



**Barcelona
Supercomputing
Center**
Centro Nacional de Supercomputación



Impact of Tropical Atlantic variability on Tropical Pacific predictability

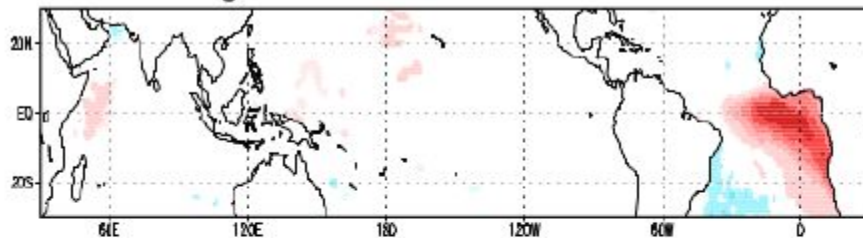
Eleftheria Exarchou

Maria-Belen Rodríguez De Fonseca (UCM), Teresa Losada (UCM), Irene Polo (UCM), Pablo Ortega (BSC), Francisco Doblas-Reyes (BSC)

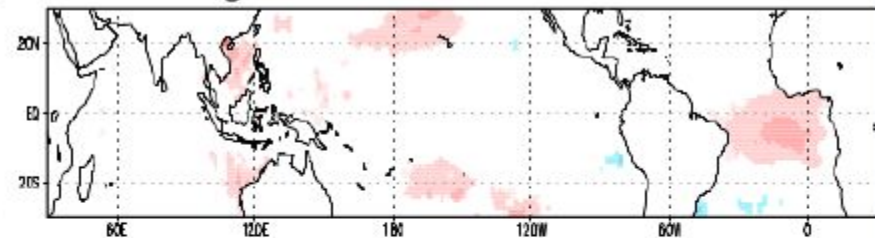
TA variability influences ENSO variability

Summer equatorial Atlantic SST are highly anticorrelated with the winter SST in Tropical Pacific under a negative AMO

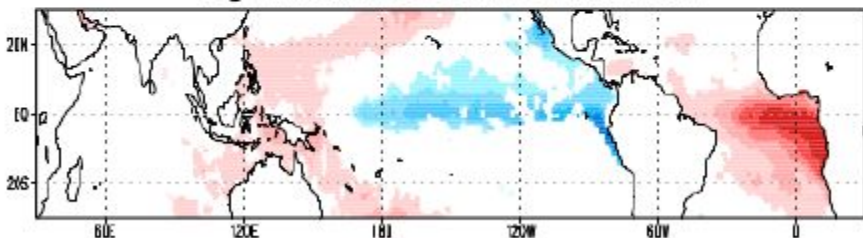
reg Atl3 SST OBS JJAS 1949-1978



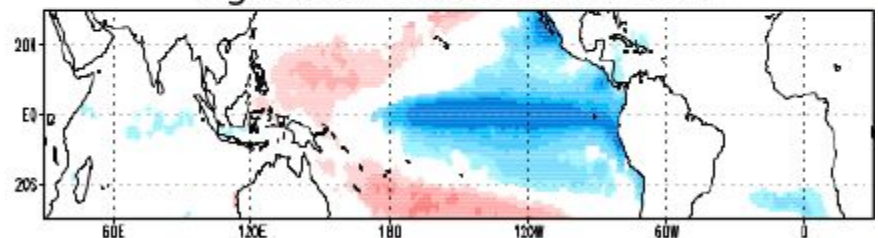
reg Atl3 SST OBS DJFM 1949-1978



reg Atl3 SST OBS JJAS 1979-2001



reg Atl3 SST OBS DJFM 1979-2001



Rodriguez-Fonseca et al [2009]

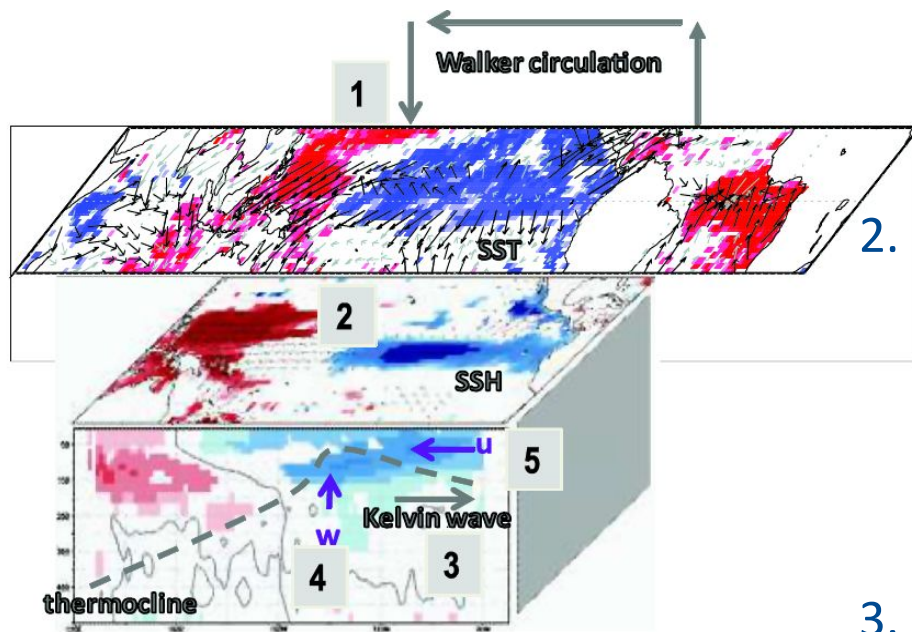
Ding et al [2011]

Polo et al [2008]

Frauen and Dommenges 2012

Dommenges et al 2006.

Atl/Pac connection through walker circulation



1. Anomalous heating from Atlantic Nino → anomalous convergence in Atlantic → anomalous divergence and subsidence in central/western Pacific
2. Anomalous easterly wind stress in central Pacific → anomalous Ekman upwelling and thermocline shallowing in Central Pacific → piling of surface warm water in the west Pacific
3. The thermocline anomaly propagates eastwards as a Kelvin wave
4. The shallowing thermocline brings cold water to the surface → stronger easterly surface wind anomalies (+ve feedback)

From Polo et al., 2015

Research questions:

- Are current GCMs able to reproduce the ATL/PAC teleconnection?
- Does this teleconnection - when present- increase predictability of Tropical Pacific?

Research questions

Research questions:

- Are current GCMs able to reproduce the ATL/PAC teleconnection?
- Does this teleconnection - when present- increase predictability of Tropical Pacific?

Methodology

Analysis of the North american Multi-Model Ensemble [NMME, Kirtman et al. 2014] and EUROSIP forecasts systems

- 14 systems in total
- Period 1980-2004, June start dates, 8-10 months long, all ensembles available

Research questions

Research questions:

- Are current GCMs able to reproduce the ATL/PAC teleconnection?
- Does this teleconnection - when present- increase predictability of Tropical Pacific?

Methodology

Analysis of the North American Multi-Model Ensemble [NMME, Kirtman et al. 2014] and EUROSIP forecasts systems

- 14 systems in total
- Period 1980-2004, June start dates, 8-10 months long, all ensembles available

Sensitivity study with EC-Earth

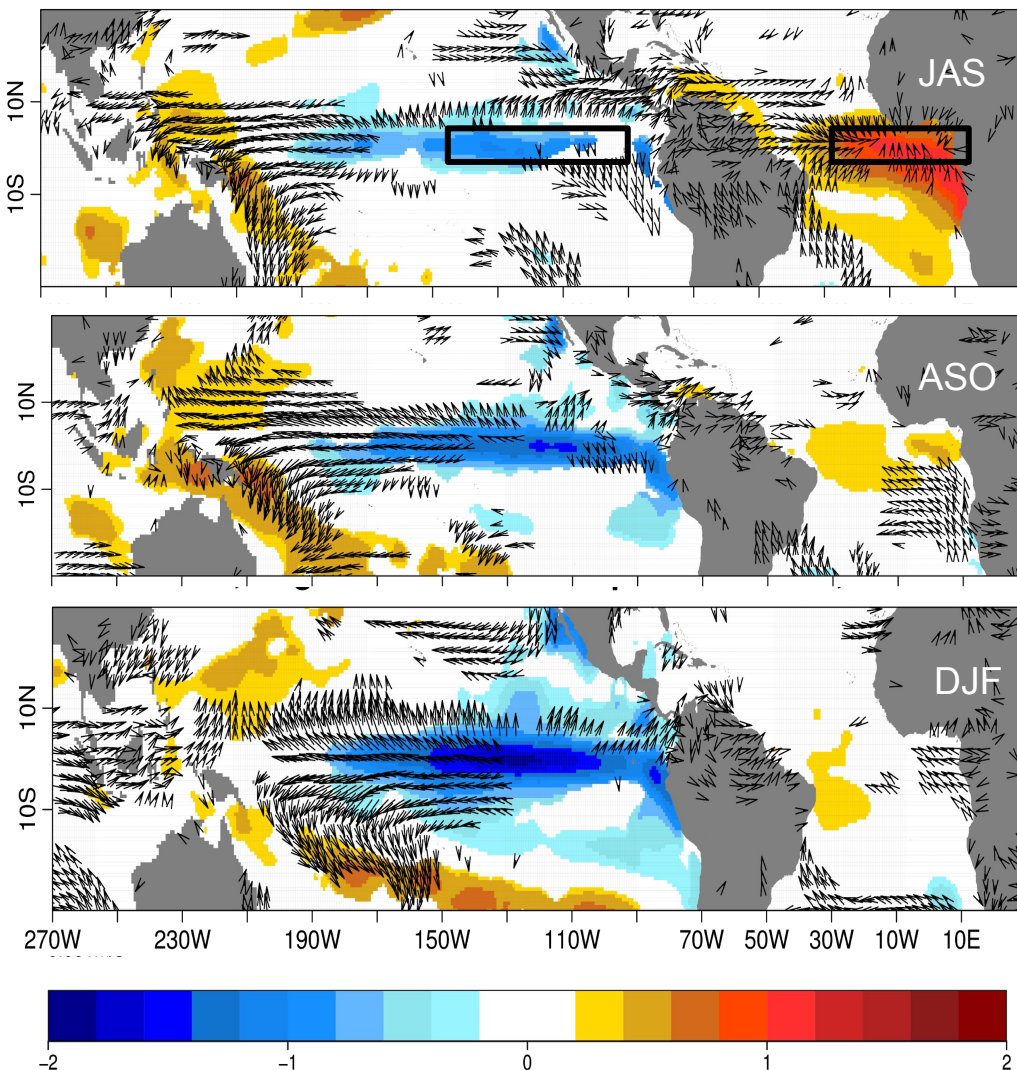
Seasonal predictions where we replace the wind stress over the Equatorial Atlantic

→ 10 members, 1980-2004, 8 months long, June initialization

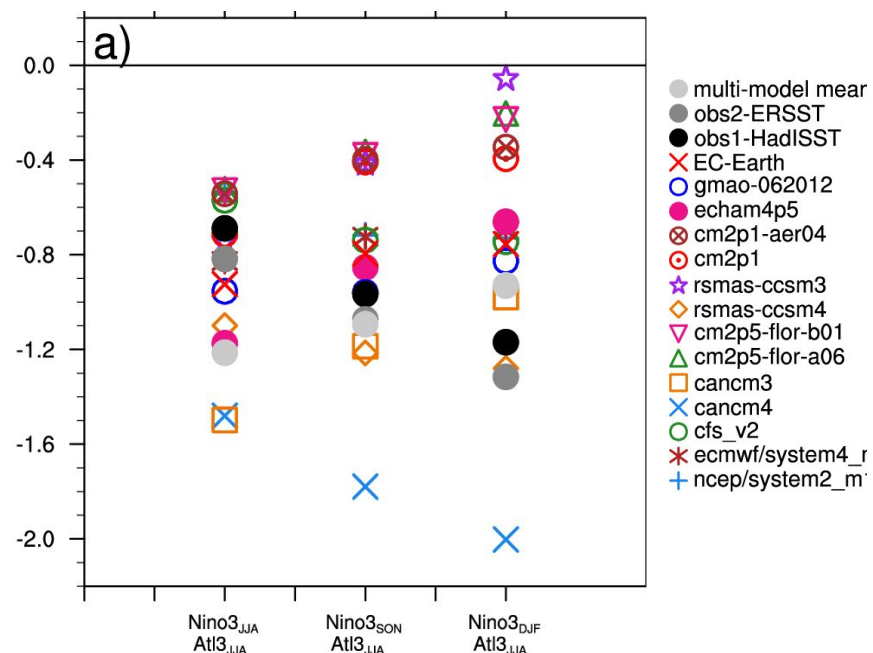
- Does this increase the skill in the TA?
- Does the representation of the connection between the two basins improve?
- Does this increase predictability in the Tropical Pacific?

Atl/Pac connection (in observations & forecasts)

Lagged regressions of SST/winds on ATL3 JJA with ERAinterim



Strength of the Atl/Pac connection (in obs & forecasts)

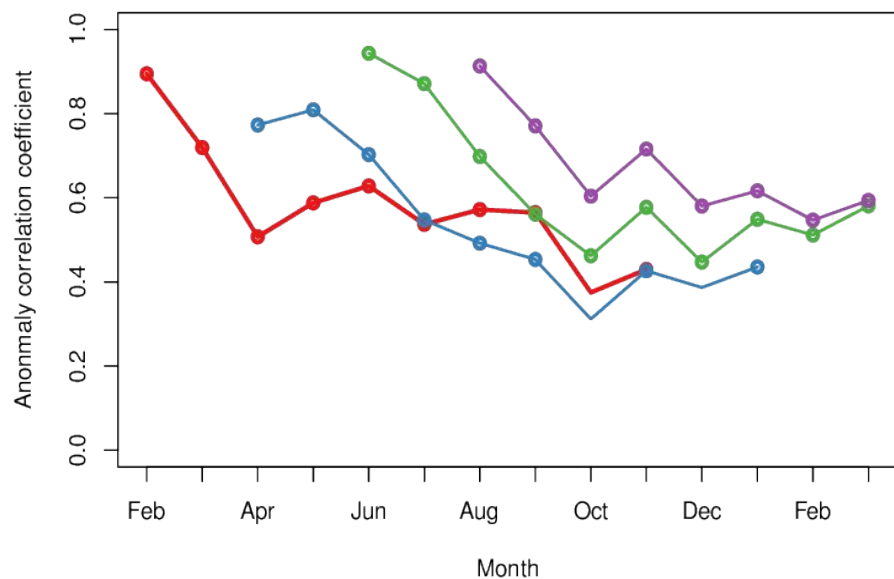


Most June initialized forecasts are able to reproduce the teleconnection!

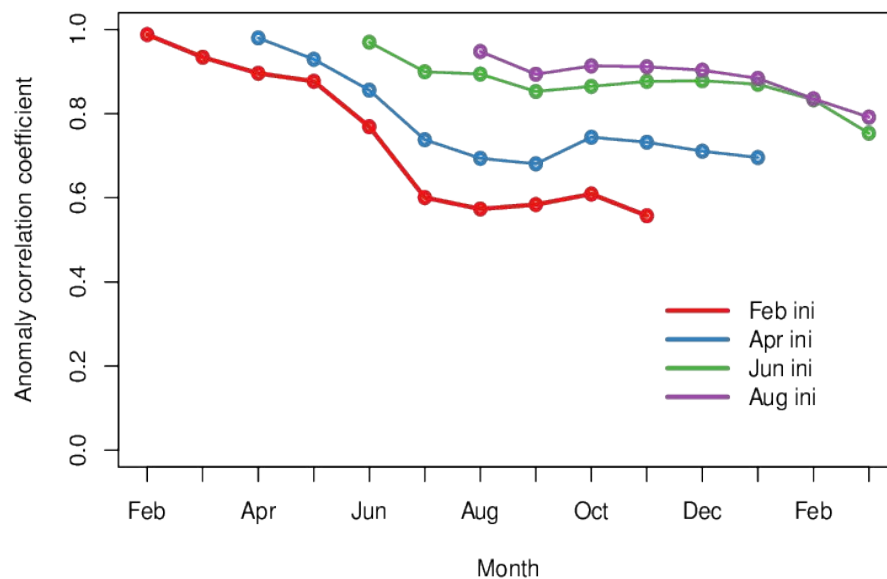
Skill in Tropical Atlantic and Pacific

Does this teleconnection - if present- increase predictability of Tropical Pacific?

Skill in ATL3



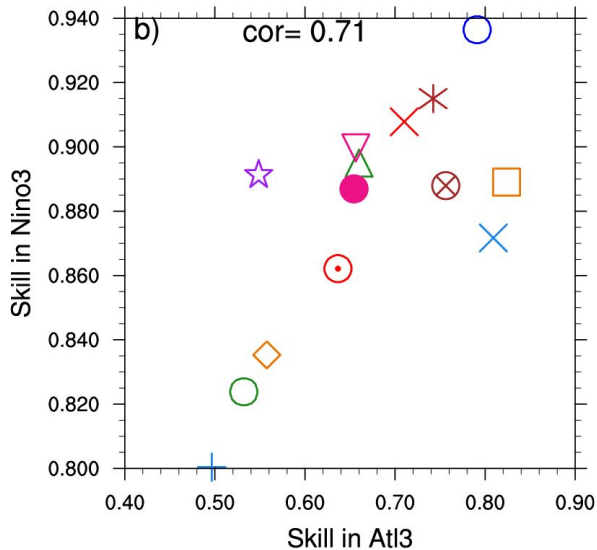
Skill in Nino3



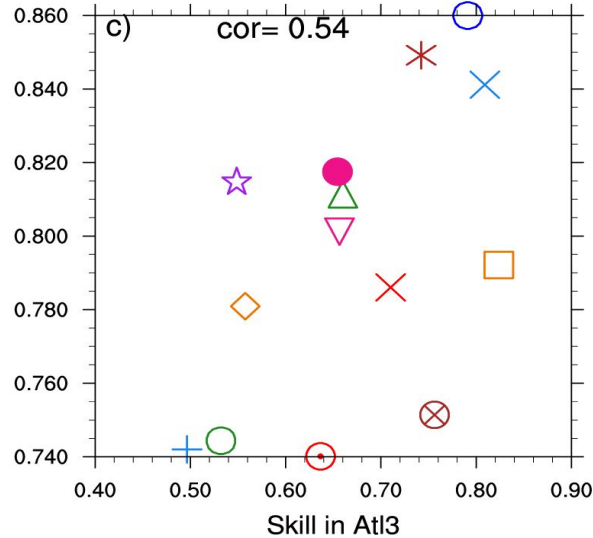
June initialized forecasts maintain high ENSO skill for longer lead times, suggesting that the summer is a key period to precondition the winter ENSO phase. This could be due to the increased ATL3 prediction skill on that season

Impacts on ENSO predictability

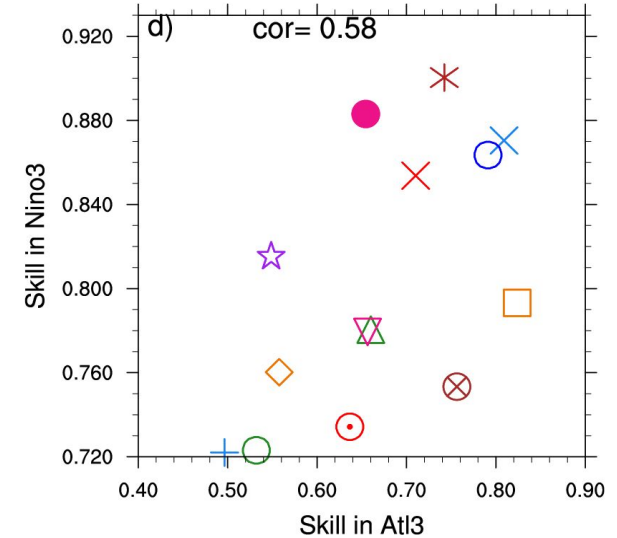
ATL3 JJA, Nino3 JJA



ATL3 JJA, Nino3 SON



ATL3 JJA, Nino3 DJF



Models with high prediction skill over the summer Tropical Atlantic also have higher skill in predicting the winter Tropical Pacific SST

- Is this because of the ATL/PAC teleconnection?
- Or simply because those models represent better the key processes behind both modes of variability?

Case study: wind stress replaced over Equatorial Atlantic

Model is EC-Earthv3.1

Wind stress is replaced in 3S-3N in Tropical Atlantic

Seasonal prediction experiments (CTR & Wind forced)) with 10 members, June start dates, 8 months , 1980-2004

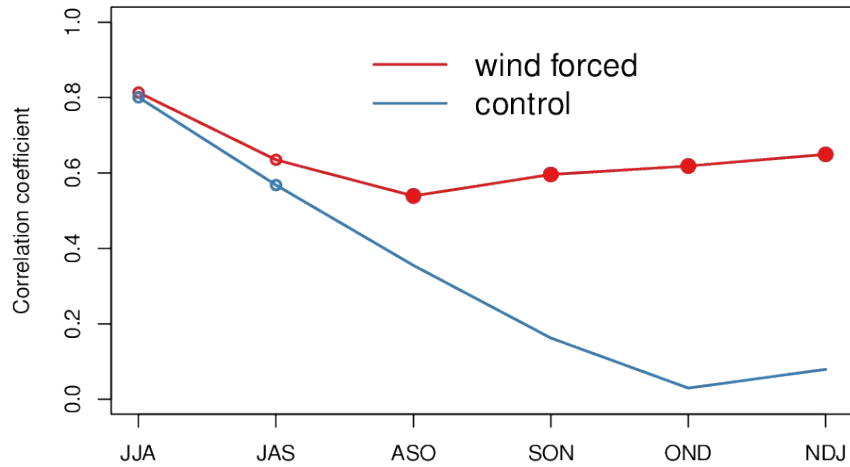
- Does this increase the skill in the TA?
- Does the representation of the connection between the two basins improve?
- Does this increase predictability in the Tropical Pacific?



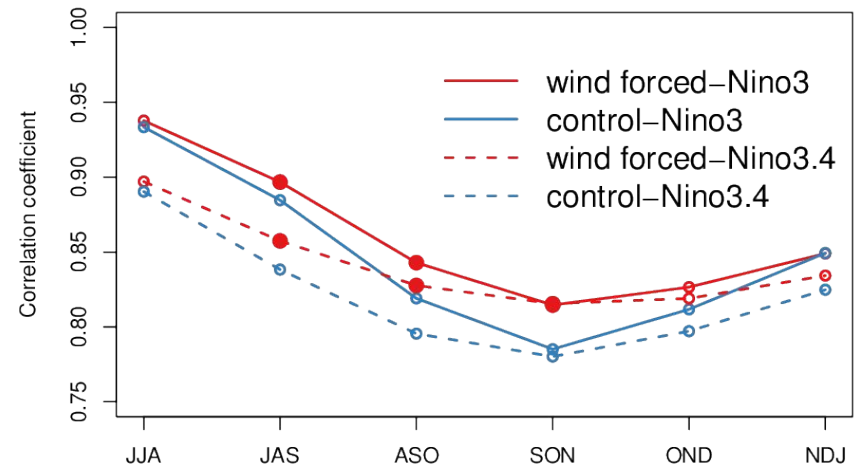
EC-Earth - A European community
Earth-System Model
(<http://www.ec-earth.org/>)

Case study: wind stress replaced over Equatorial Atlantic

Skill in ATL3



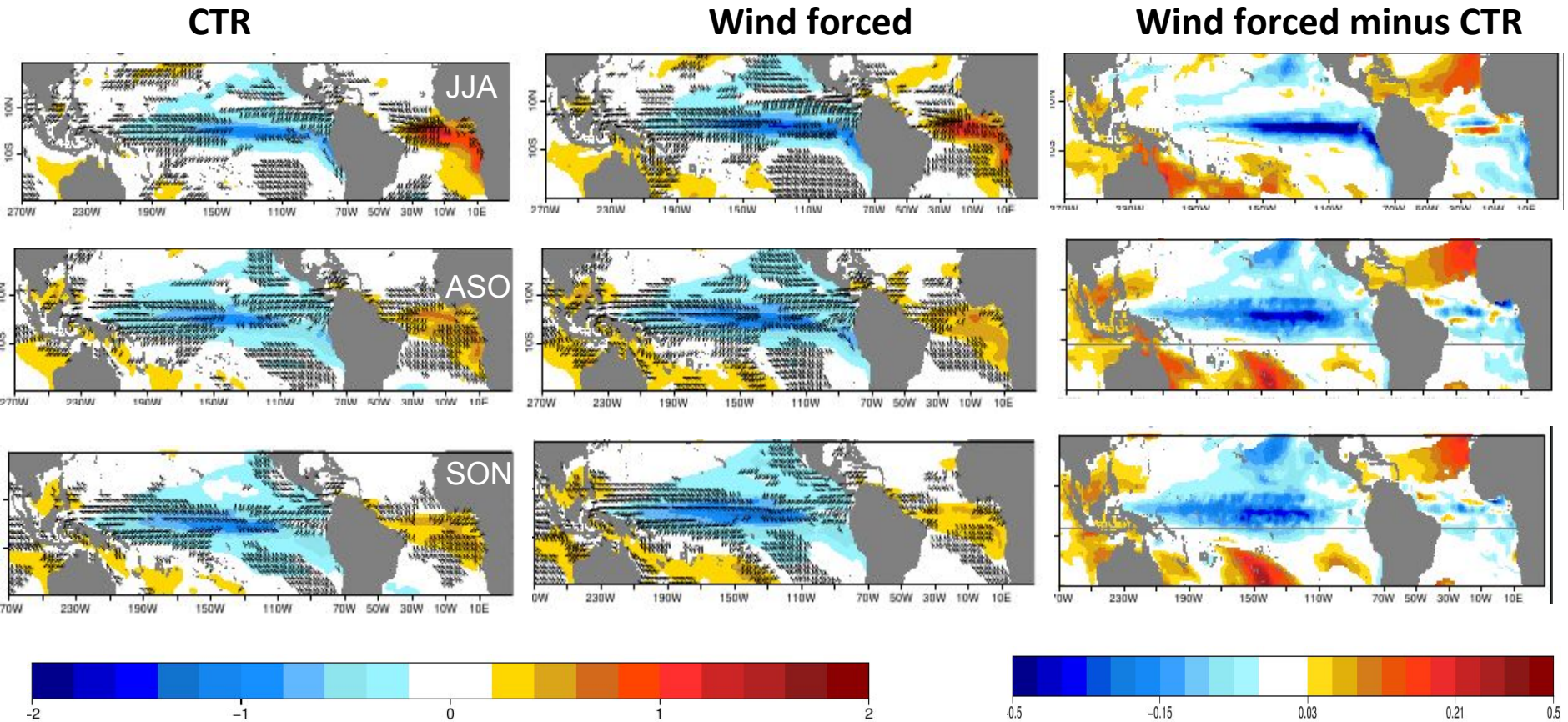
Skill in Niño3,3.4



- Improvement of skill in Tropical Atlantic after 2nd season
- Improvement of skill in Niño3,3.4 from JAS to SON

Atl/Pac connection in CTR and Wind forced

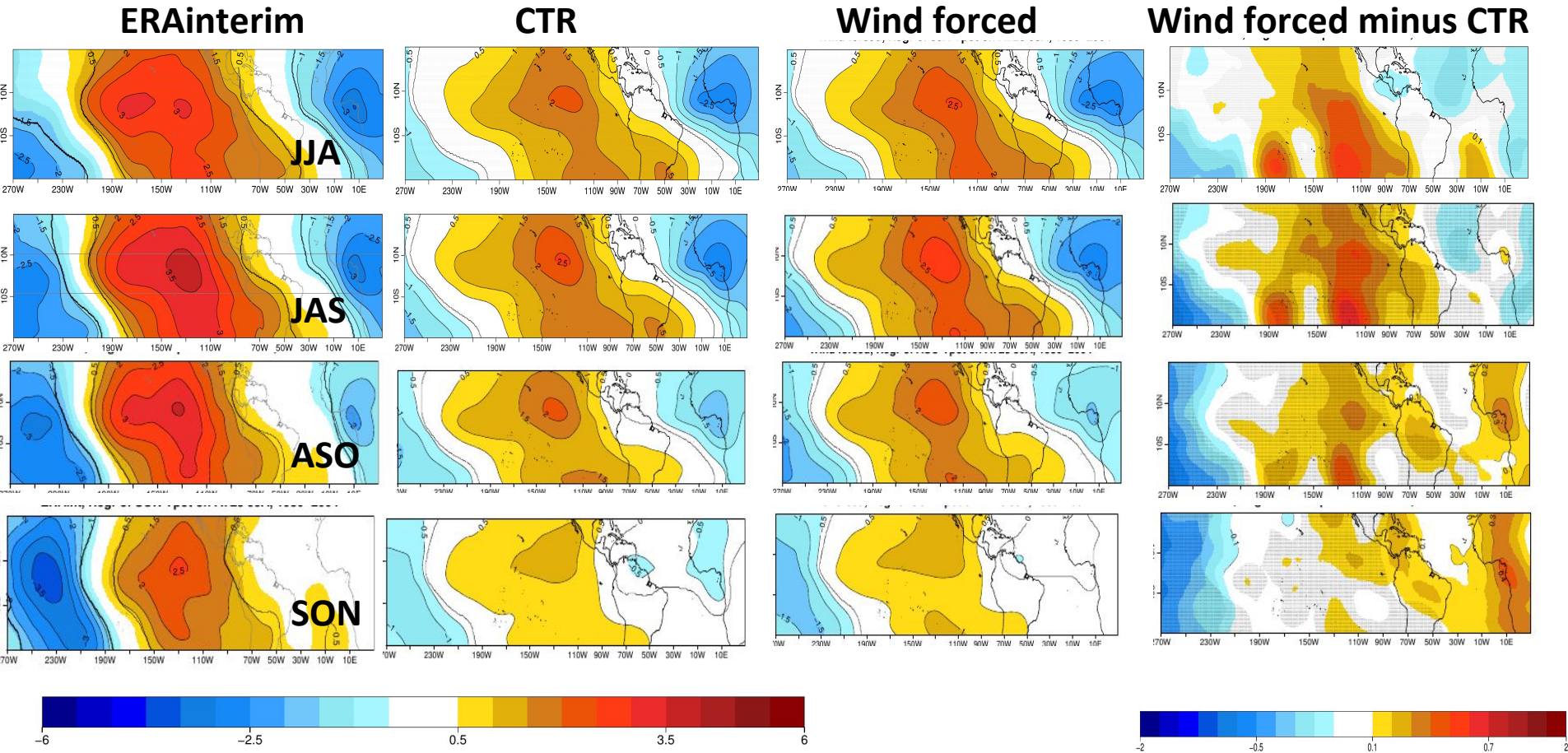
Lagged regressions of SST/winds on ATL3 JJA



Sensitivity experiment reproduces better the teleconnection

Modifications in Walker Circulation

Regression of 200 hPa velocity potential on summer ATL3



Sensitivity experiment reproduces better the teleconnection

Summary

Models within the NMME/EUROSIP multimodel ensemble with high prediction skill over the summer Tropical Atlantic tend to have higher skill in predicting the winter Tropical Pacific SST

Models within the NMME/EUROSIP multimodel ensemble with high prediction skill over the summer Tropical Atlantic tend to have higher skill in predicting the winter Tropical Pacific SST

We hypothesize that this is (at least partly) due to the Atl/Pac connection

Replacing wind stress over Tropical Atlantic in EC-Earth v3.1 results in

- **Better skill in Tropical Atlantic**
- **Improved Atlantic/Pacific teleconnection**
- **and, higher skill in winter Tropical Pacific SST**

Models within the NMME/EUROSIP multimodel ensemble with high prediction skill over the summer Tropical Atlantic tend to have higher skill in predicting the winter Tropical Pacific SST

We hypothesize that this is (at least partly) due to the Atl/Pac connection

Replacing wind stress over Tropical Atlantic in EC-Earth v3.1 results in

- Better skill in Tropical Atlantic
- Improved Atlantic/Pacific teleconnection
- and, higher skill in winter Tropical Pacific SST

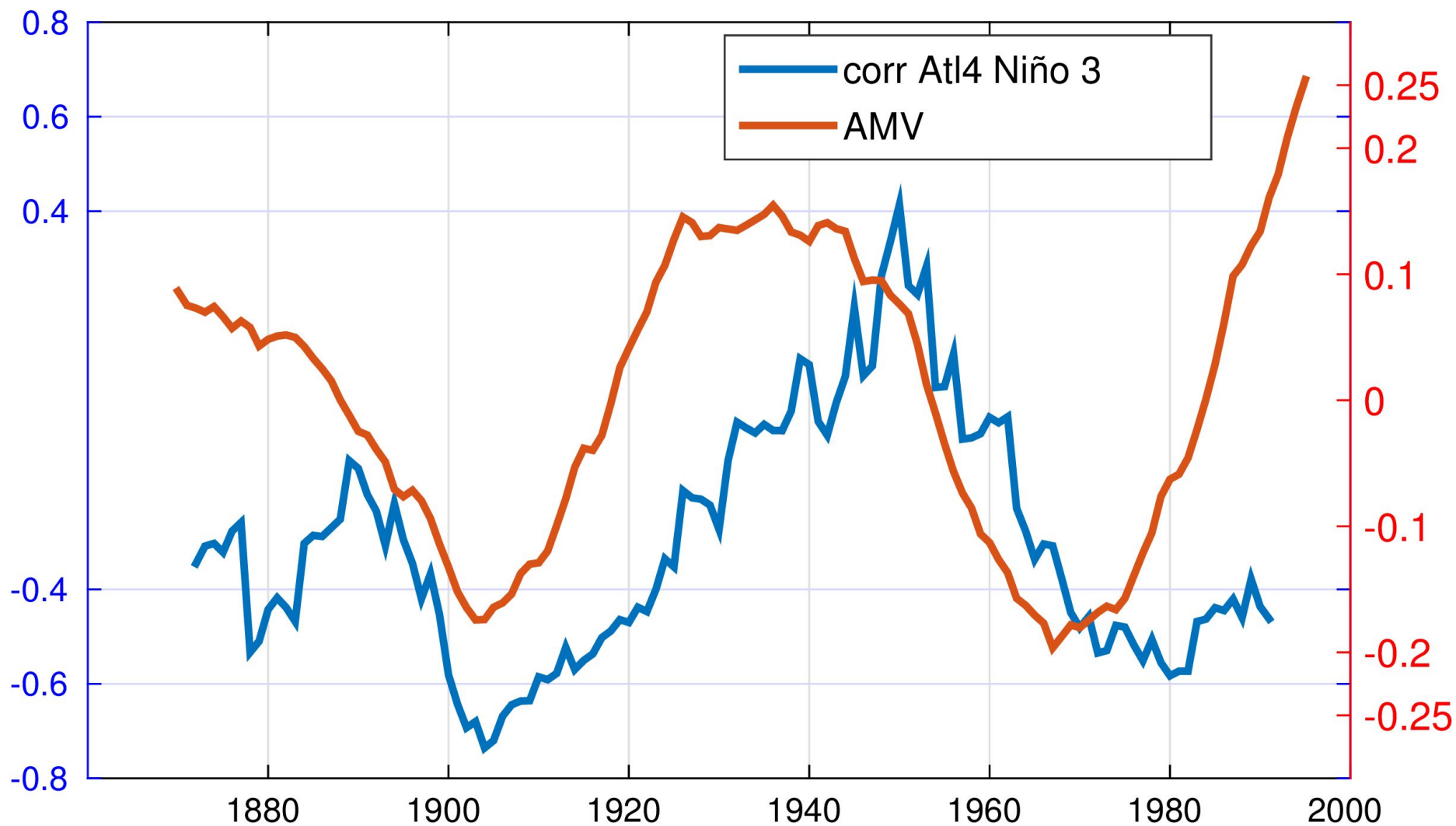
Thank you for your attention!

Models used

Model	Start dates	ensembles	length	period
<i>NCEP (system2)</i>	02,04,06,08	24	10 mon	1982 – 2004
<i>ECMWF(system4)</i>	—"—	51	7 mon	1981 – 2004
cfs_v2	—"—	32	10 mon	1982 – 2004
cancm4	—"—	10	10 mon	1981 – 2004
cancm3	—"—	10	10 mon	1981 – 2004
cm2p5-flor-a06	—"—	12	10 mon	1980 – 2004
cm2p5-flor-b01	—"—	12	10 mon	1980 – 2004
rsmas-ccsm4	—"—	10	10 mon	1982 – 2004
rsmas-ccsm3	—"—	6	10 mon	1982 – 2004
cm2p1	—"—	10	10 mon	1982 – 2004
cm2p1-aer04	—"—	10	10 mon	1982 – 2004
echam4p5	—"—	12	8 mon	1982 – 2004
gmao-062012	—"—	12	9 mon	1981 – 2004
EC-Earth CTR	06	10	8 mon	1980 – 2004
EC-Earth Wind_forced	06	10	8 mon	1980 – 2004

^aKirtman et al. (2014)).

Analysis of AMO modulation of ATL-PAC in observations



Martin-Rey et al (2014,2015)