



State Key Laboratory of Numerical Modelling for Atmospheric Sciences
and Geophysical Fluid Dynamics(LASG)
Institute of Atmospheric Physics Chinese Academy of Sciences

Global climate impacts of ENSO

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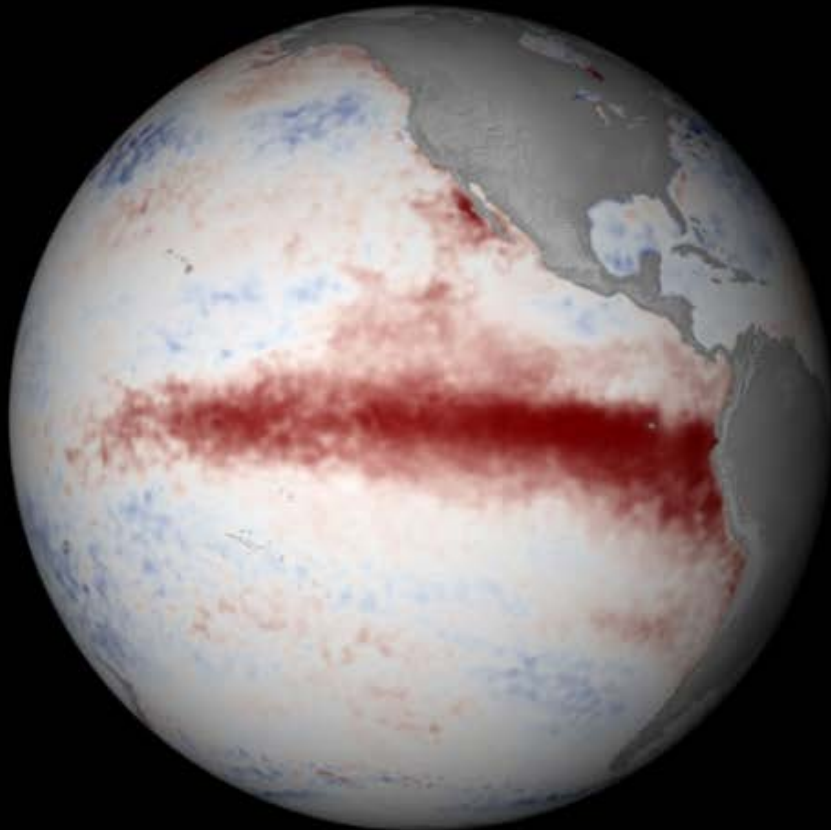
Outline



- **What is ENSO?**
- **Gill model**
- **Impacts of ENSO on Indian Ocean**
 - Indian Ocean dipole
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 - Pacific-North America (PNA) pattern in winter
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- **Impacts of ENSO on East Asian monsoon (Thursday)**

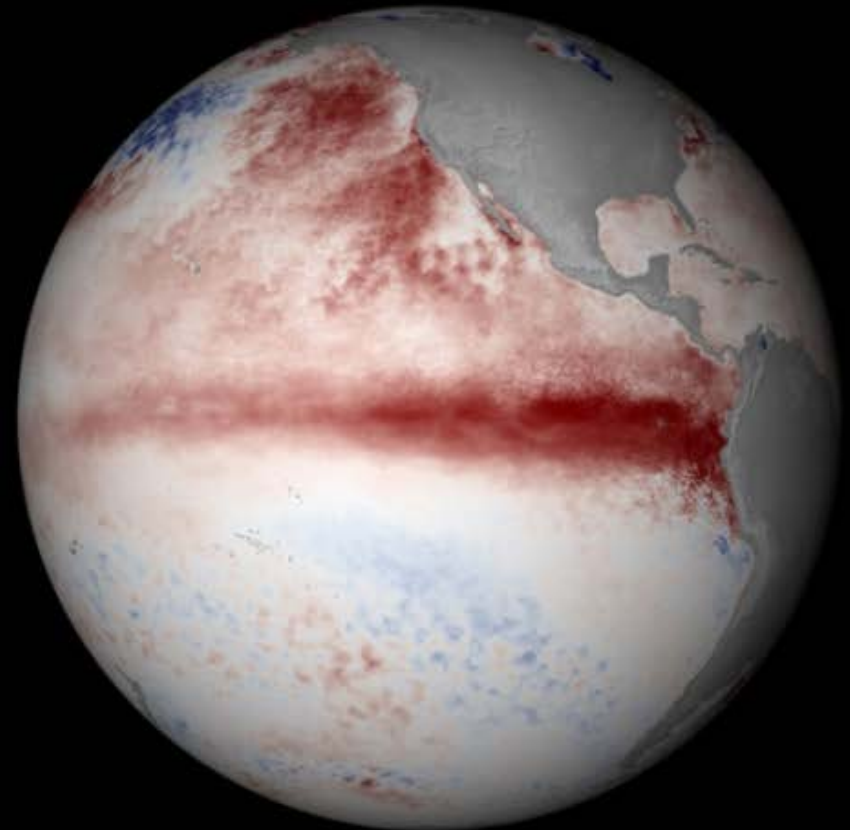


What is El Nino?

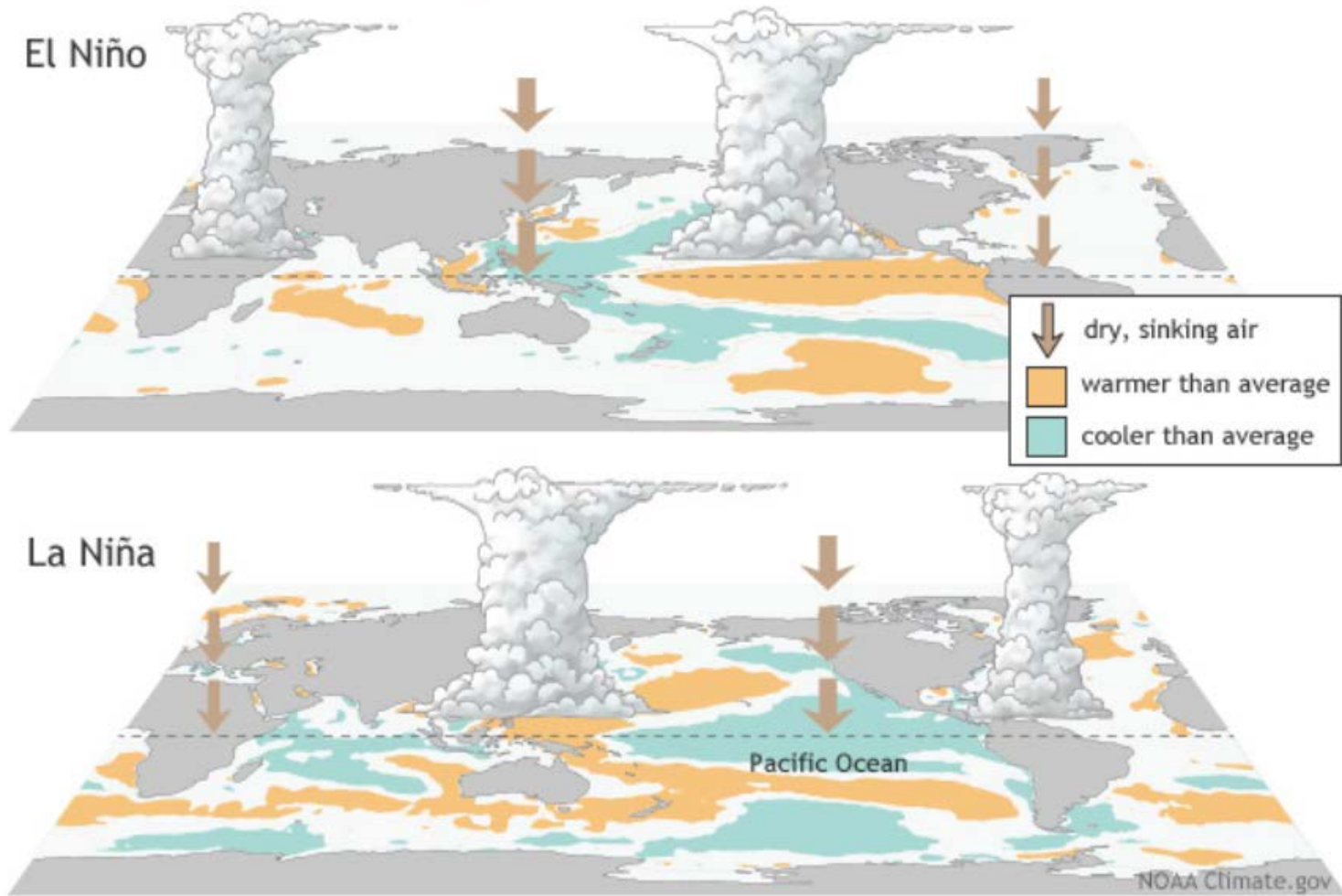


November 1997

NOAA

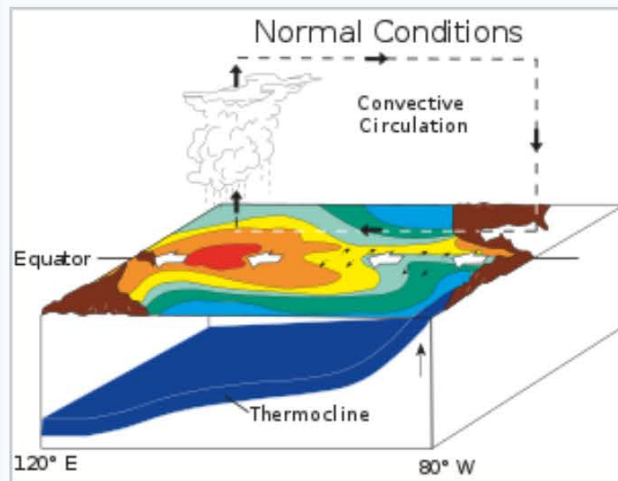


July 2015



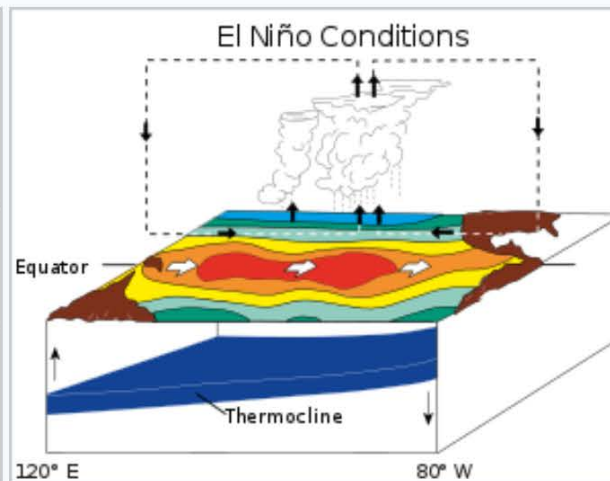


Normal



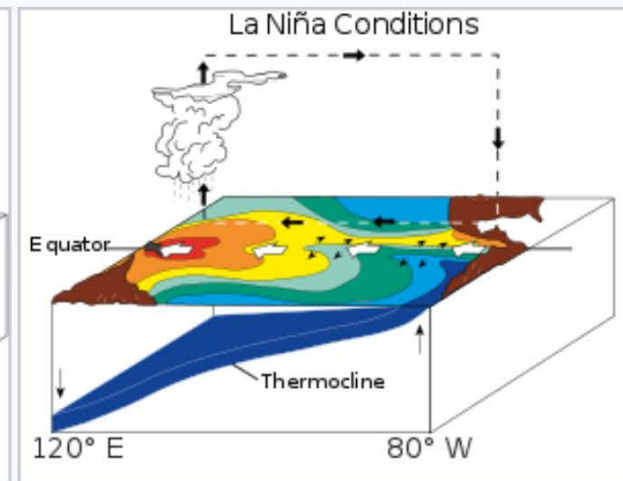
Normal Pacific pattern: Equatorial winds gather warm water pool toward the west. Cold water upwells along South American coast.

El Nino

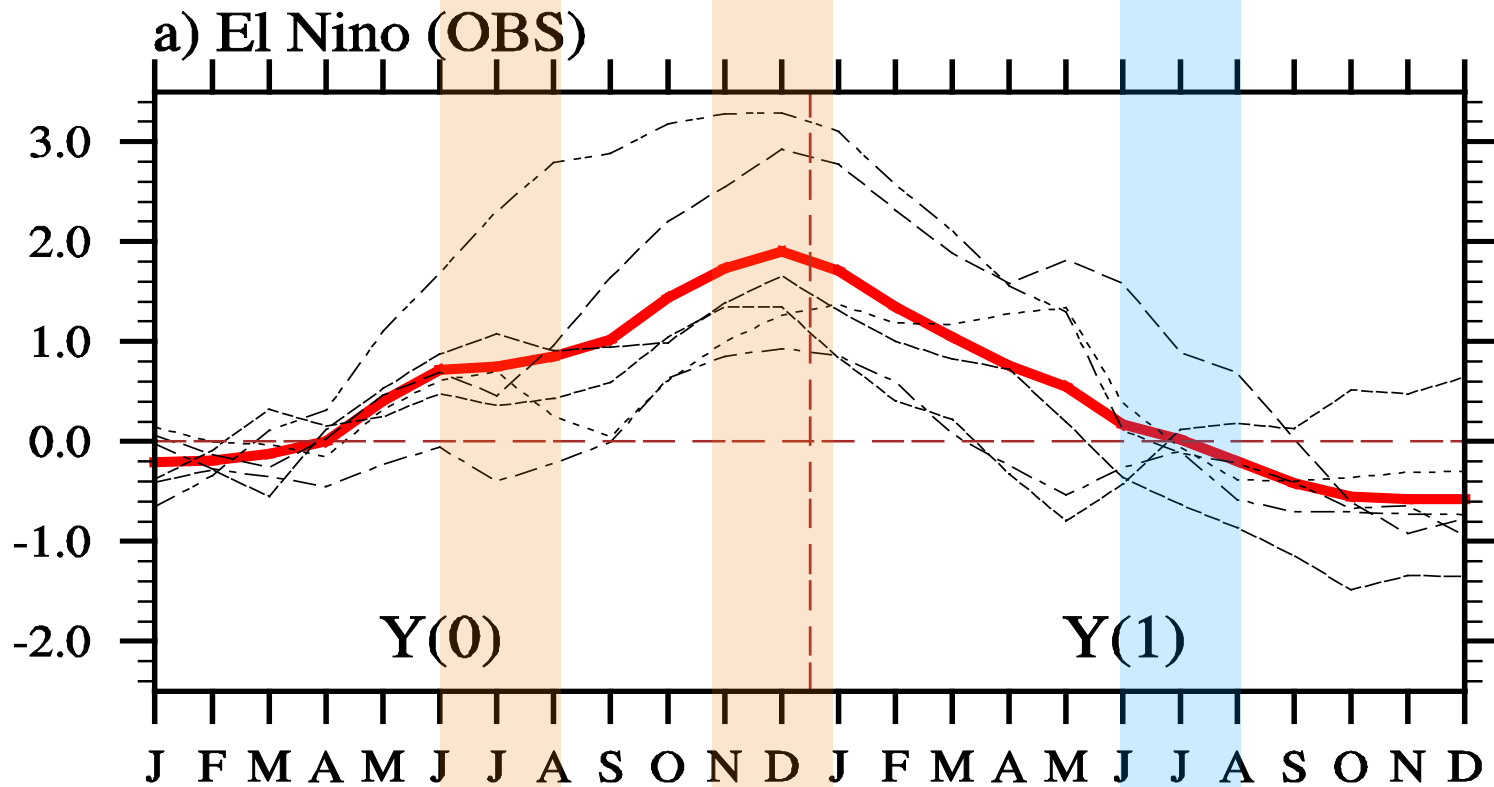


El Niño conditions: Warm water pool approaches the South American coast. The absence of cold upwelling increases warming.

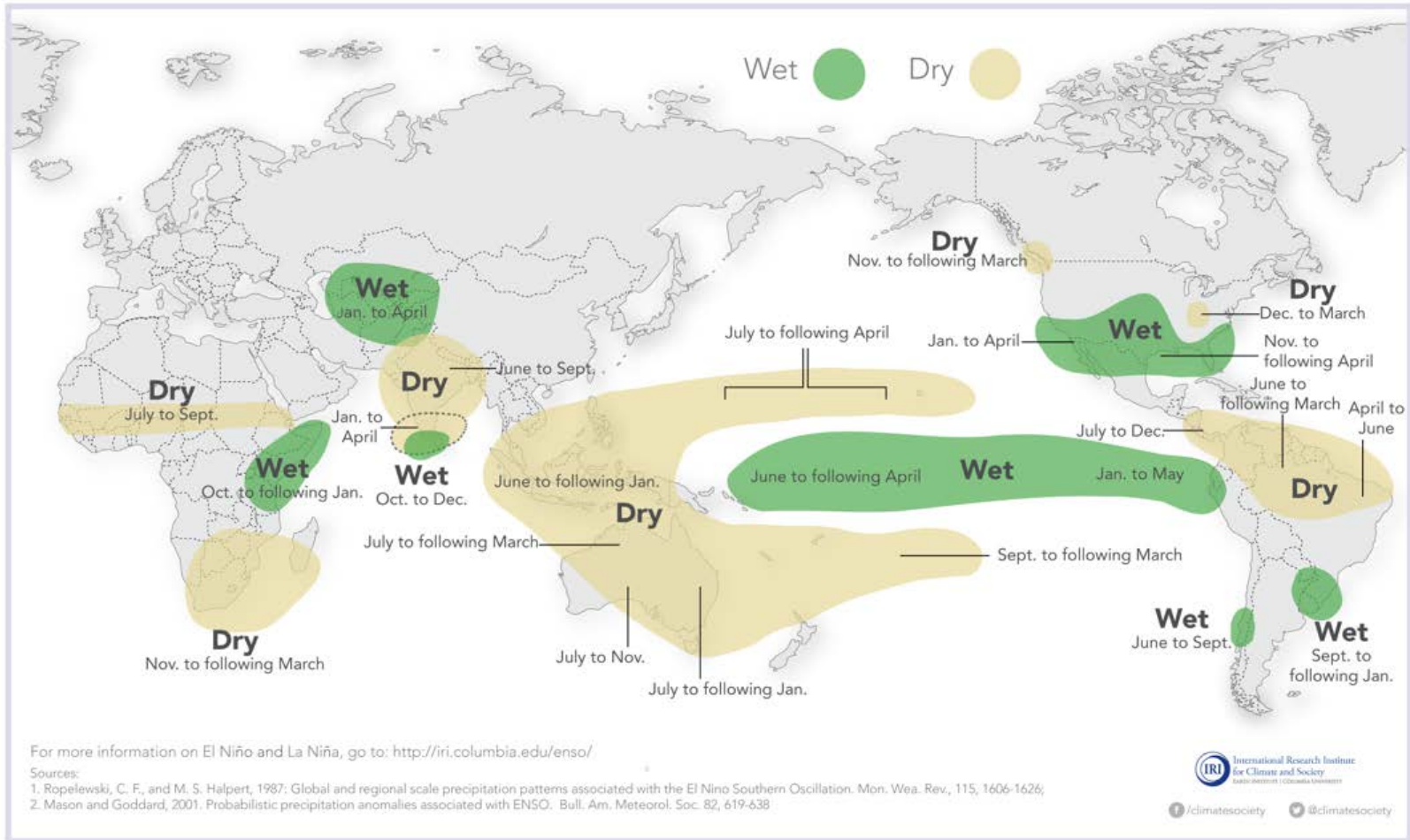
La Nina



La Niña conditions: Warm water is farther west than usual.



Monthly mean Niño3 (5° S– 5° N, 150° – 90° W) SST anomalies



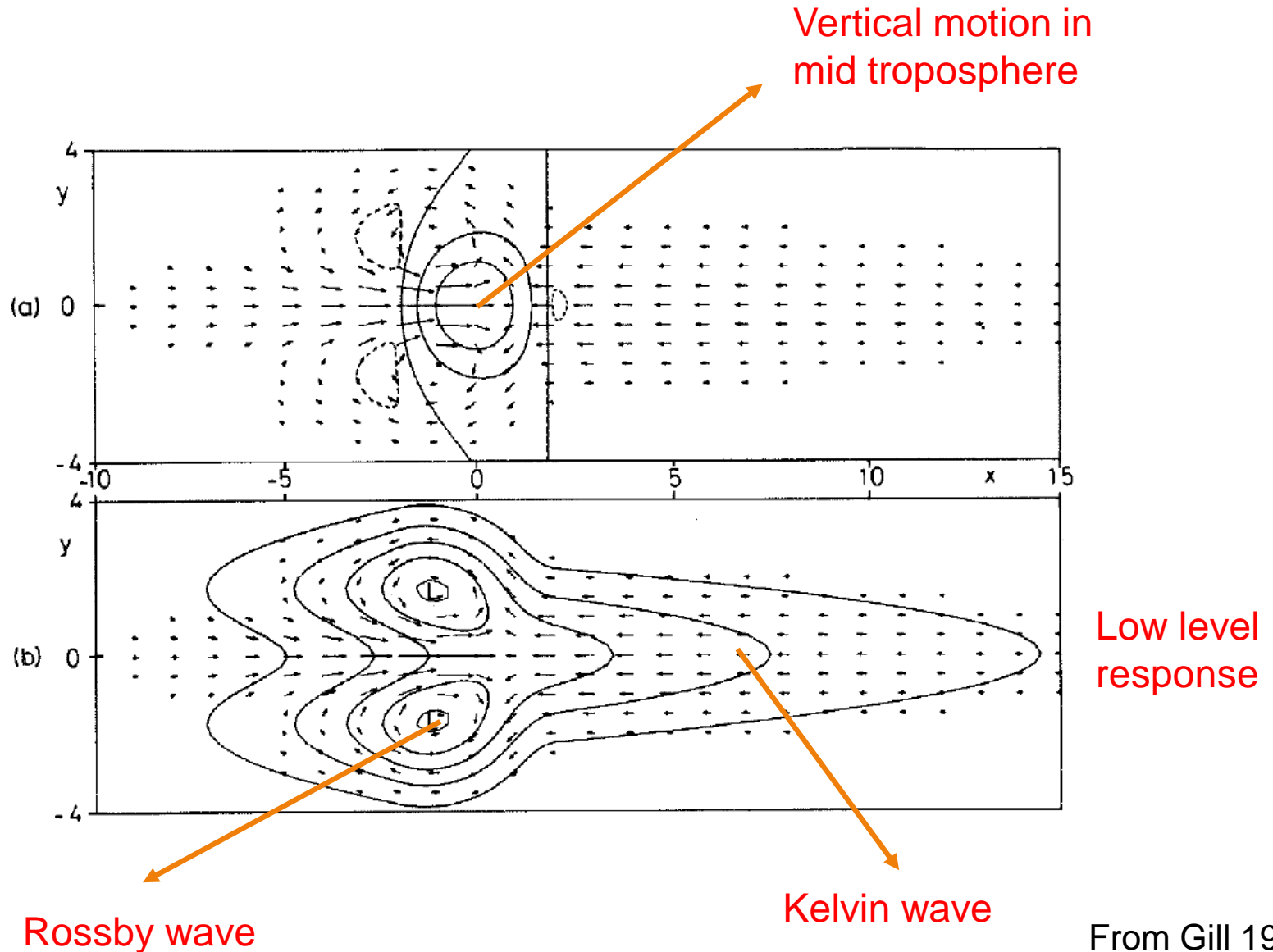


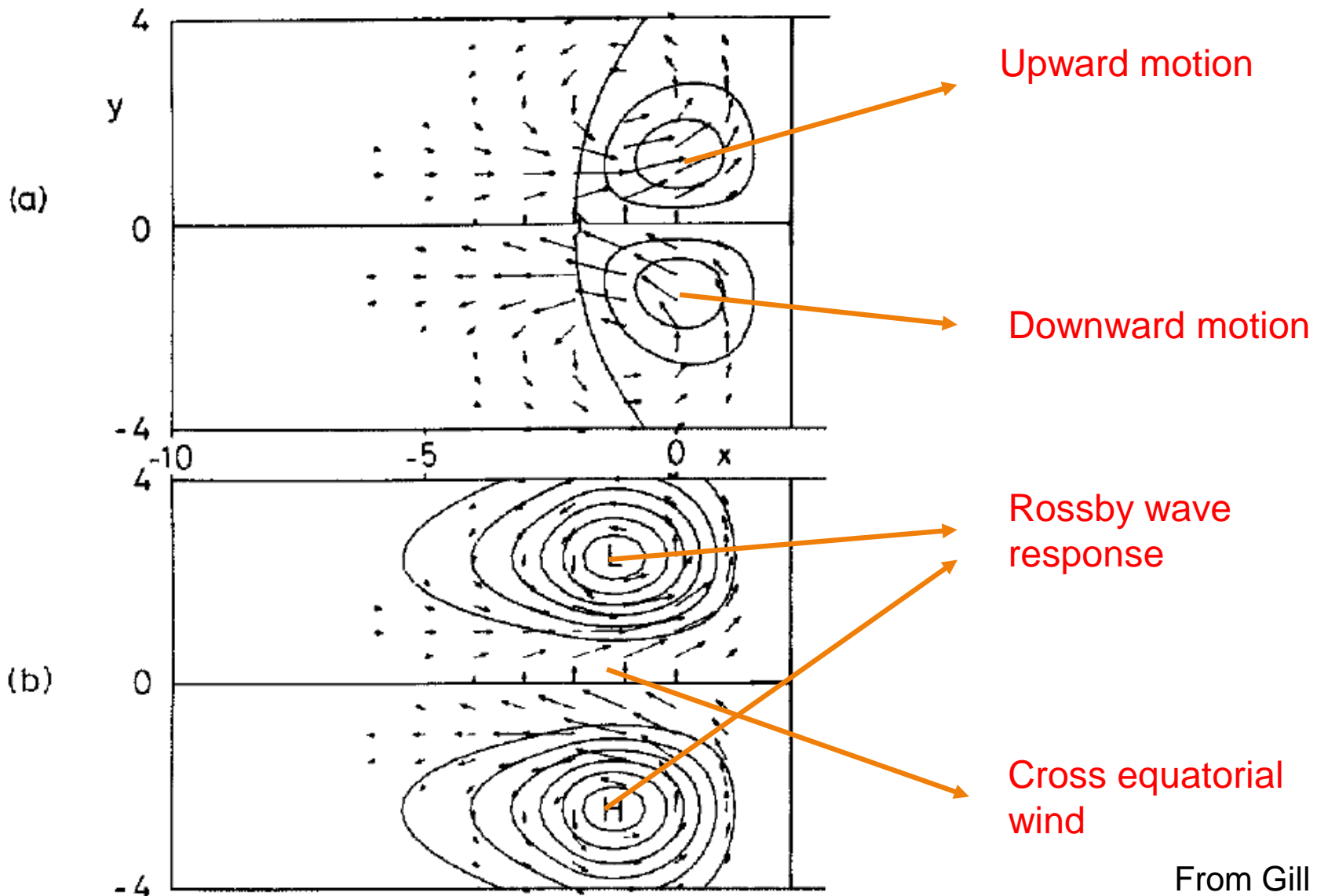
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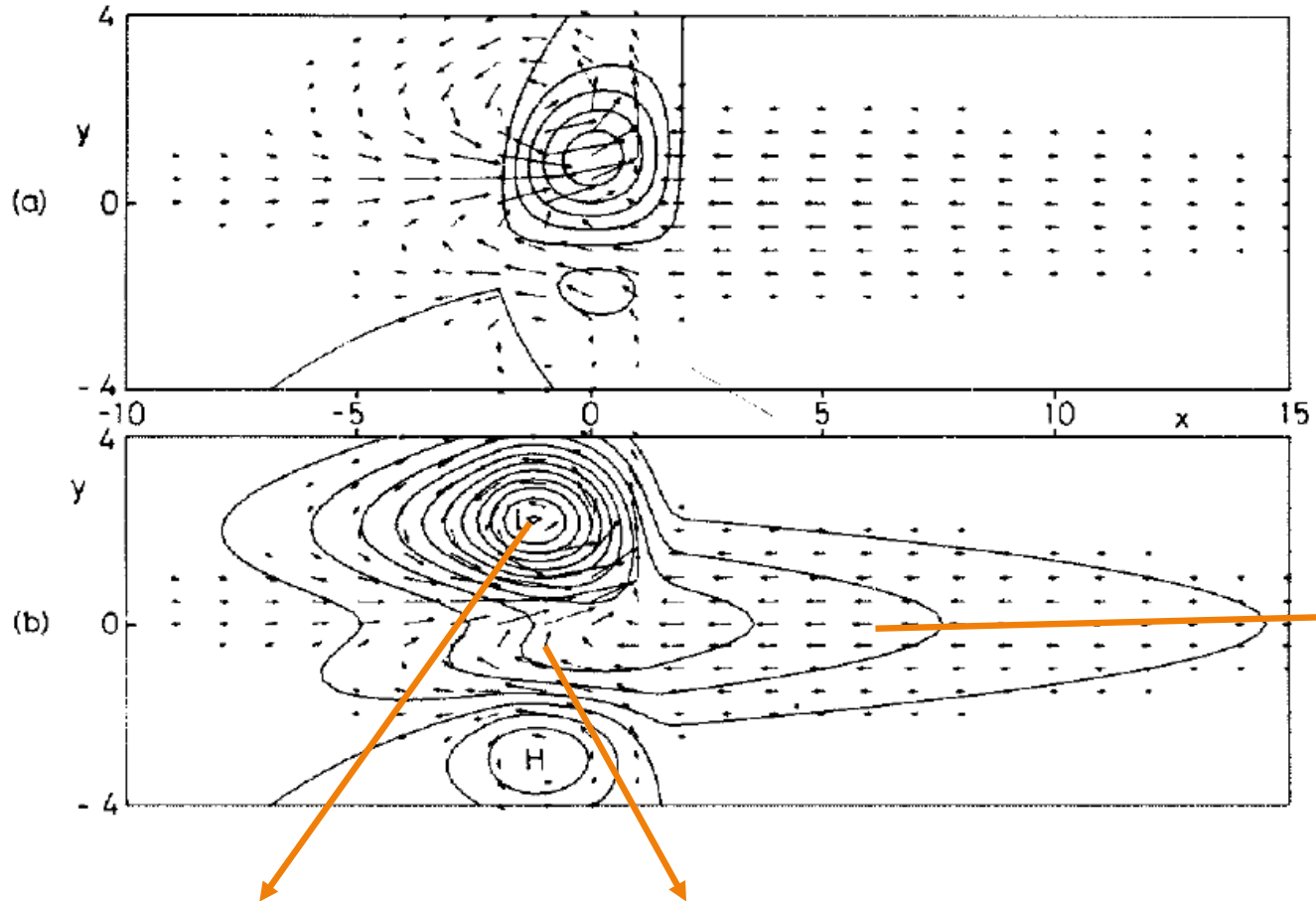


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Responses to heating symmetric about equator







Heating only in NH
, combination of
above two types of
forcing

Kelvin wave
response

Rossby wave
response

Cross-equatorial
wind



Outline

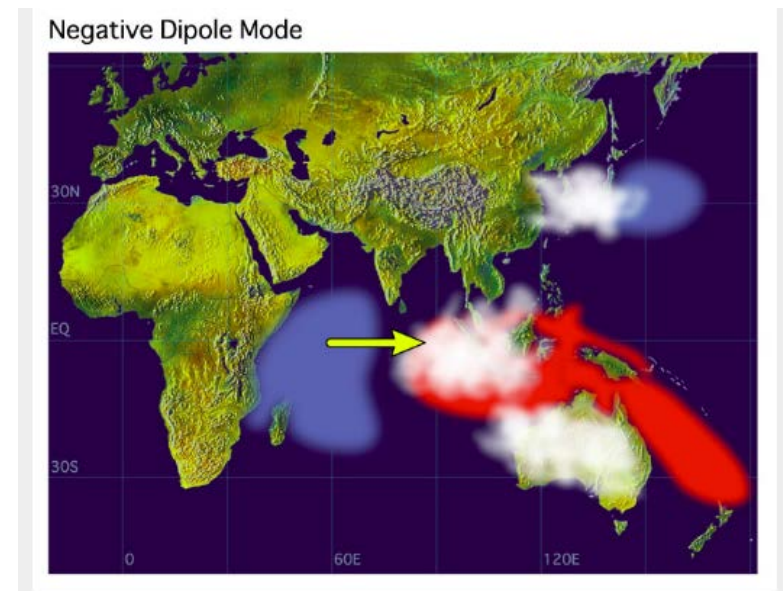
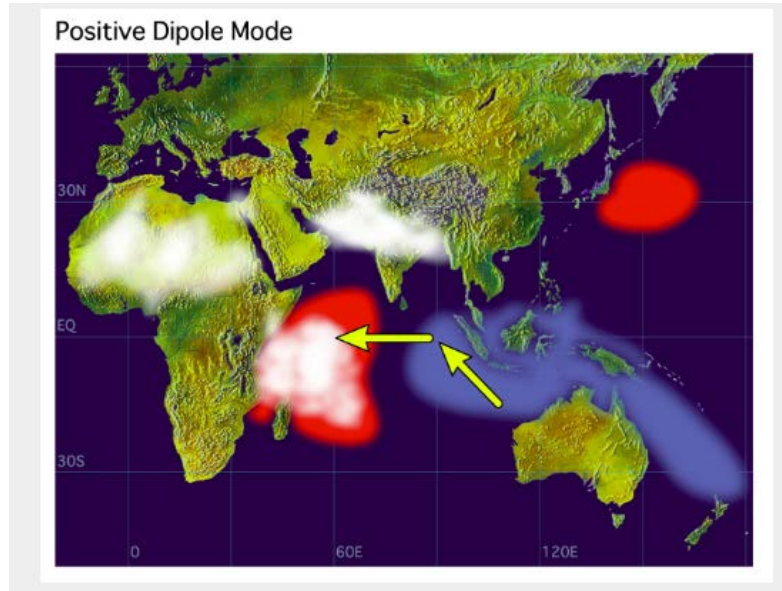


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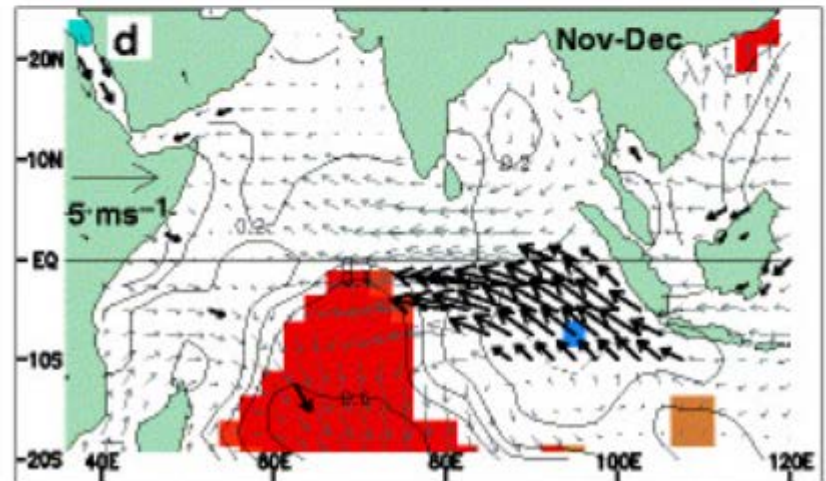
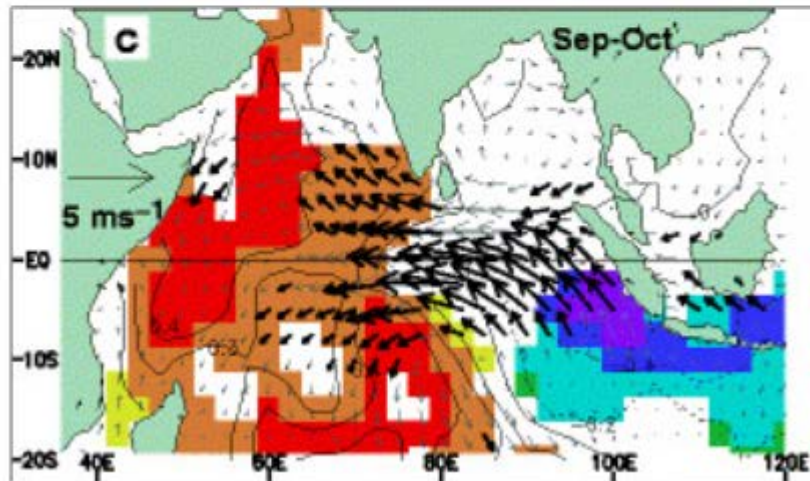
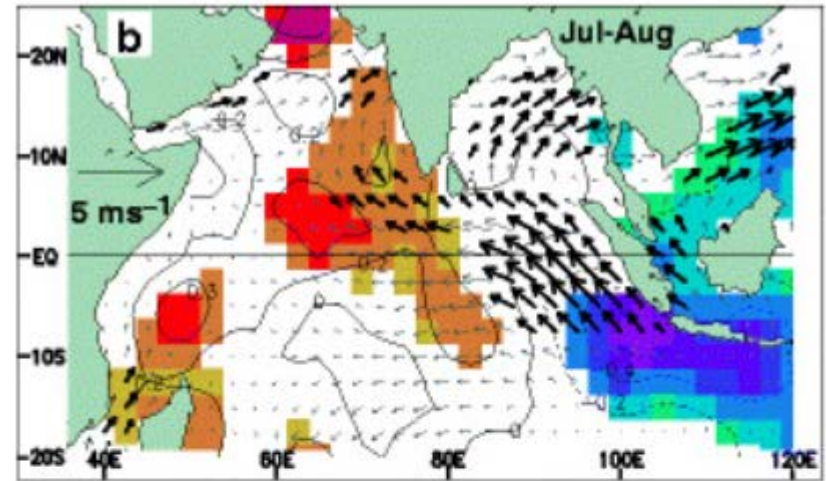
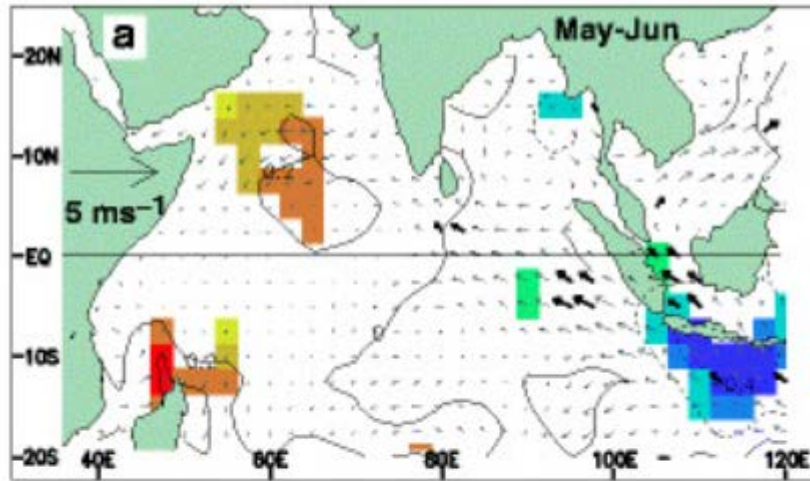


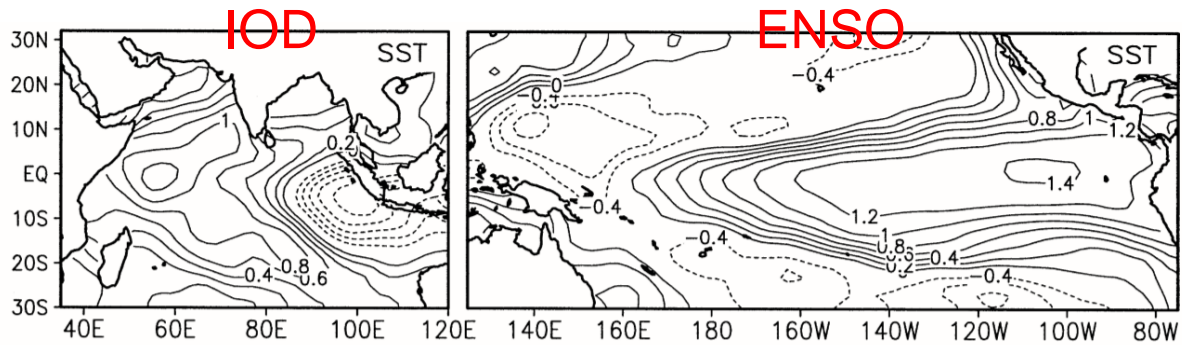
Positive IOD

Negative IOD

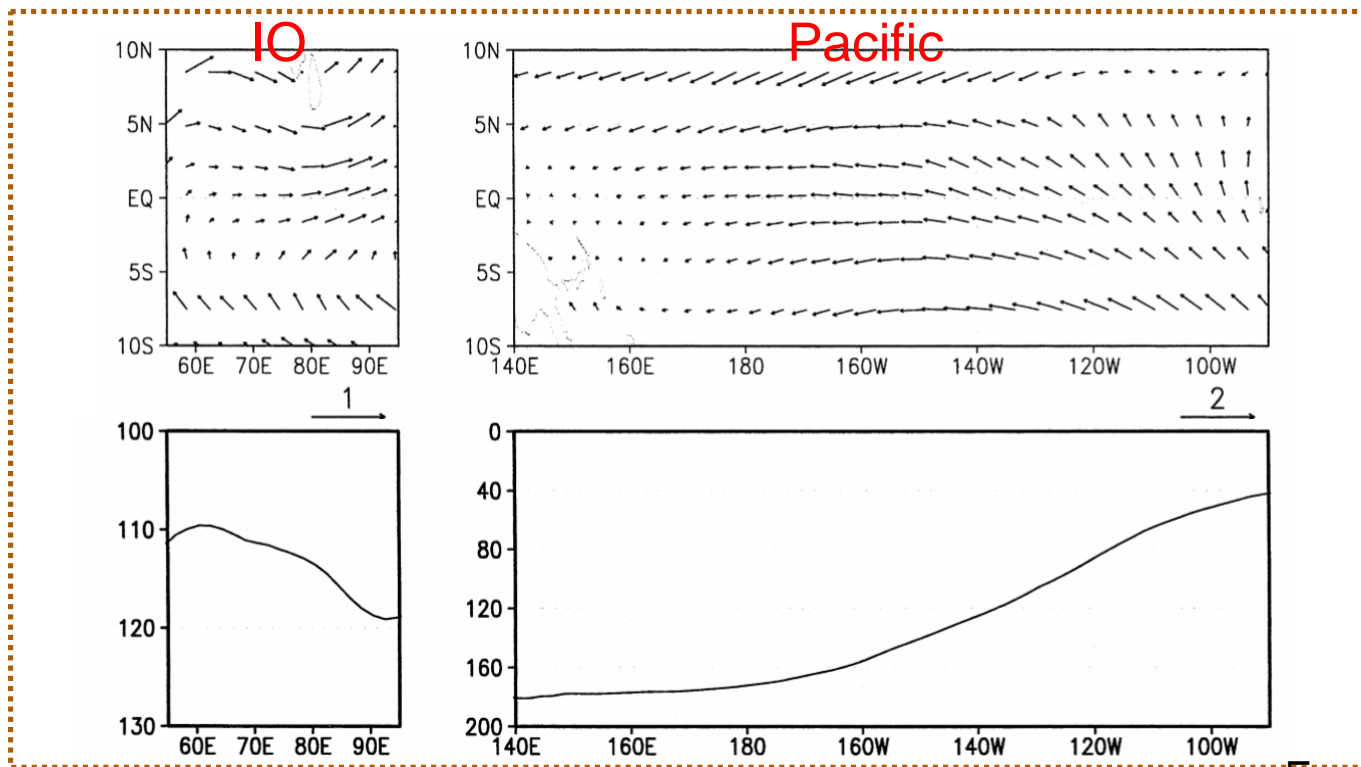


From JAMESTEC



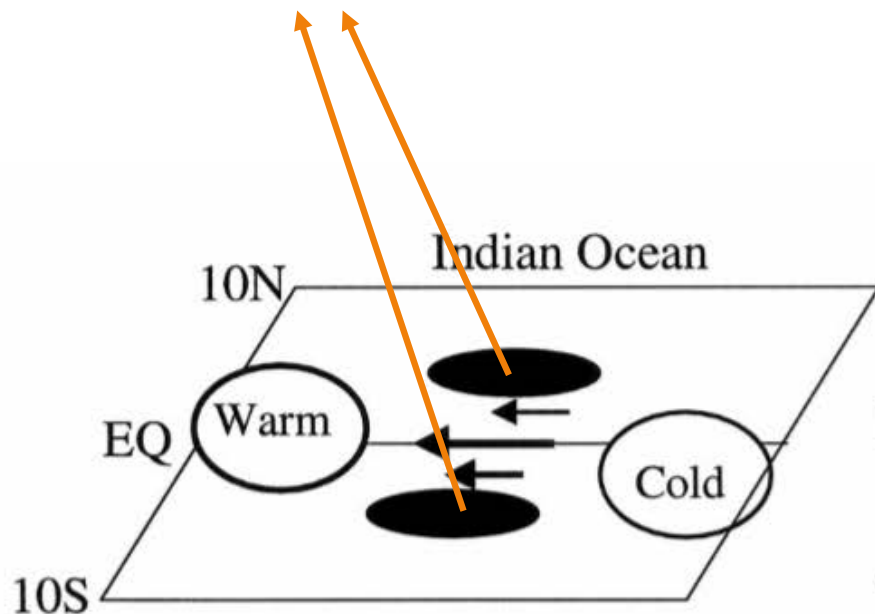


Difference in climatology

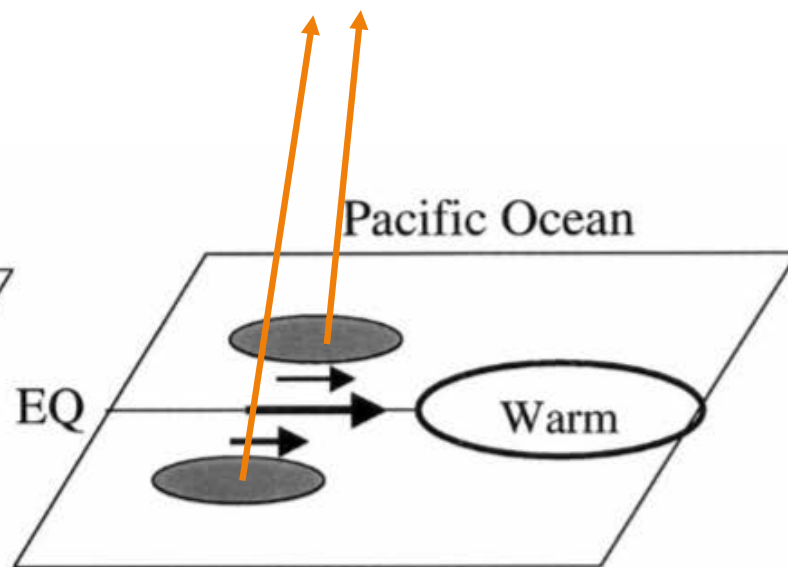




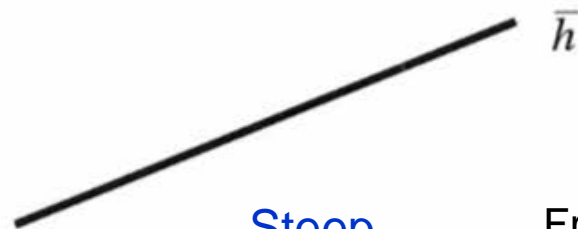
Downwelling
Rossby wave
driven by
anticyclonic vort



Upwelling Rossby
wave driven by
cyclonic vort



Gentle

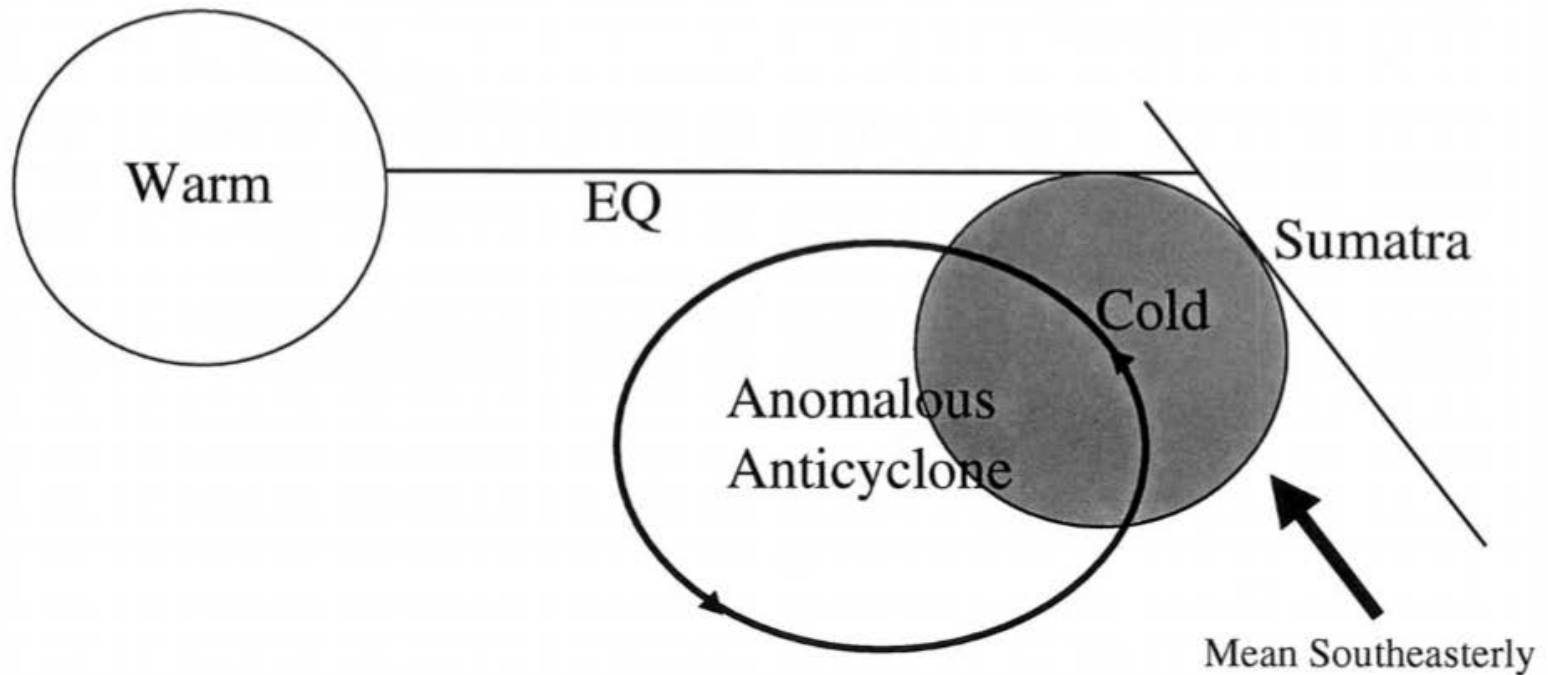


Steep

From Li et al. 2003

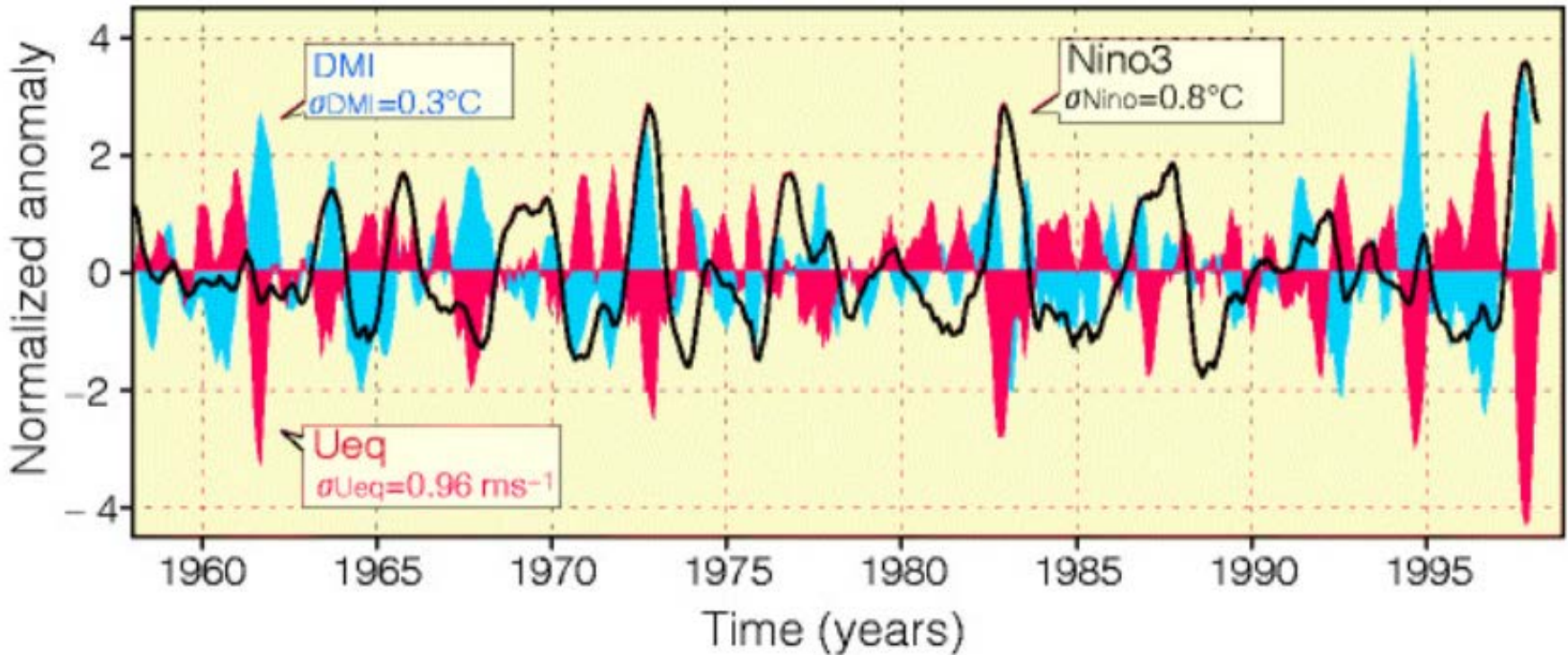


Wind-evaporation-SST positive feedback



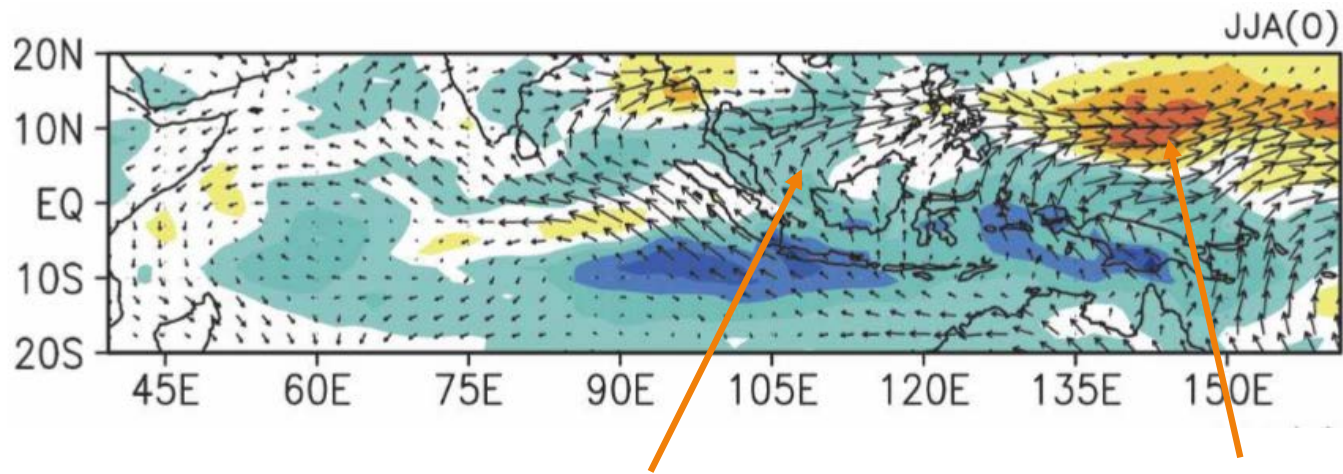
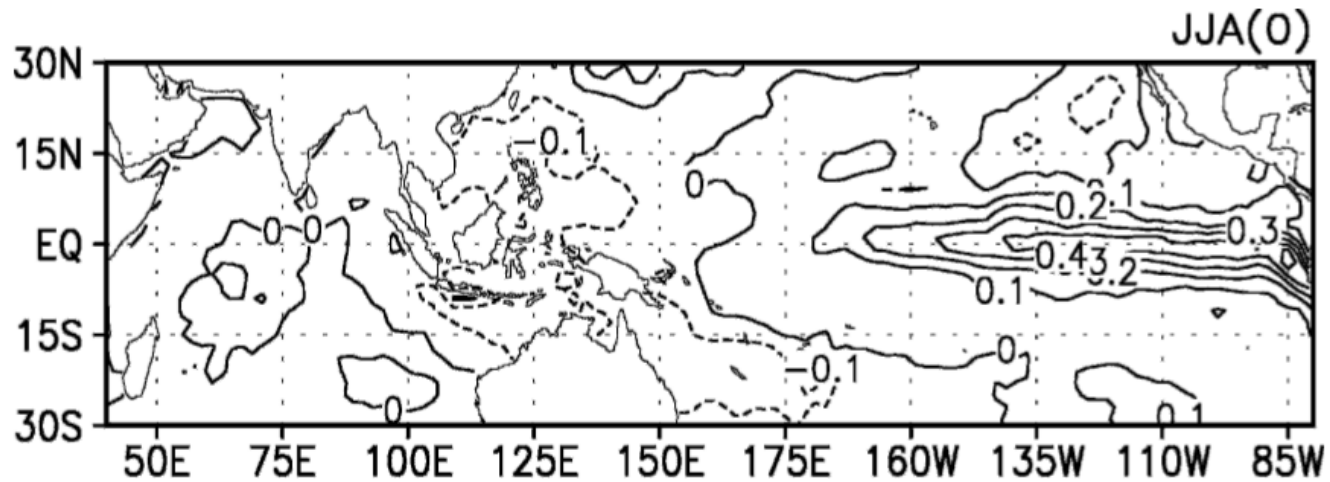


IOD is highly associated with ENSO



From Saji et al. 1999

How ENSO stimulate IOD ?



Cross-equatorial
wind

Enhanced WNP
monsoon



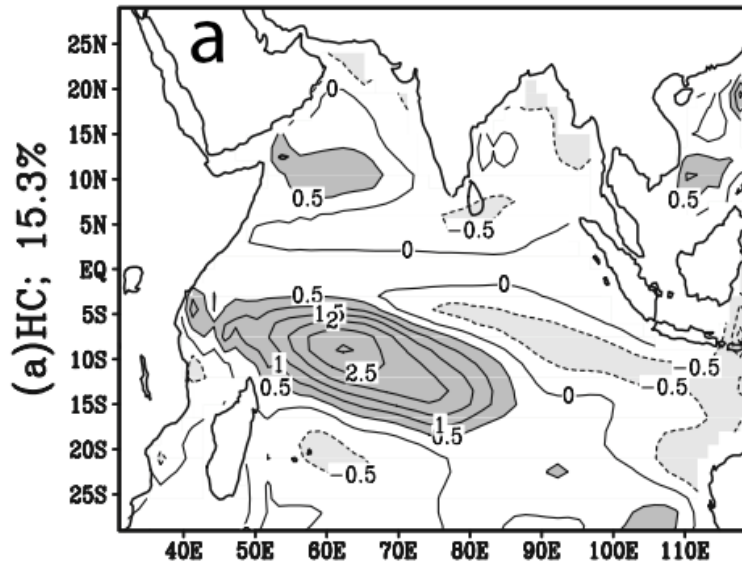
Outline



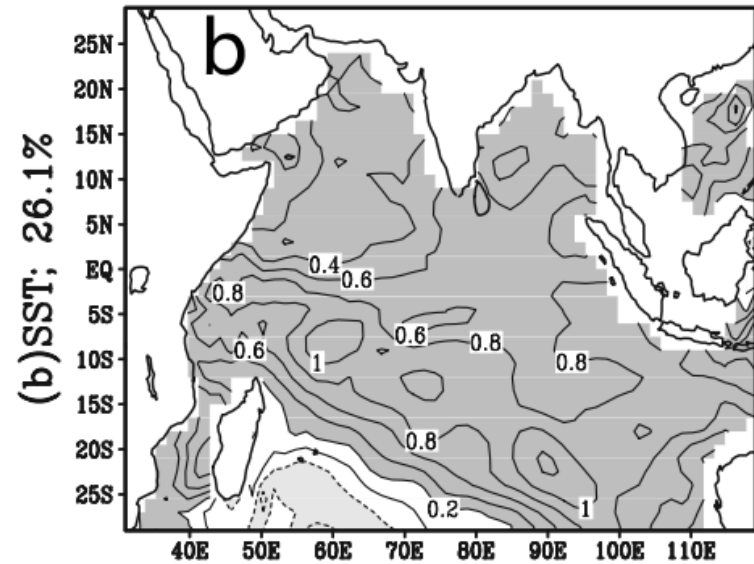
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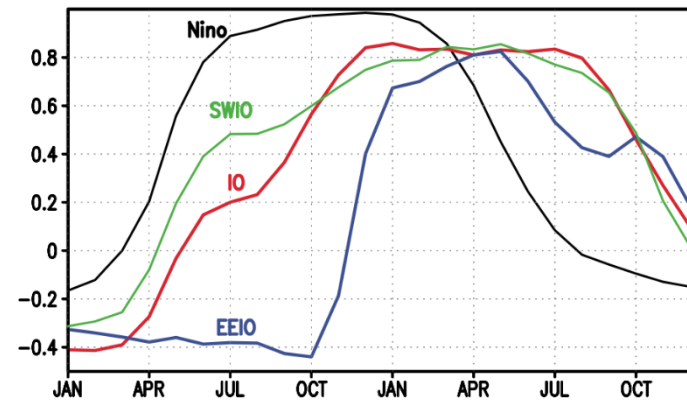
300m HC

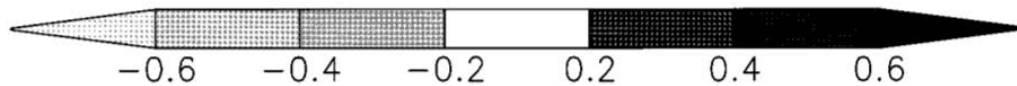
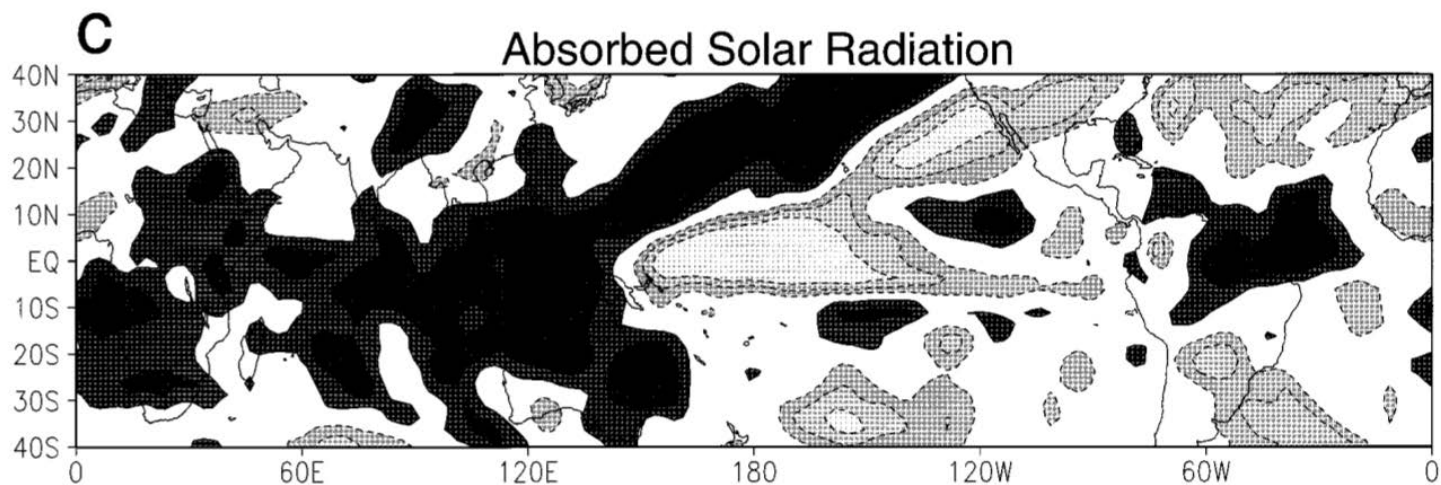
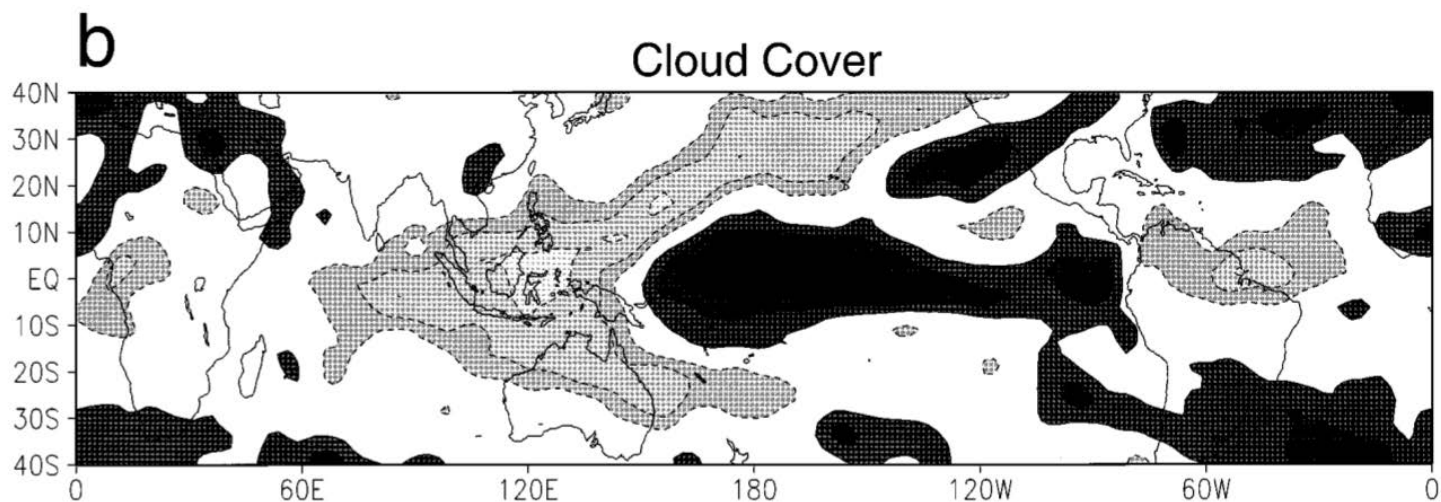


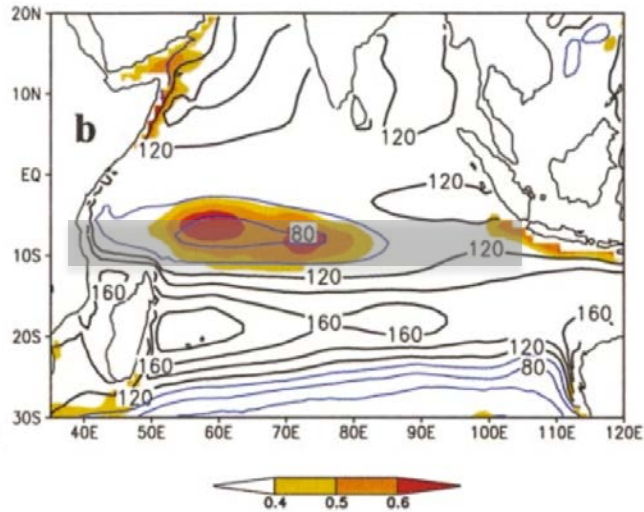
SST



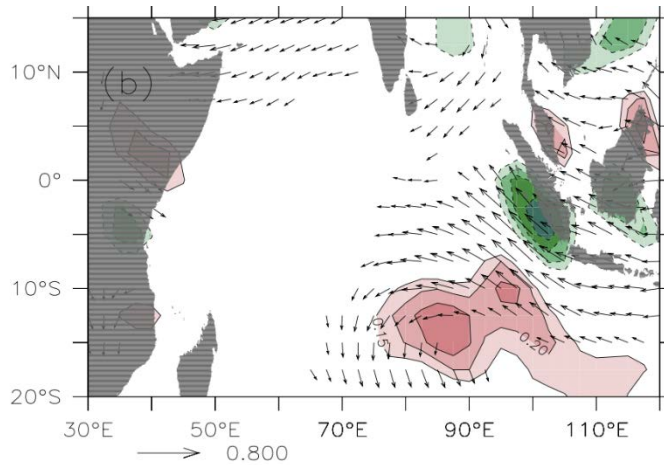
IOBM lags ENSO about one season



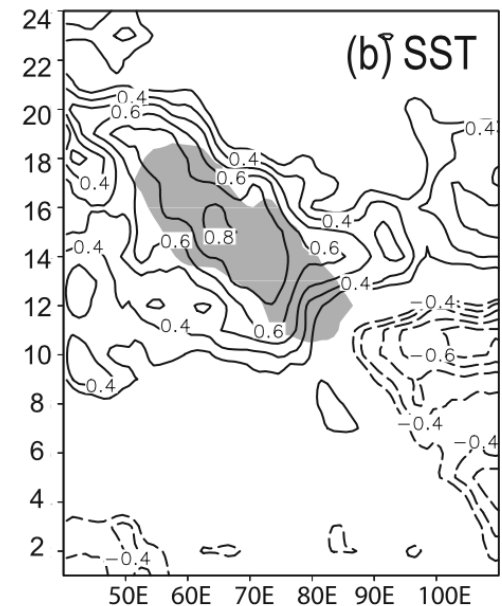
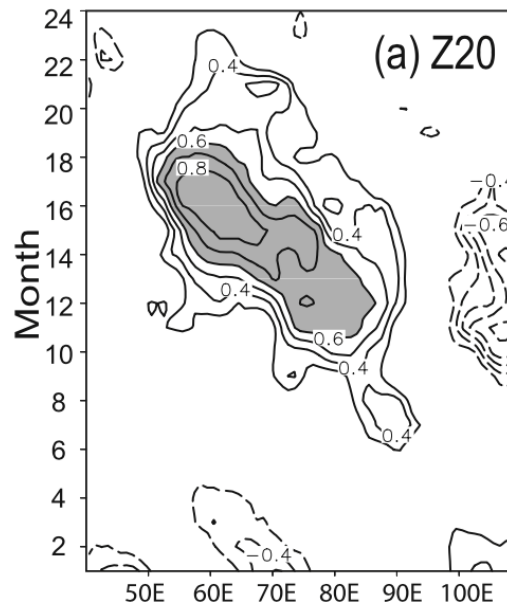




From Xie et al. 2002



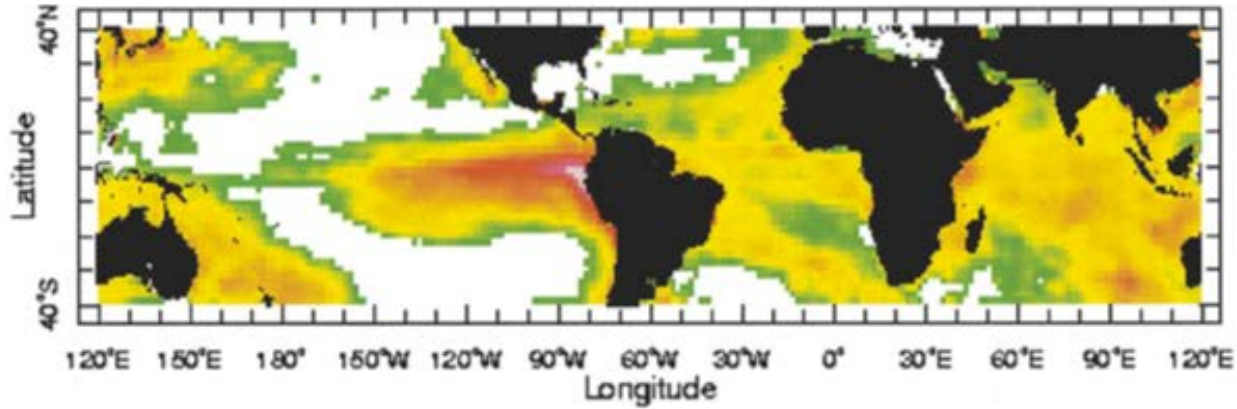
From Yu et al. 2005



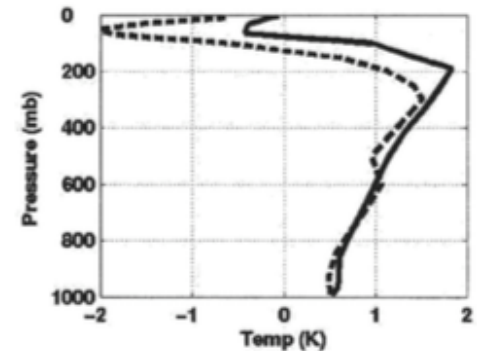
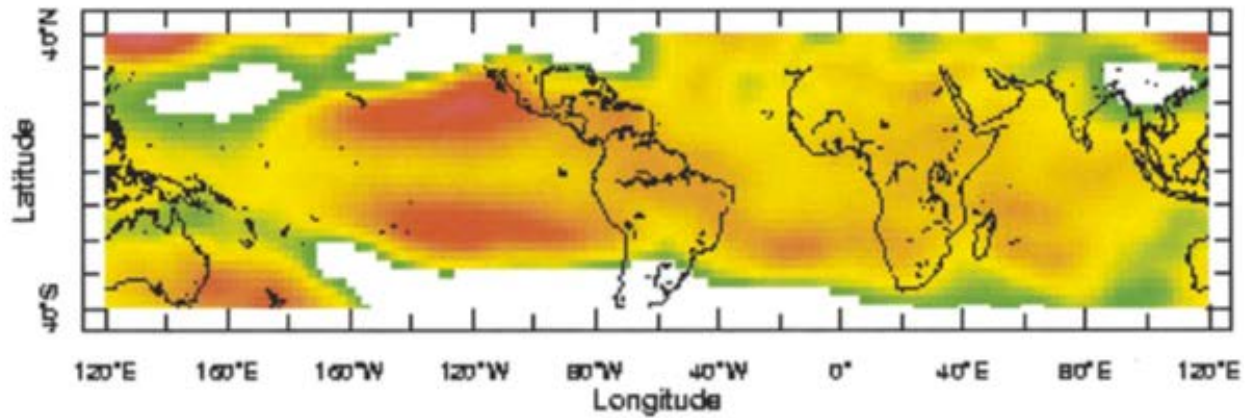
From Xie et al. 2002



SST



400hPa T





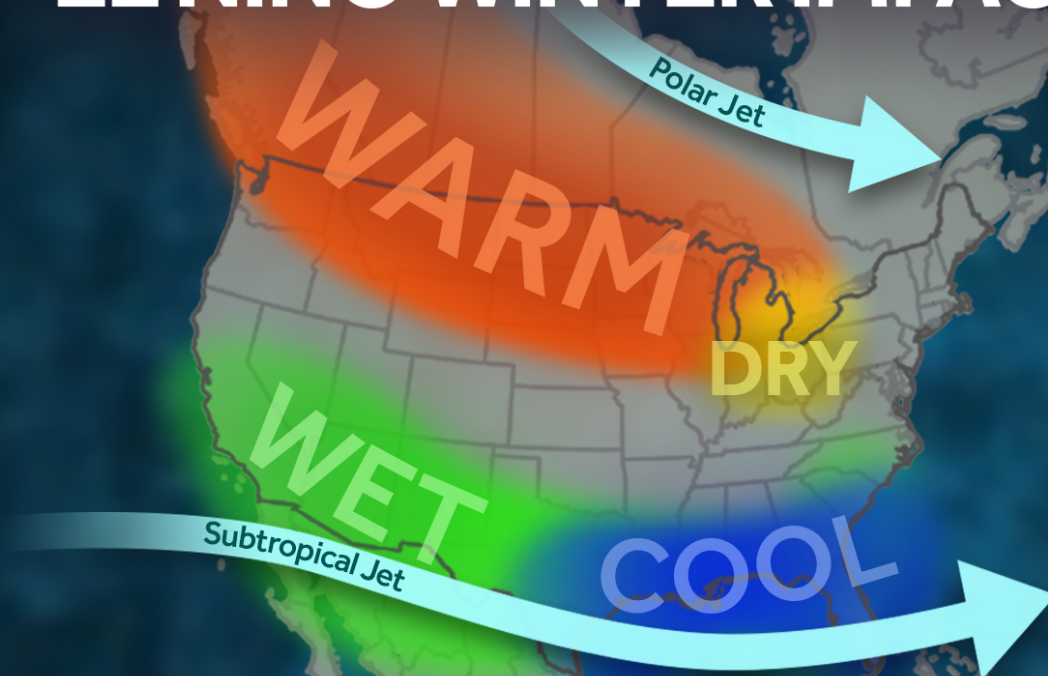
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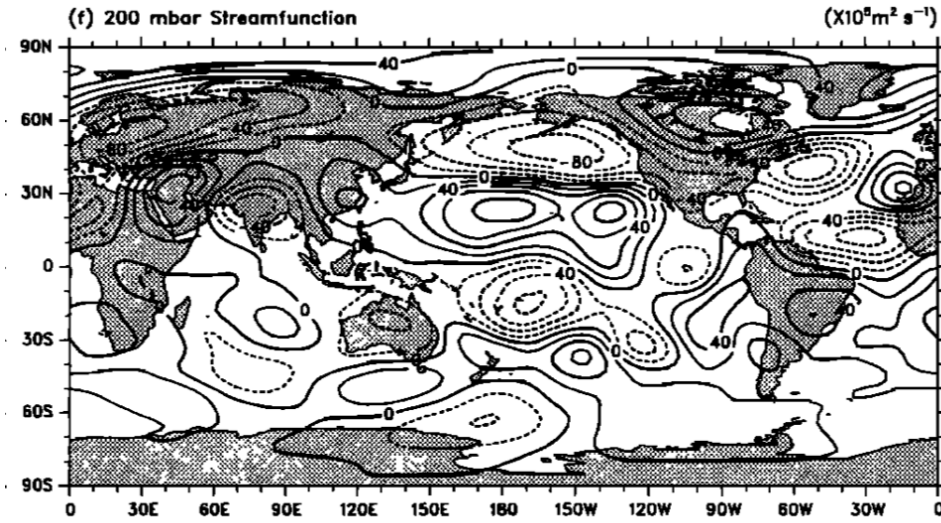


EL NIÑO WINTER IMPACTS

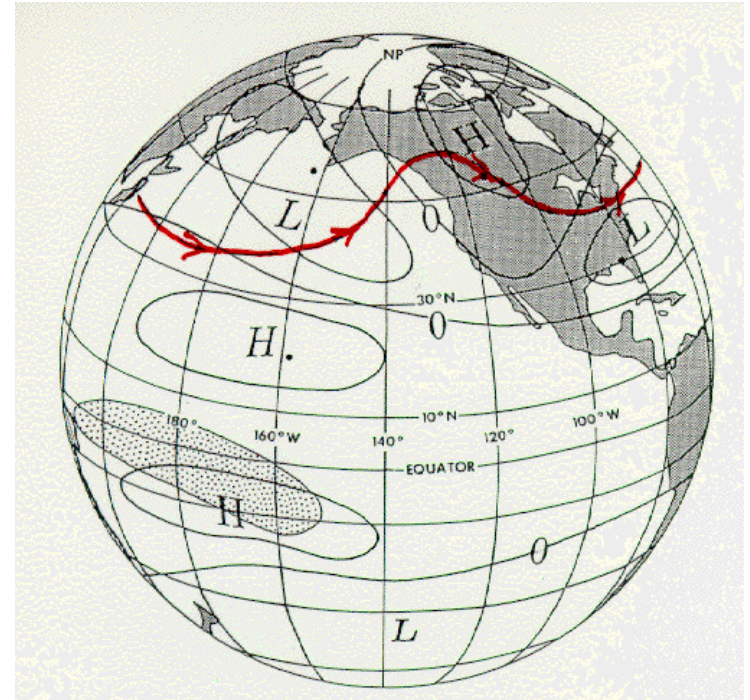


Source: NOAA Climate Prediction Center

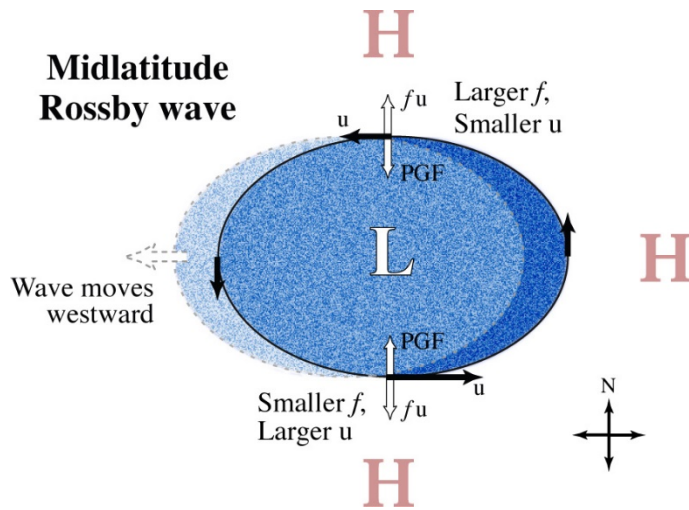
CLIMATE CO CENTRAL



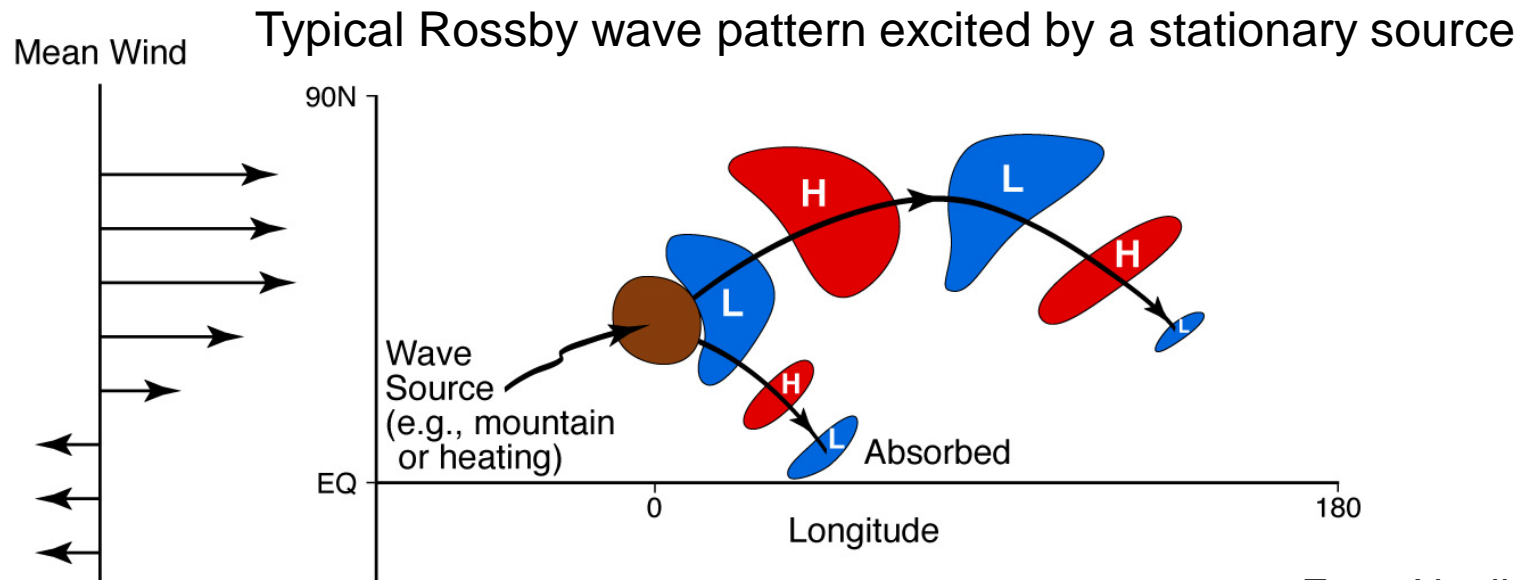
From Trenberth et al. 1998



From Horel and Wallace 1981



Rossby wave propagates westward when mean wind is zero

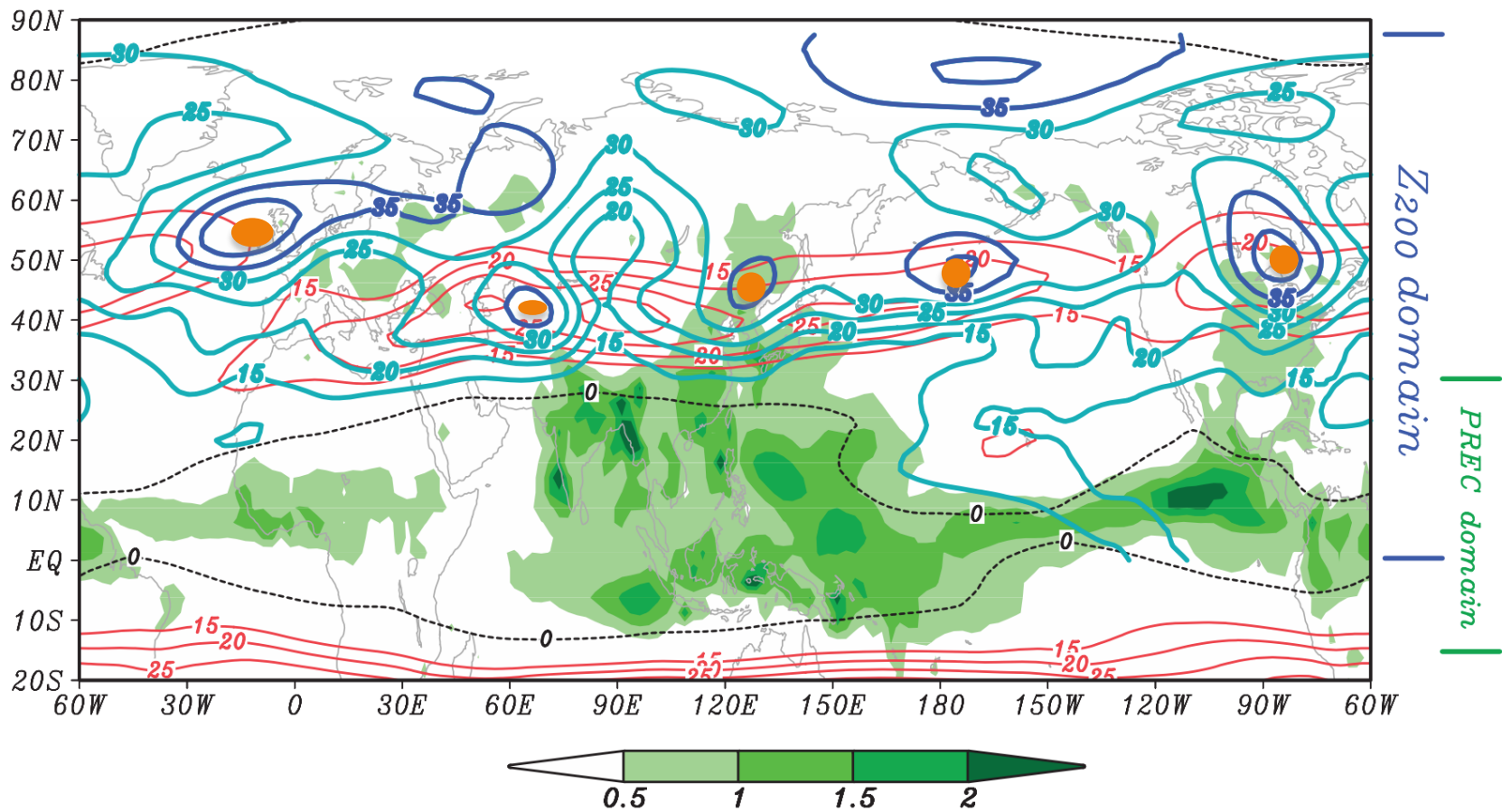


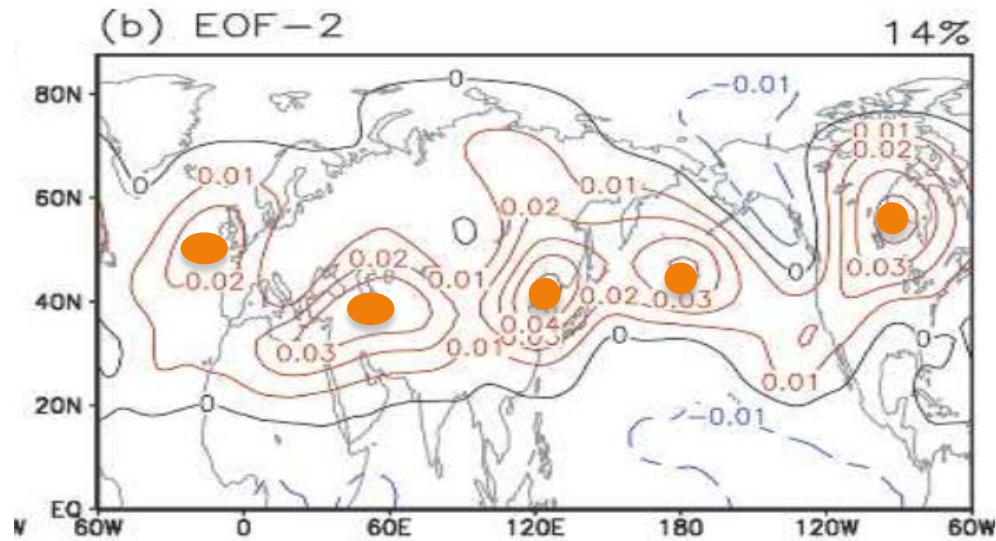


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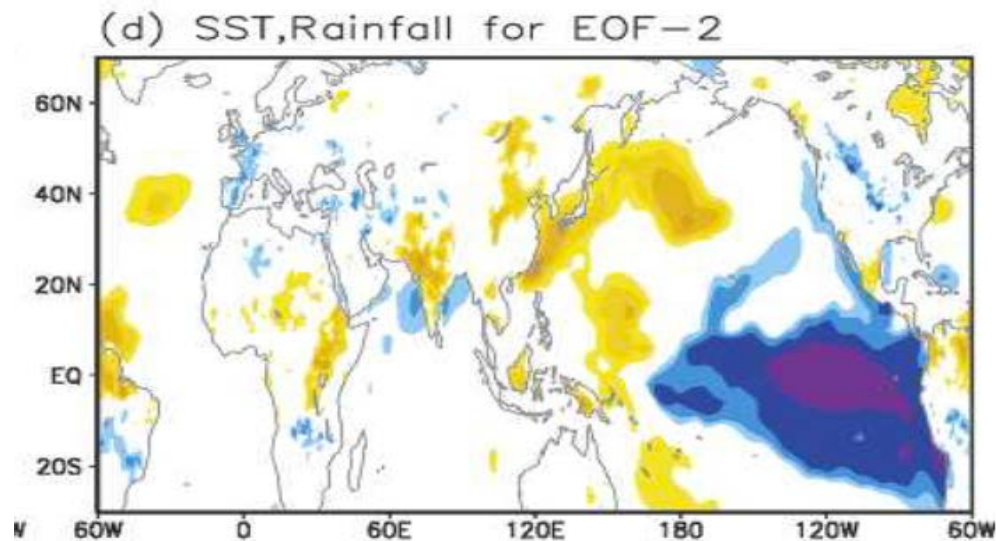


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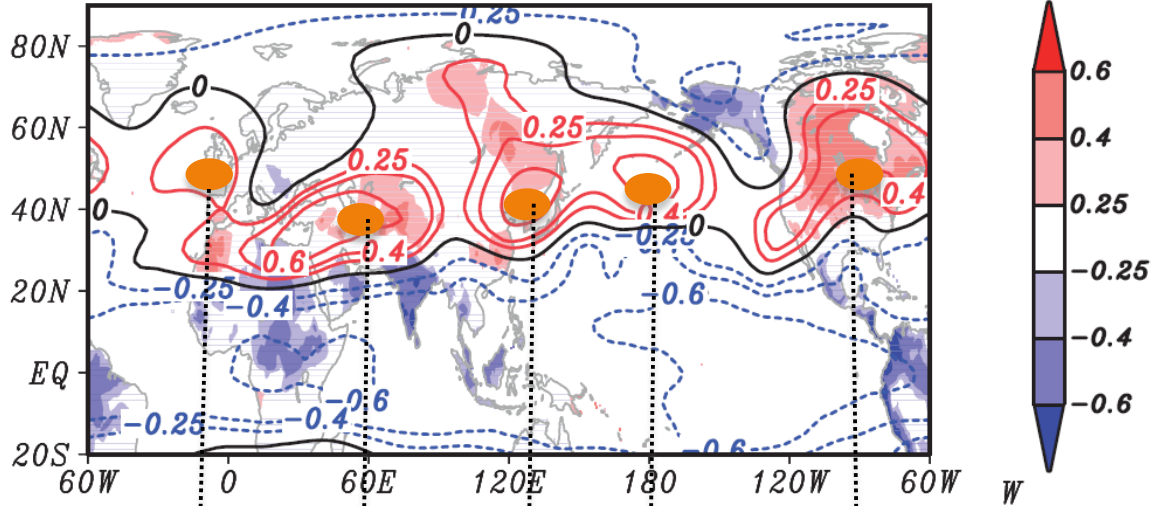
Zonal wave number 5



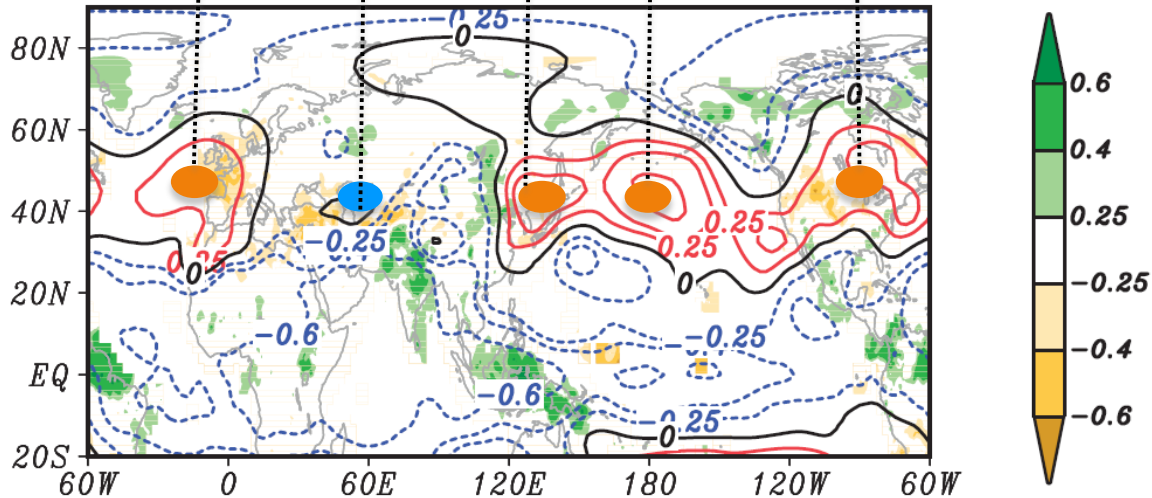
La Nina-like SSTAs pattern



(a) r of M1 with Z200 and temp.



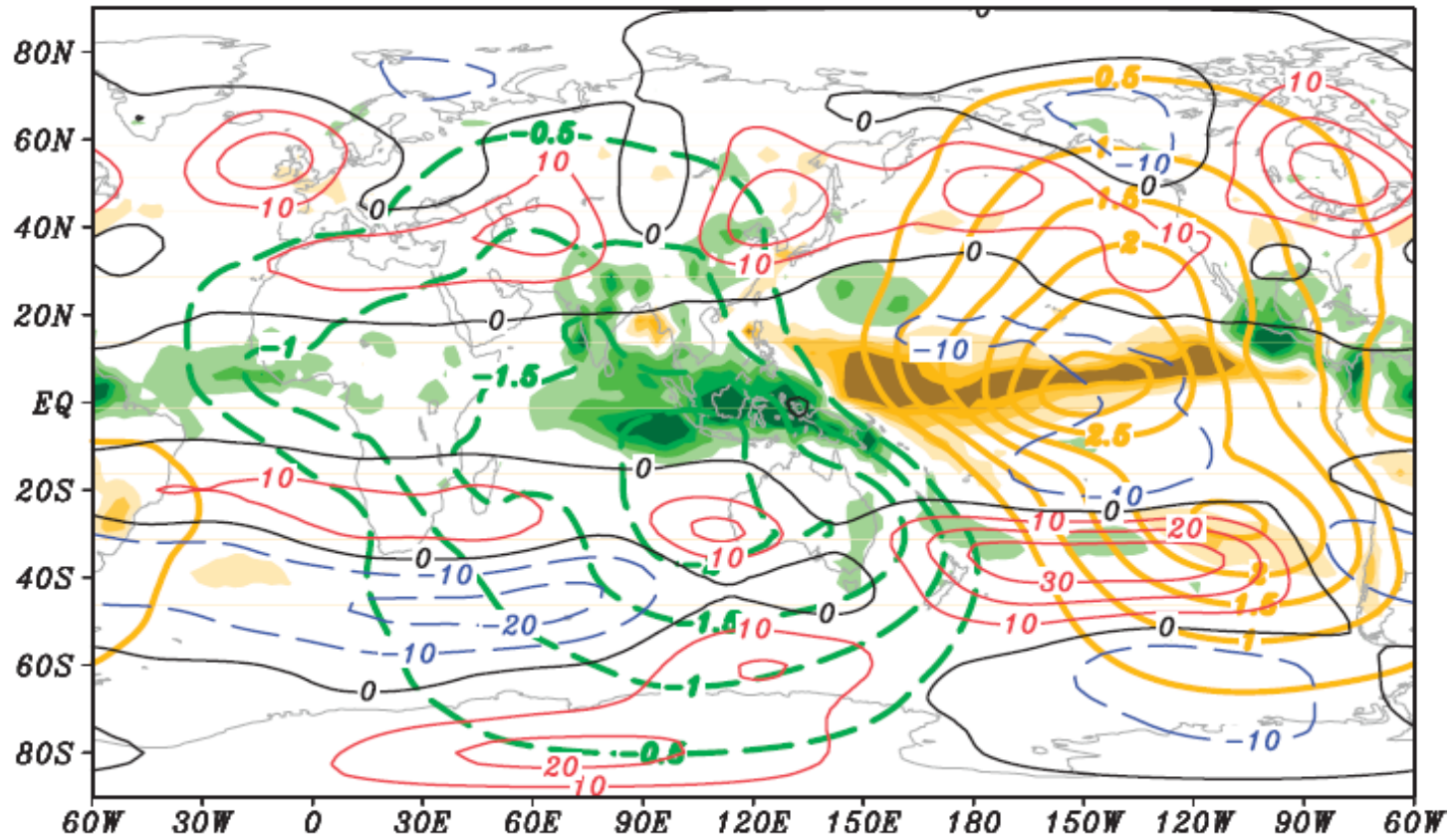
(b) r of M1 with Z700 and rainfall



From Ding et al. 2011



(a) JJA(0) PREC, VP and Z200





Summary



- ENSO is a air-sea coupled system and dominant mode on the interannual time scale
- ENSO has global climate impacts
- IOD is stimulated by ENSO through enhancing WNP summer monsoon
- IOBM is driven by ENSO through an atmospheric bridge
- ENSO excites CGT pattern in its developing summer and PNA pattern in its mature winter



References



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- Schott, F. A. et al. Indian Ocean circulation and climate variability. *Rev. Geophys*, 47.

A blue-tinted globe of the Earth is centered in the background. The text "Thank You!" is overlaid in the center of the globe. The text is white with a pink-to-white gradient and a black outline. The background transitions from blue at the top to orange at the bottom.

Thank You!