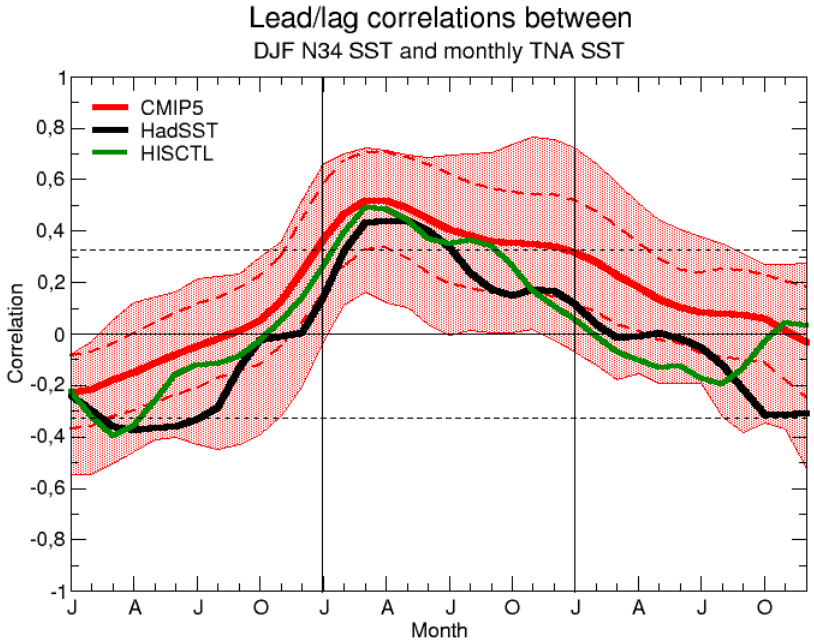


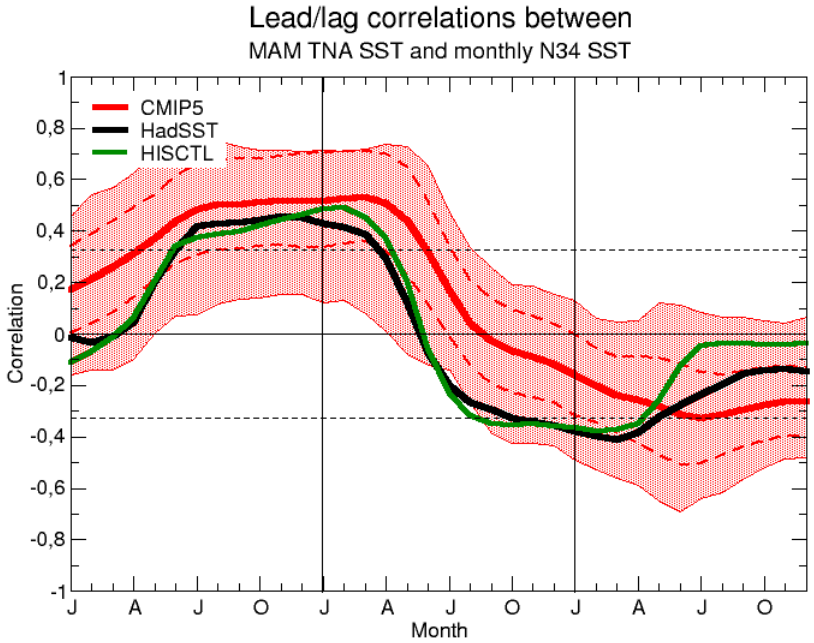
DPETNA


Lead/lag correlations between
DJF N34 SST and monthly TNA SST
HISCTL
HadSST
HISSST
Correlation
Month
J A J O J A J O J A J O


Lead/lag correlations between
MAM TNA SST and monthly N34 SST
HISCTL
HadSST
HISSST
Correlation
Month
J A J O J A J O J A J O


MAM SST anomalies
TROP. NORTH ATL. [5N-25N,60W-20W]
HISCTL (R=0.06)
HISSST (R=0.47)
HadSST
SST anomaly (°C)
YEARS
1980 1985 1990 1995 2000 2005 2010


Lead/lag correlations between
DJF N34 SST and monthly TNA SST
CMIP5
HadSST
HISCTL
Correlation
1
0,8
0,6
0,4
0,2
0
-0,2
-0,4
-0,6
-0,8
-1
J A J O J A J O J A J O
Month


Lead/lag correlations between
MAM TNA SST and monthly N34 SST
CMIP5
HadSST
HISCTL
Correlation
1
0,8
0,6
0,4
0,2
0
-0,2
-0,4
-0,6
-0,8
-1
J A J O J A J O J A J O
Month

DPETNA