

Transition of the ENSO teleconnection to the Euro-Atlantic region from early to late winter: Role the Indian Ocean

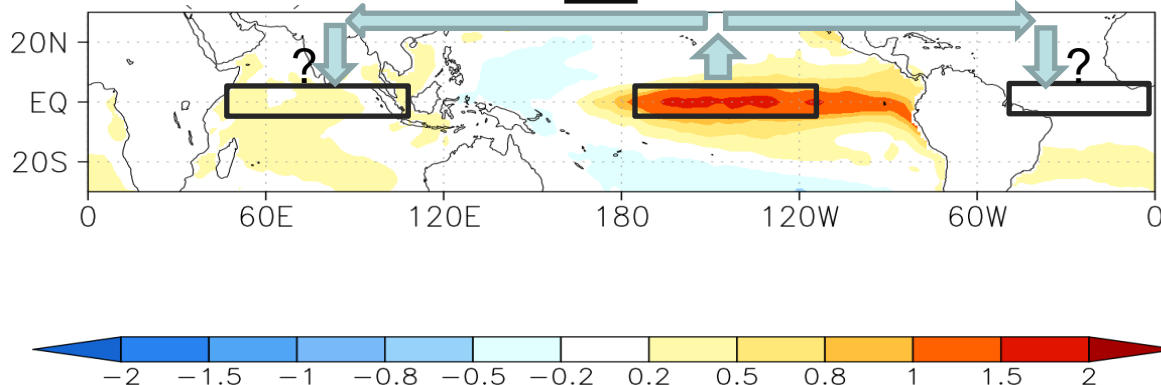
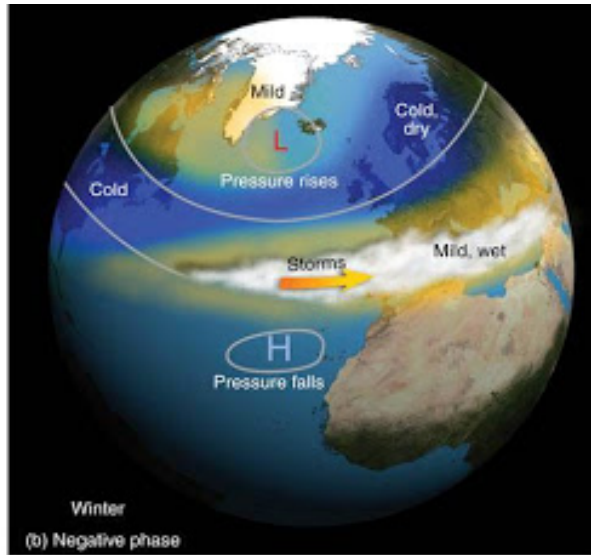
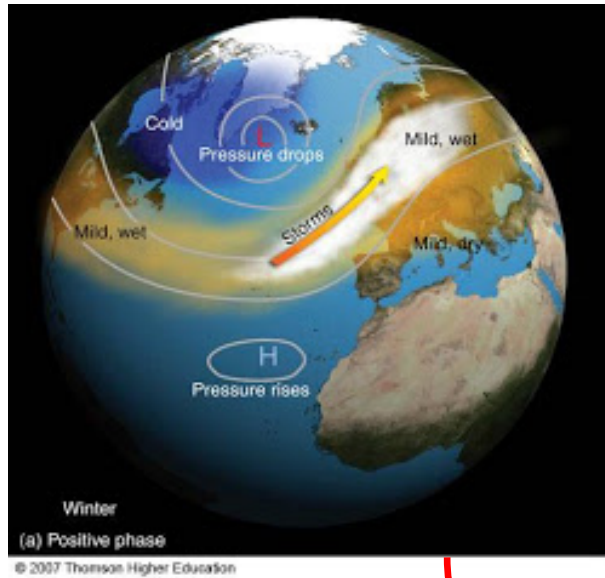
Muhammad Adnan Abid

(ICTP/CECCR)

email: mabid@ictp.it

Co-Authors: F. Kucharski (ICTP/CECCR), F. Molteni (ECMWF), In-Sik Kang (SOED), A. Tompkins (ICTP), M. Almazroui (CECCR)

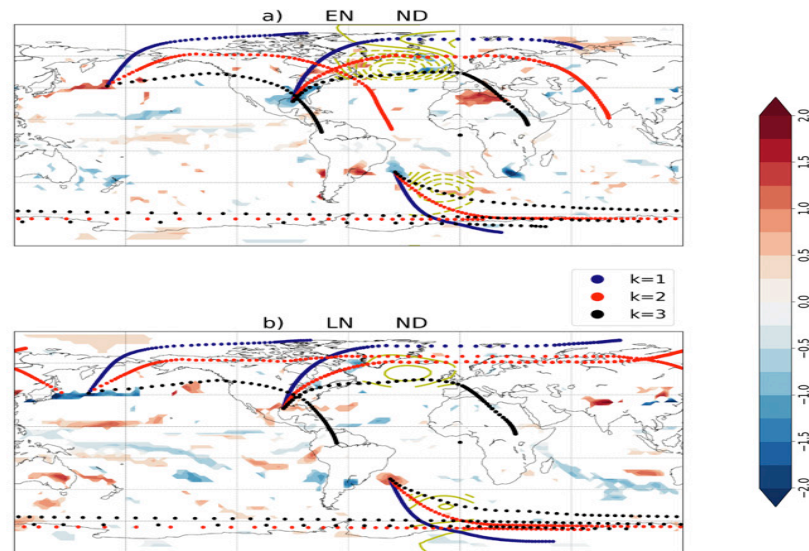
Introduction



- How are Circulation anomalies in the **Euro Atlantic Sector** are linked with ENSO during boreal winter?
- Is there a persistence teleconnection ENSO over Atlantic sector during Dec-Jan-Feb?
- What is the role of the other tropical basins in ENSO teleconnections to the Euro Atlantic Circulation anomalies on intra-seasonal timescale?

Motivation

- King et al. (2018) highlighted the intra-seasonal variability of the circulation anomalies over the Euro-Atlantic region from early to late winter. They highlighted that early winter ENSO teleconnections needs to more attention and ENSO teleconnection with other tropical basins may play some role (**BAMS, 2018**; DOI:10.1175/BAMS-D-17-0020.1)
- Ayarzaguena et al. (2018) then identified that ENSO-Atlantic connection modulates the early winter positive North Atlantic circulation anomalies in Euro-Atlantic Sector.



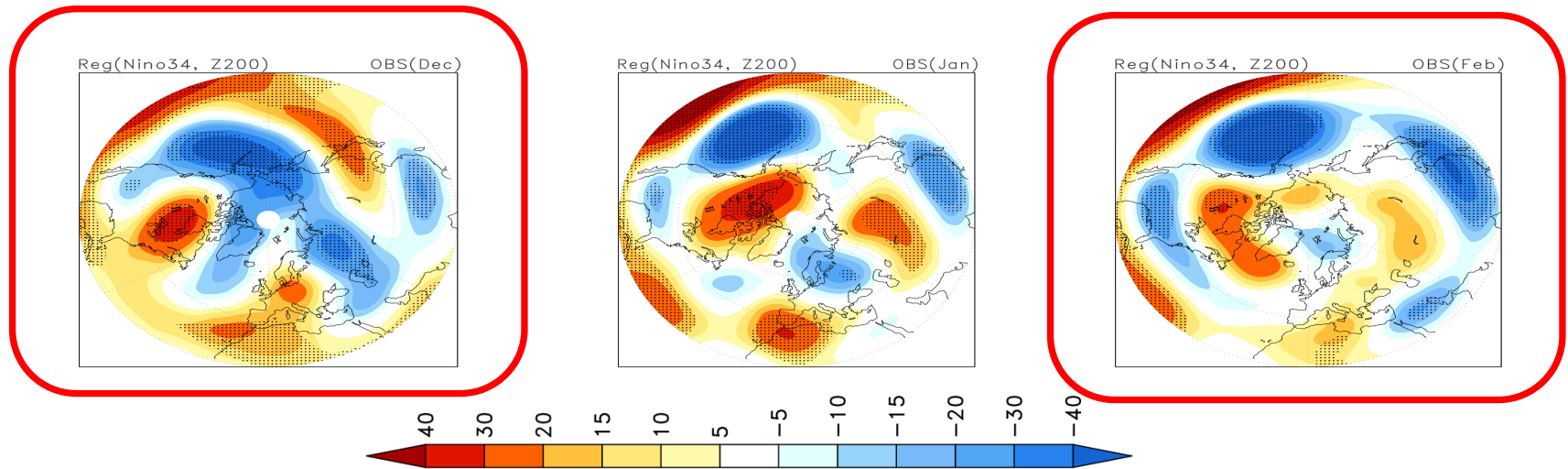
(source: *Intraseasonal Effects of El Niño–Southern Oscillation on North Atlantic Climate*; JCL 2018; DOI: 10.1175/JCLI-D-18-0097.1)

Dataset and Methodology

- European Reanalysis dataset (ERA-Interm) was used as reanalysis for the period 1981-2015.
- Rainfall dataset was adapted from Global Precipitation Climatology Project (GPCP).
- HadISST dataset was adapted as observed Sea Surface temperature
- European Centre for Medium-Weather Forecast (ECMWF) seasonal forecast System-5 (SEAS5) dataset was used for 1981-2015.
 - Total 25-ensemble members are available for November Initial condition

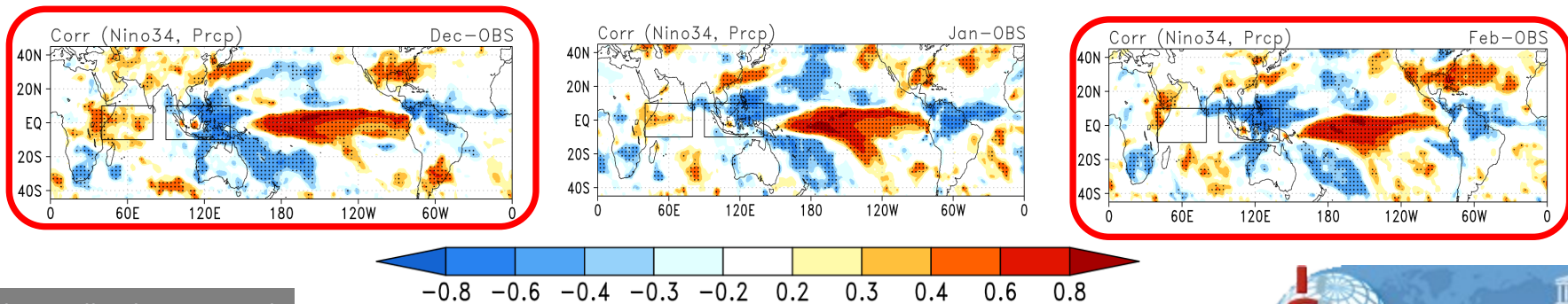
ENSO-Tropical Indian Ocean connection

Niño3.4 forced Circulation anomalies in North Atlantic Sector from early to late winter



1- Niño3.4 SST forces Tropical west-east Indian Ocean (TWEIO) rainfall dipole

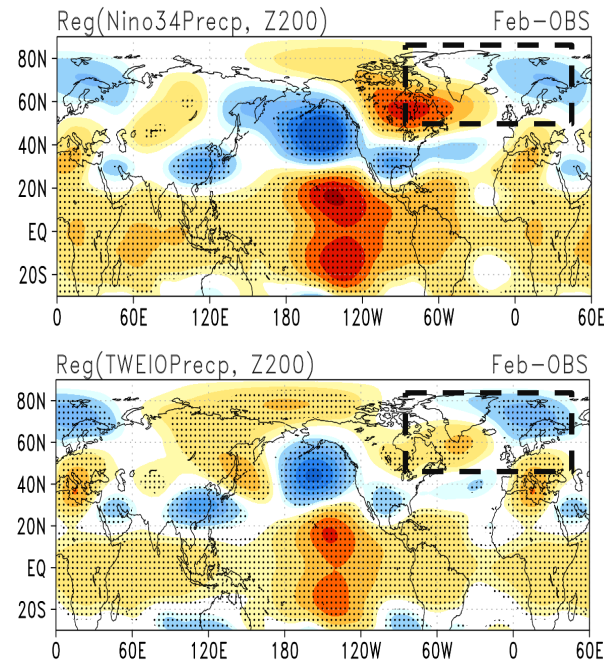
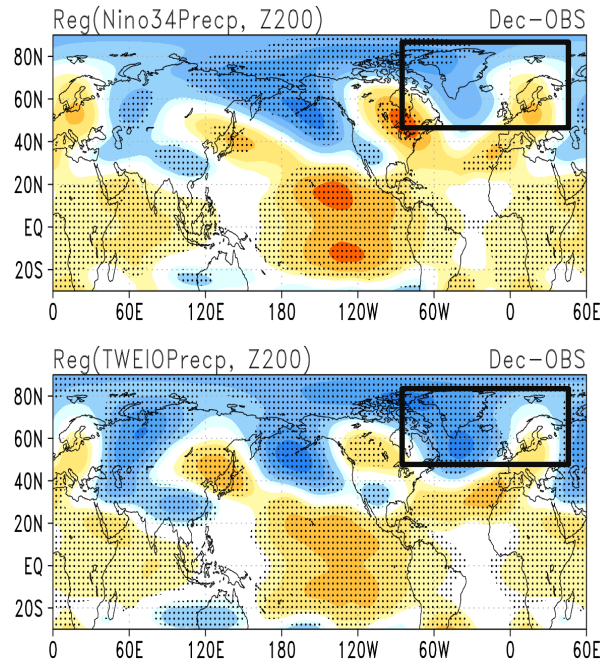
2- TWEIO rainfall dipole is stronger in early compared to late winter



Euro-Atlantic Circulation anomalies: ENSO vs TWEIO (Observations)

Early Winter
(December)

Late Winter
(February)

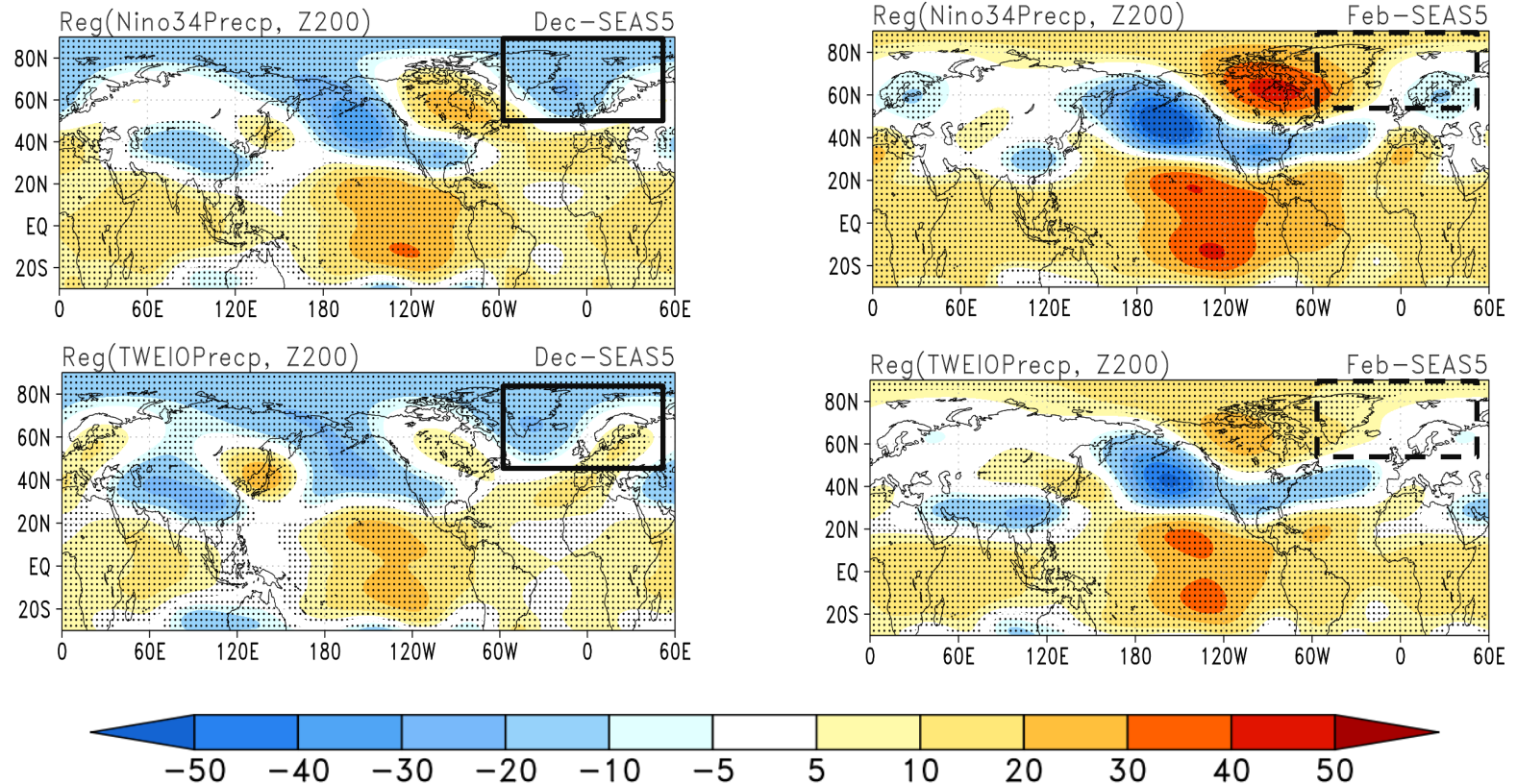


ENSO forced
Circulation
anomalies

TWEIO forced
Circulation
anomalies



Euro-Atlantic Circulation anomalies: ENSO vs TWEIO (ECMWF-SEAS5)



Both model and observations show TWEIO forced upper-level circulation anomalies over North Atlantic sector are stronger compared to ENSO but still we do not know, which basin dominates.

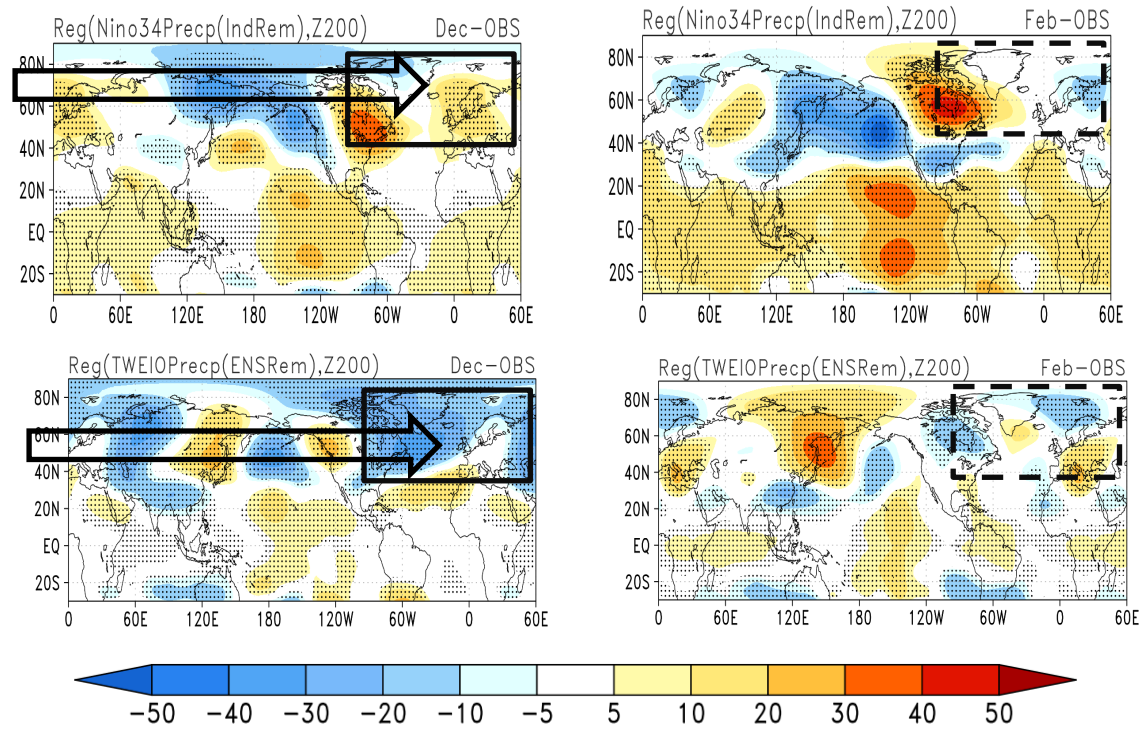
Separating ENSO and Indian Ocean response

To separate the ENSO and tropical Indian ocean response, partial regression method was adapted shown as following

$$X(t)_{res} = X(t) - b \times X(t)_{RM}$$

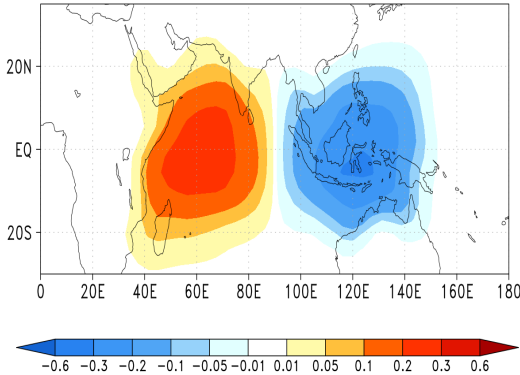
Missing upper level negative height anomalies in early winter in the Euro-Atlantic region

Stronger upper level response shows Indian ocean dominates

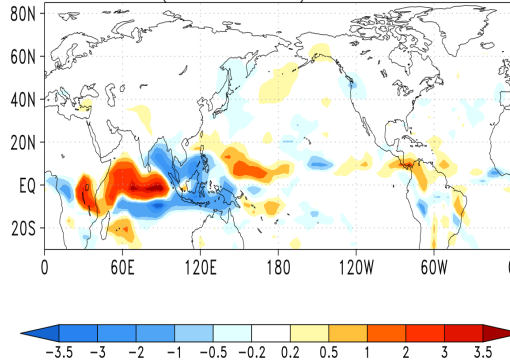


Model Experimentation

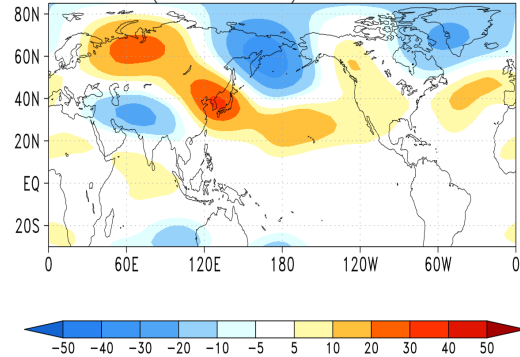
Trop. West-East Ind. Ocean Dip. Pattern



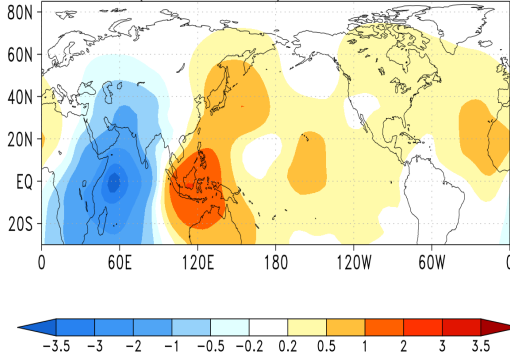
Dec-PRCP(Pert - CTL)



Dec-GPH(Pert - CTL)



Dec-CHI(Pert - CTL)



Two experiments were conducted with intermediate Atmospheric General Circulation Model (SPEEDY)

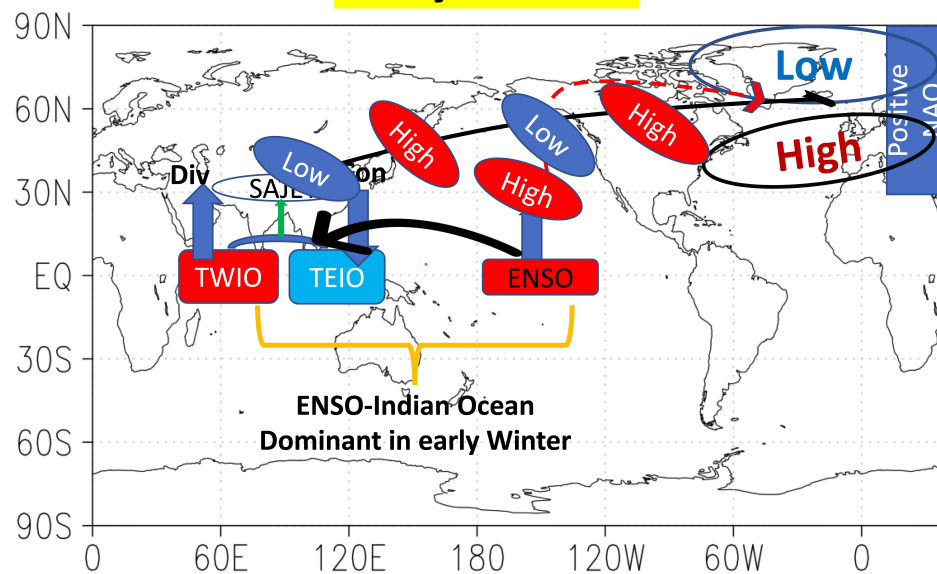
1- Control (CTL) Exp with prescribed observed SSTs

2- Perturbed Exp (PERT)

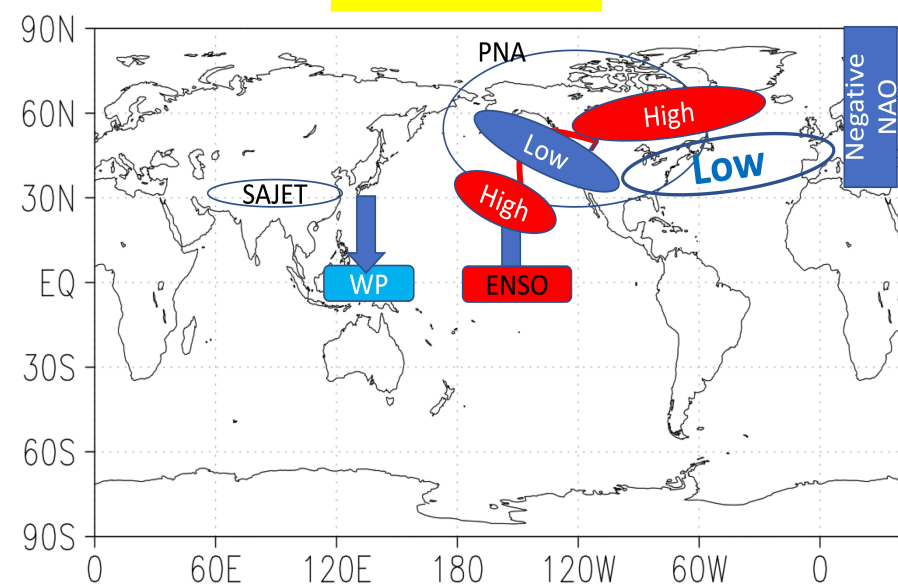
- Heating anomalies are added as dipole shown in **a)**
- Total 140 ensemble members were simulated, where each member were simulated for six months starting every member from October.

Possible Mechanism: Early to Winter ENSO-NAO teleconnections

Early Winter



Late Winter



Concluding Remarks

- Early to late winter Euro-Atlantic circulation anomalies show transitions over North Atlantic sector, mainly due to the changing ENSO-Indian Ocean intra-seasonal relationship.
- The Indian ocean dipole enforces the upper-level convergence over eastern Indian ocean compensated by upper-level divergence over western Indian Ocean forcing the subtropical South Asian Jet which acts a Rossby wave source for the North Atlantic region
- These findings have a strong implications over the monthly time scale predictability. It also shows that traditional averaging for 3-month seasonal mean may not be appropriate to analyze regional skill.
- This could be further investigated for other available prediction systems.
- It is important to revisit the atmospheric teleconnections in the ENSO-interbasin framework.

Thanks

Further Information:

Separating the Indian and Pacific Ocean impacts on the Euro-Atlantic response to ENSO and its transition from early to late winter

(in review; Journal of Climate; 2020)