How fast will be the phase-transition of 15/16 El Nino ?

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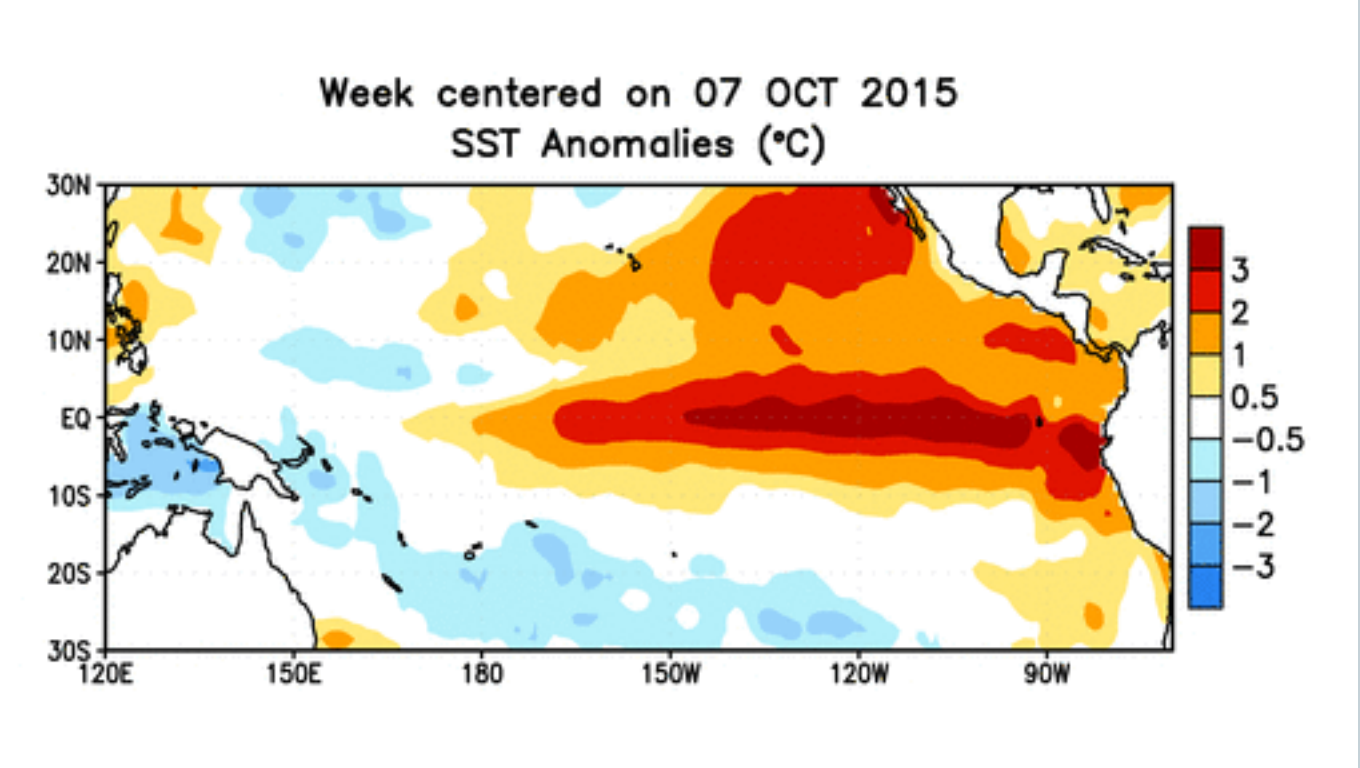
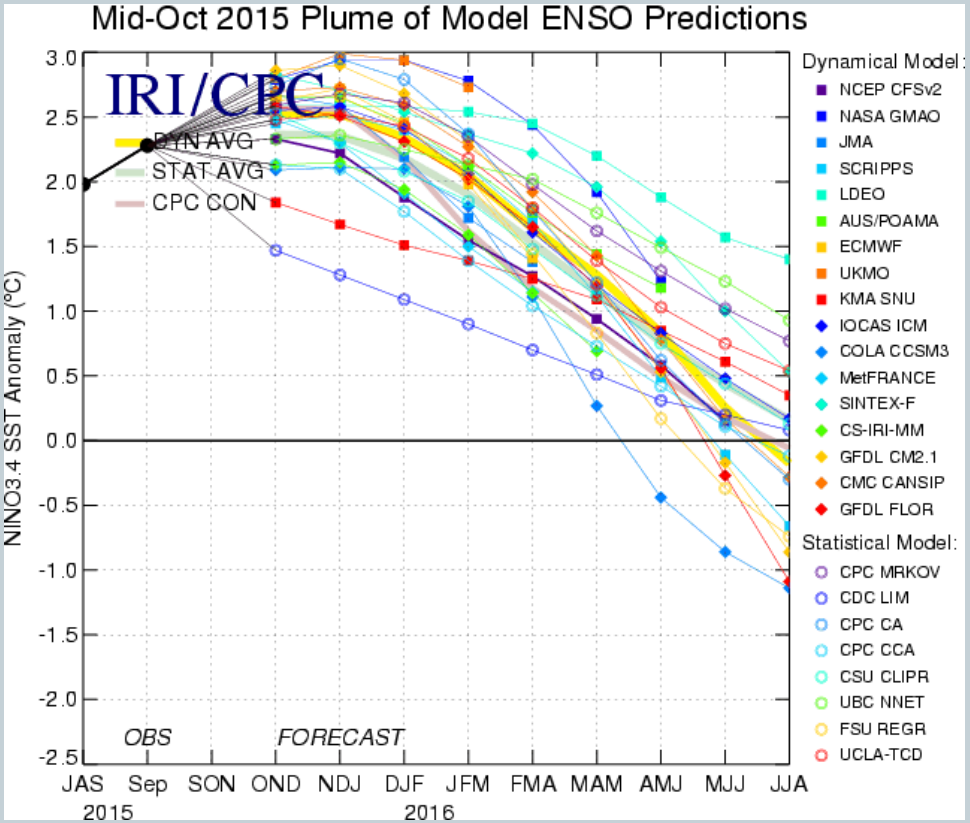
2015/16 El Nino outlook



One of strongest El Nino events is about to occur this year

Nino3.4 forecast plumes from IRI



Several models expect cold phase of ENSO will occur from 2015 summer, but some do not.

→ What can possibly determine the speed of phase-transition of ENSO?

Factors control the ENSO phase-transition

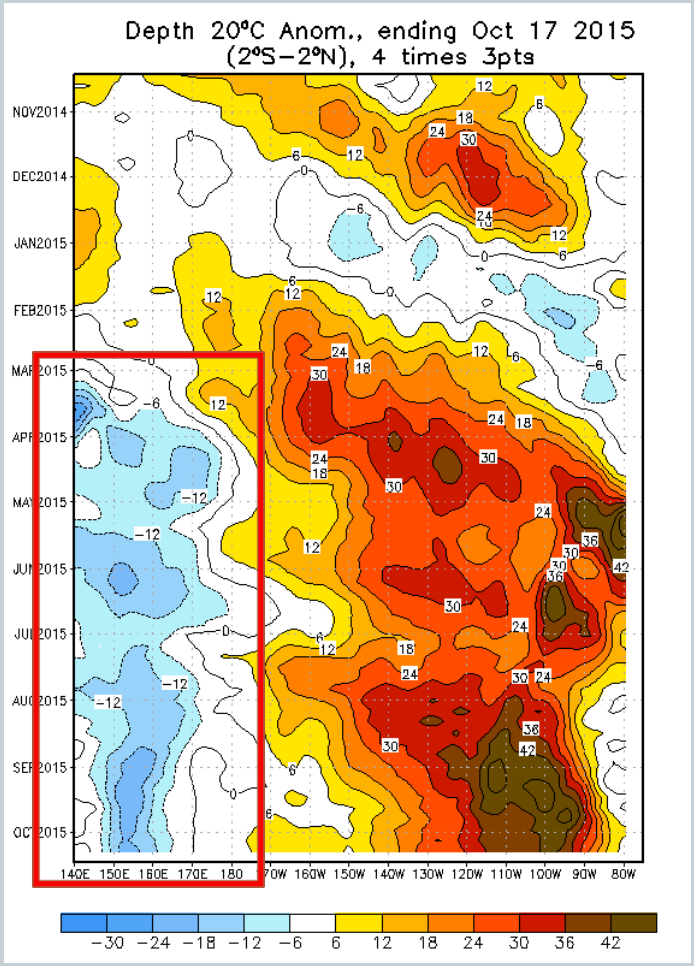
Oceanic pre-cursors

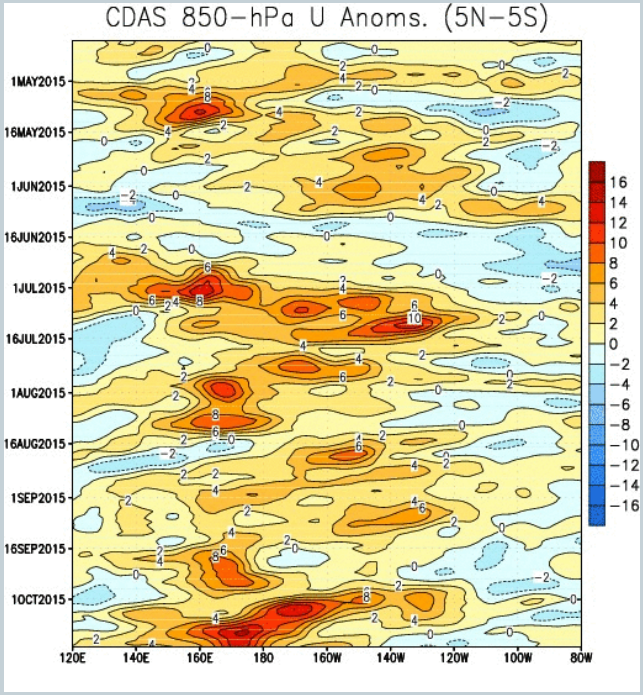
1. Equatorial oceanic heat content
2. Indian Ocean SST
3. Atlantic SST
4. North Pacific SLP, and etc…

Atmospheric pre-cursor

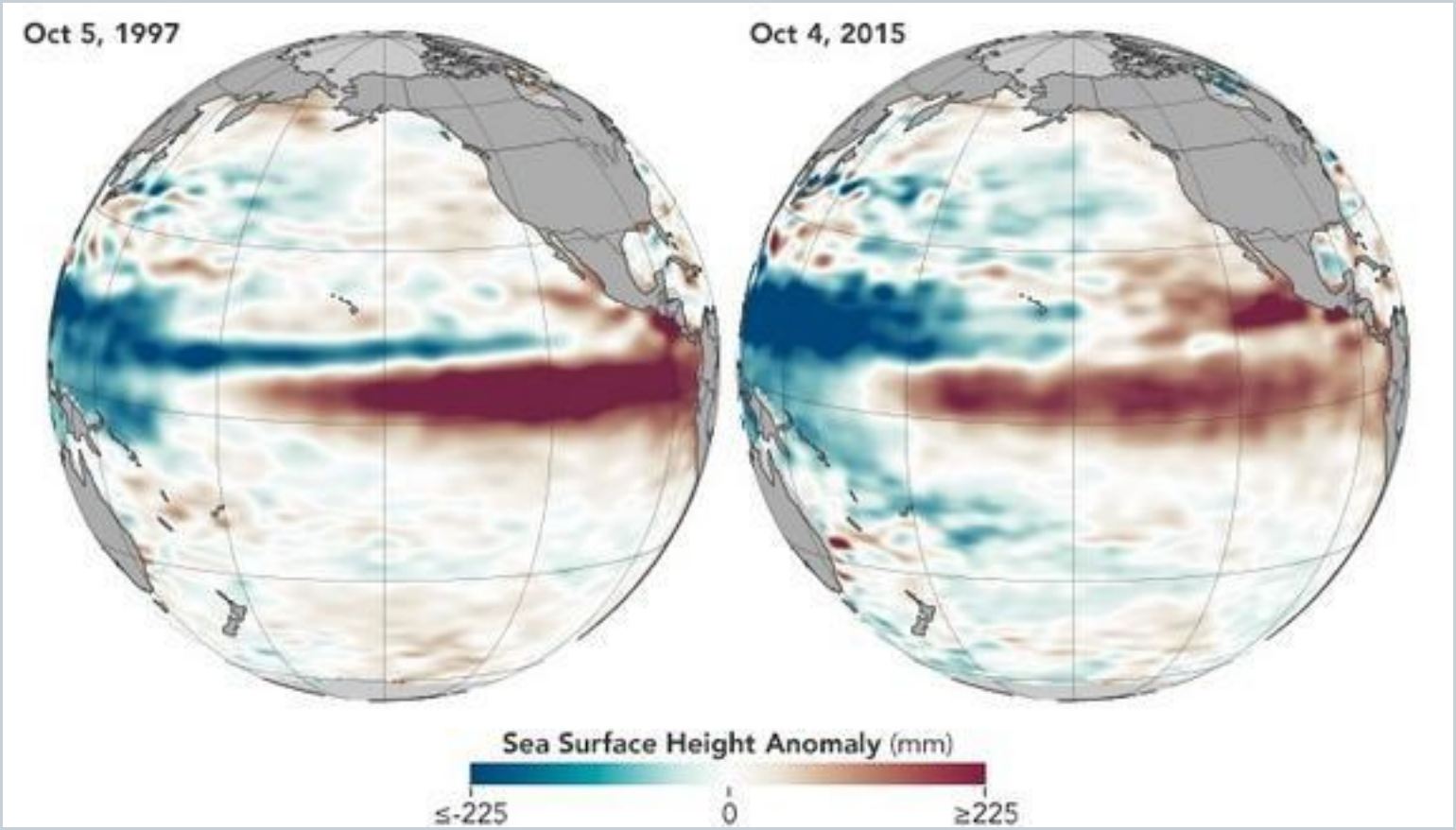
1. Meridional wind stress location

Equatorial heat contents in 2015/16





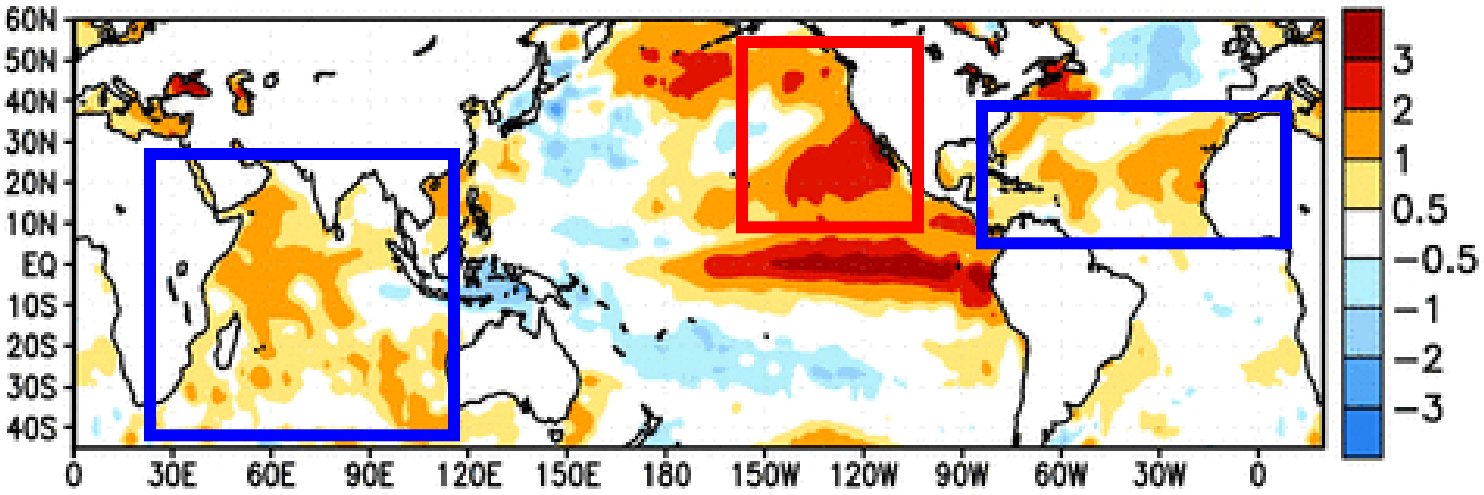
Comparison of SSH anomalies with 97/98 case



The off-equatorial SSH anomalies during 2015 are even stronger than that in 97/98 El Nino

Current SST anomalies outside of Pacific

SST anomalies during 2015.10.7



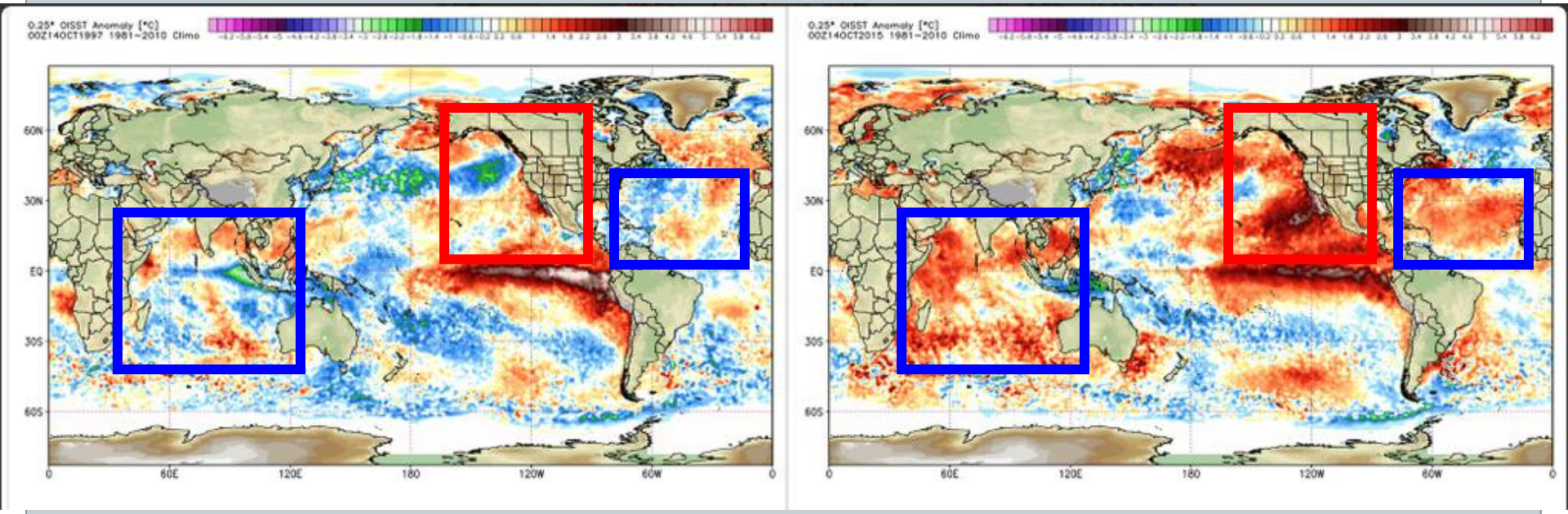
blue : leads fast transition

red : leads slow transition

SST comparison with 97/98 El Nino

Oct.4, 1997

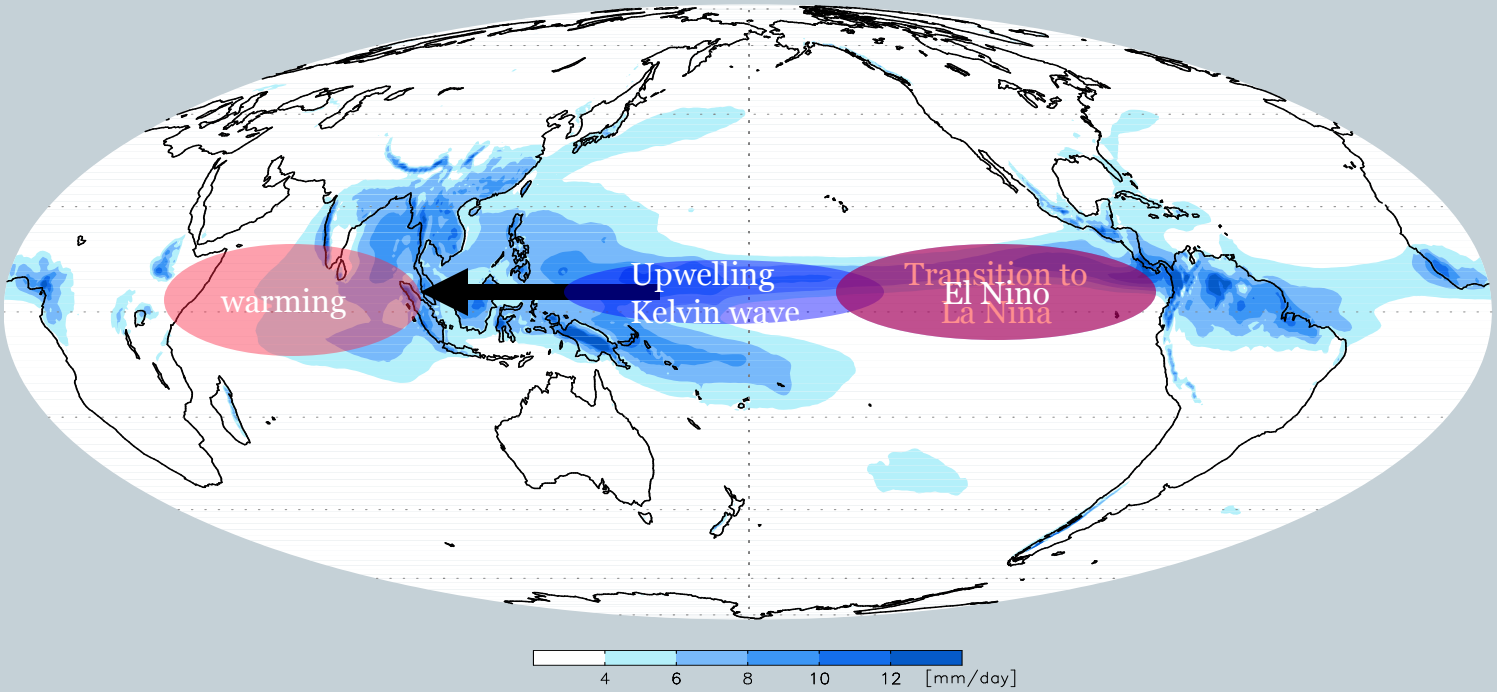
Oct.4, 2015



All three regions (Indian Ocean, Atlantic Ocean, eastern north-Pacific) exhibits stronger amplitude in 2015/16 El Nino case than that in 97/98 El Nino.

Schematic Diagram of role of Indian Ocean

Role of IO Warming on Tropical Pacific

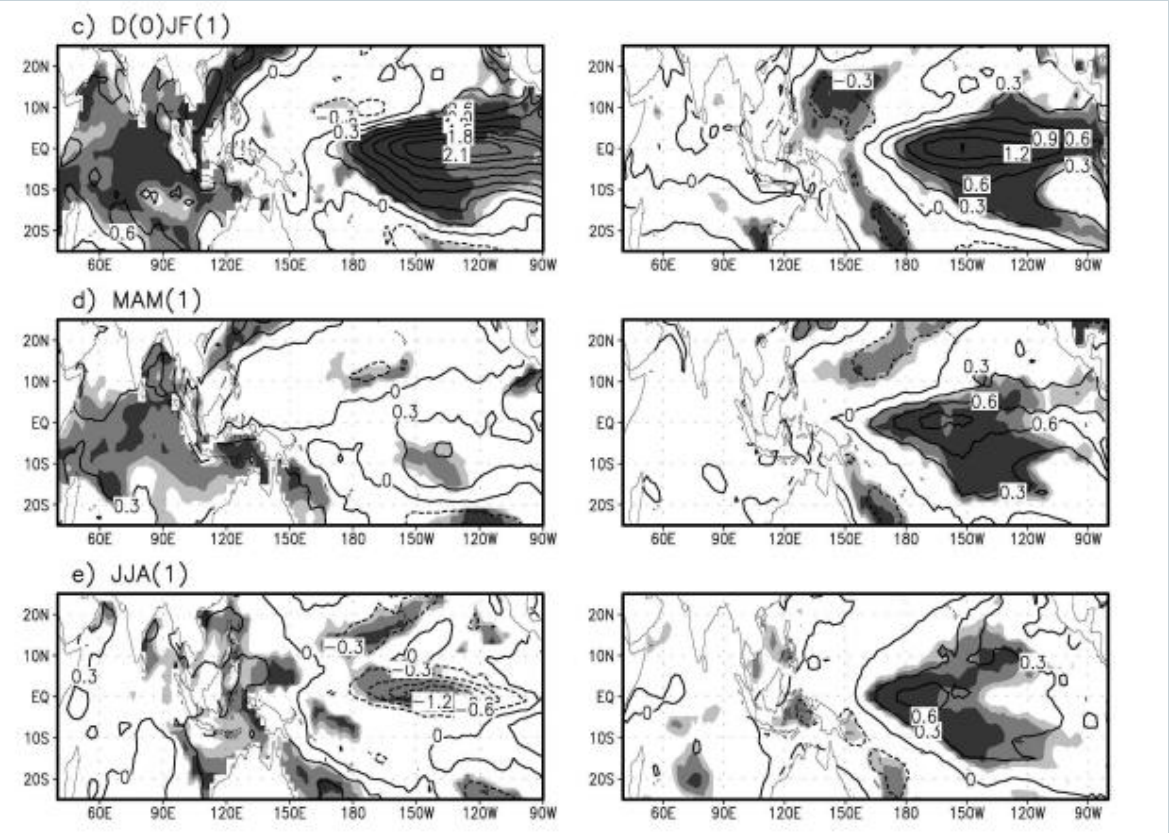


- **Indian Ocean warming triggers the fast-transition of the El Nino**

Role of Indian Ocean SST

El Nino + IO warming

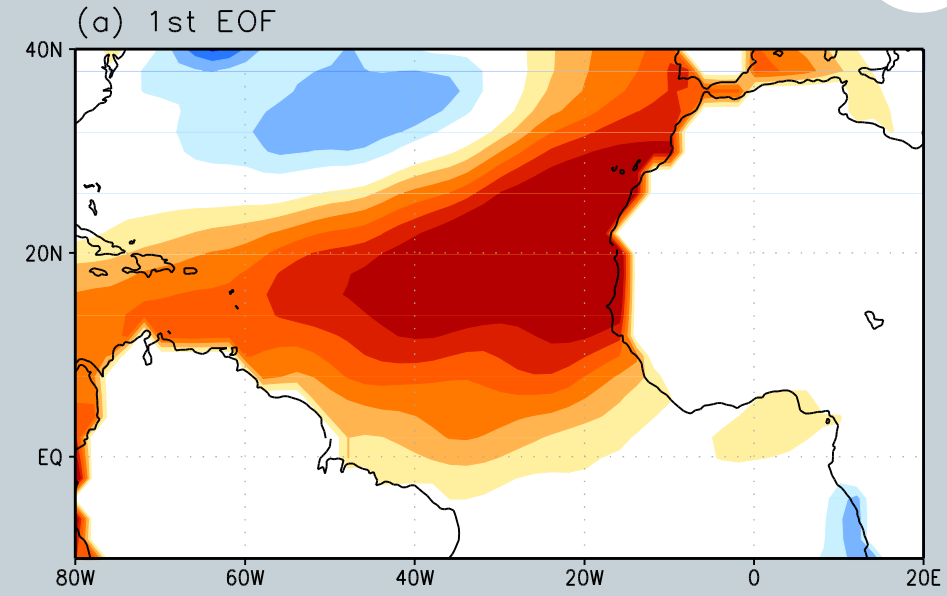
El Nino only

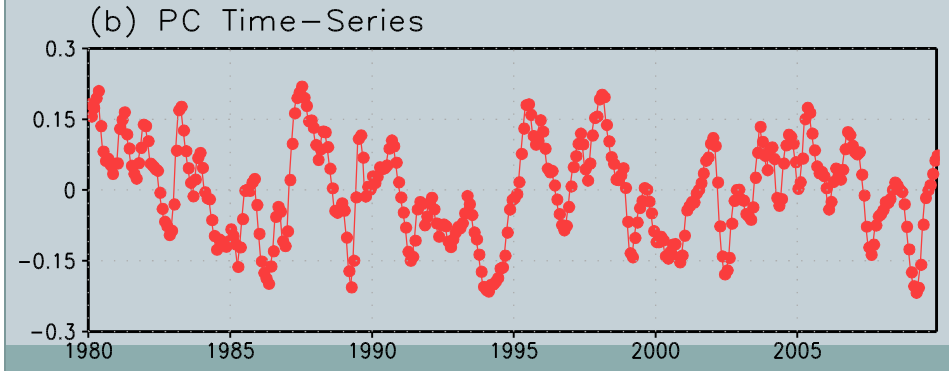


Kug and Kang (2006)

The Indian Ocean warming acts to lead the fast phase-transition of the El Nino to La Nina within a year.

North Tropical Atlantic (NTA) SST





Global Impact of NTA SST

United States

➢ It appears to explain rainfall variability in the Caribbean, Mexico, Central America, northern South America, Great Plains, and the southeastern U.S. (Enfield, 1996; Wang et al. 2006)

North Atlantic

➢ Tropical SST variations tend to enhance variance of the North Atlantic Oscillation (NAO) (Watanabe and Kimoto, 1999)

African monsoon

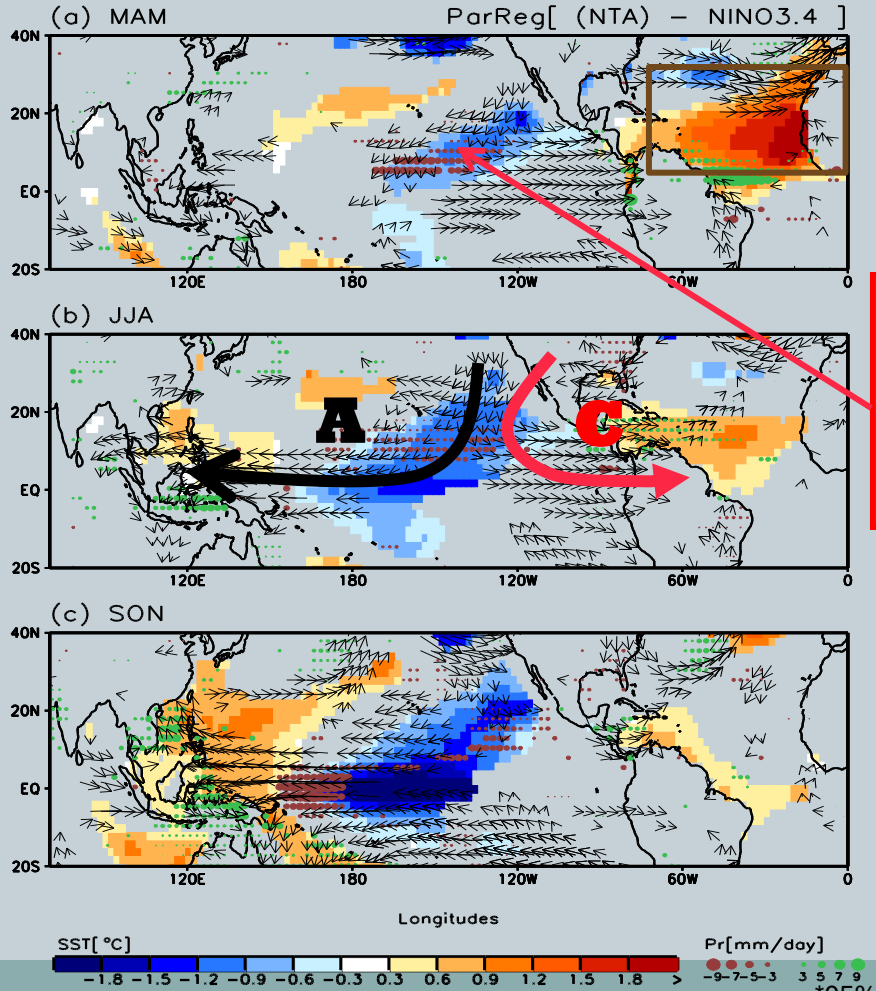
➢ the equatorial cooling exerts a significant influence on the African monsoon, intensifying the southerly winds in the Gulf of Guinea and pushing the continental rainband inland away from the Guinean coast (Okumura and Xie, 2004)

Indian monsoon

➢ the tropical Atlantic has a significant impact on the Indian monsoon through the Gill-Matsuno-type response (Kucharski et al. 2009).

Partial Regression with respect to NTA SST

SST (shading), Precipitation (dots), and 850hPa Wind (vectors)



- cold and dry advection
- increased wind speed
- SST cooling

➢ **less precipitation**

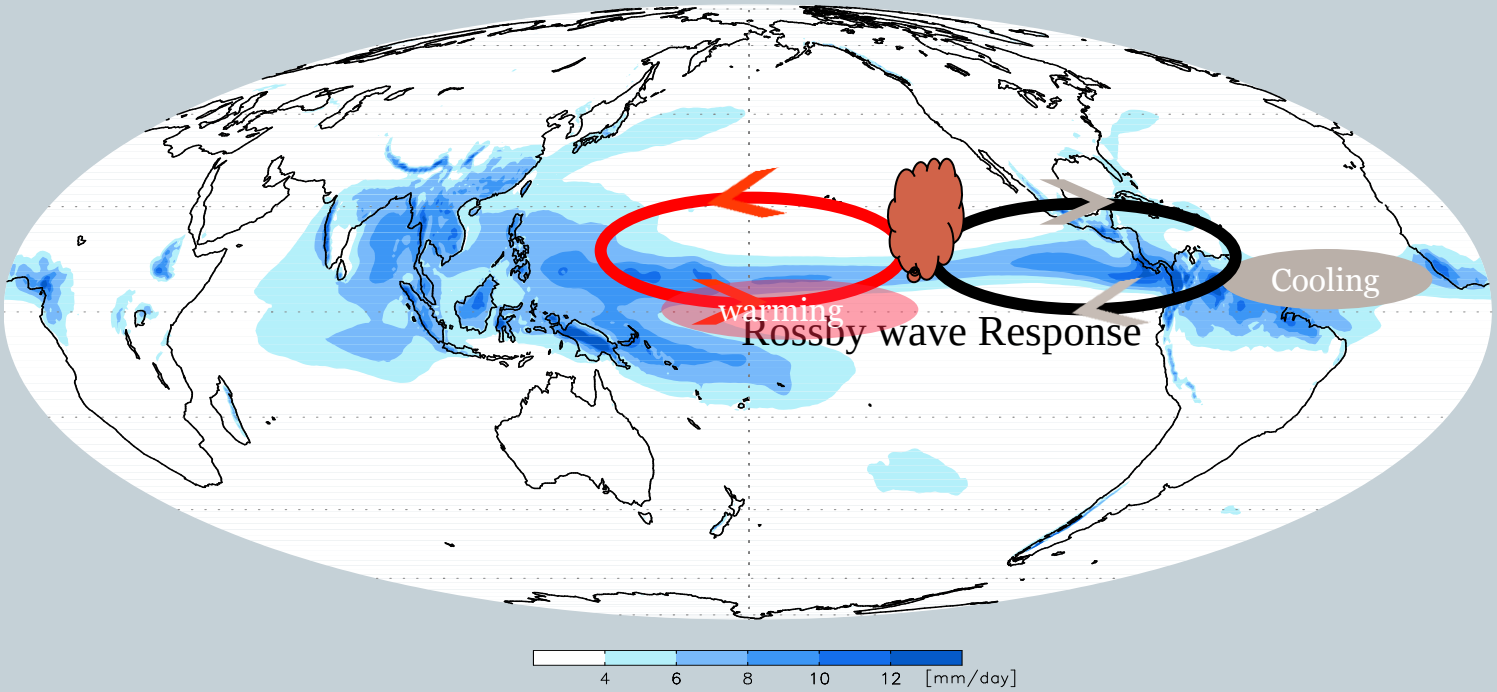
Ham et al. (2013a)

*95% confidence level

*Impact of NINO3.4 SST at D(-1)JF(0) is excluded

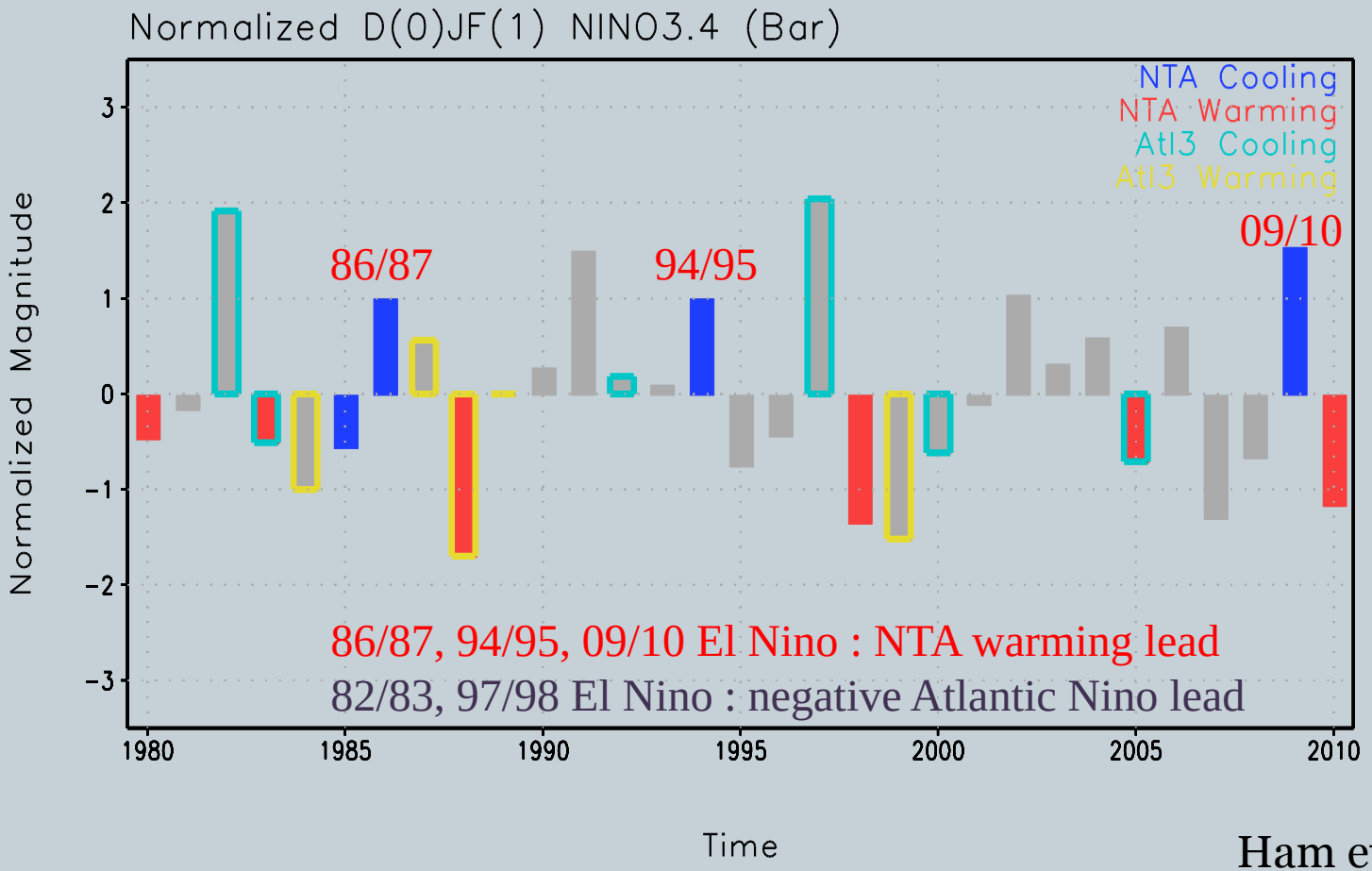
Schematic Diagram of role of NTA SST

Role of NTA Warming on Tropical Pacific



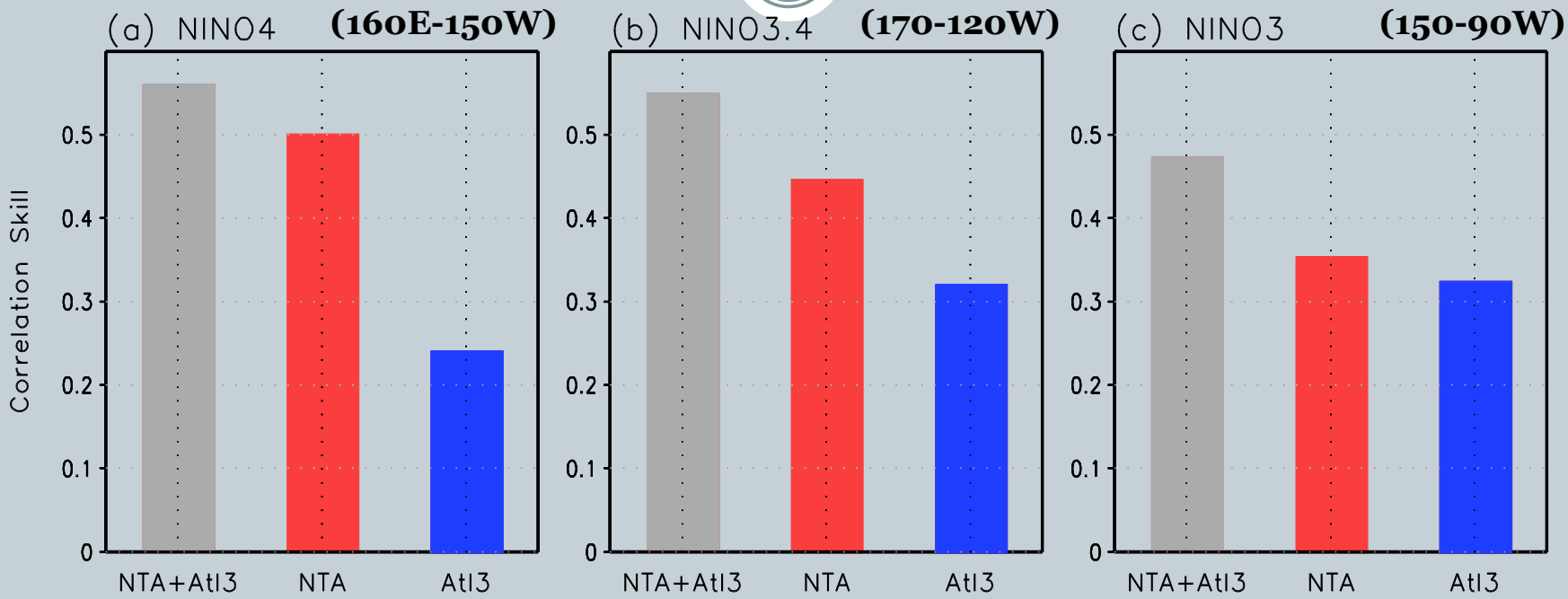
- **NTA SST during boreal spring can trigger the ENSO**
- **NTA cooling tends to be related to Central-Pacific (CP) El Nino**

Nino3.4 SST with NTA SST anomalies



Ham et al. (2013b)

Correlation skill : Statistical Forecast

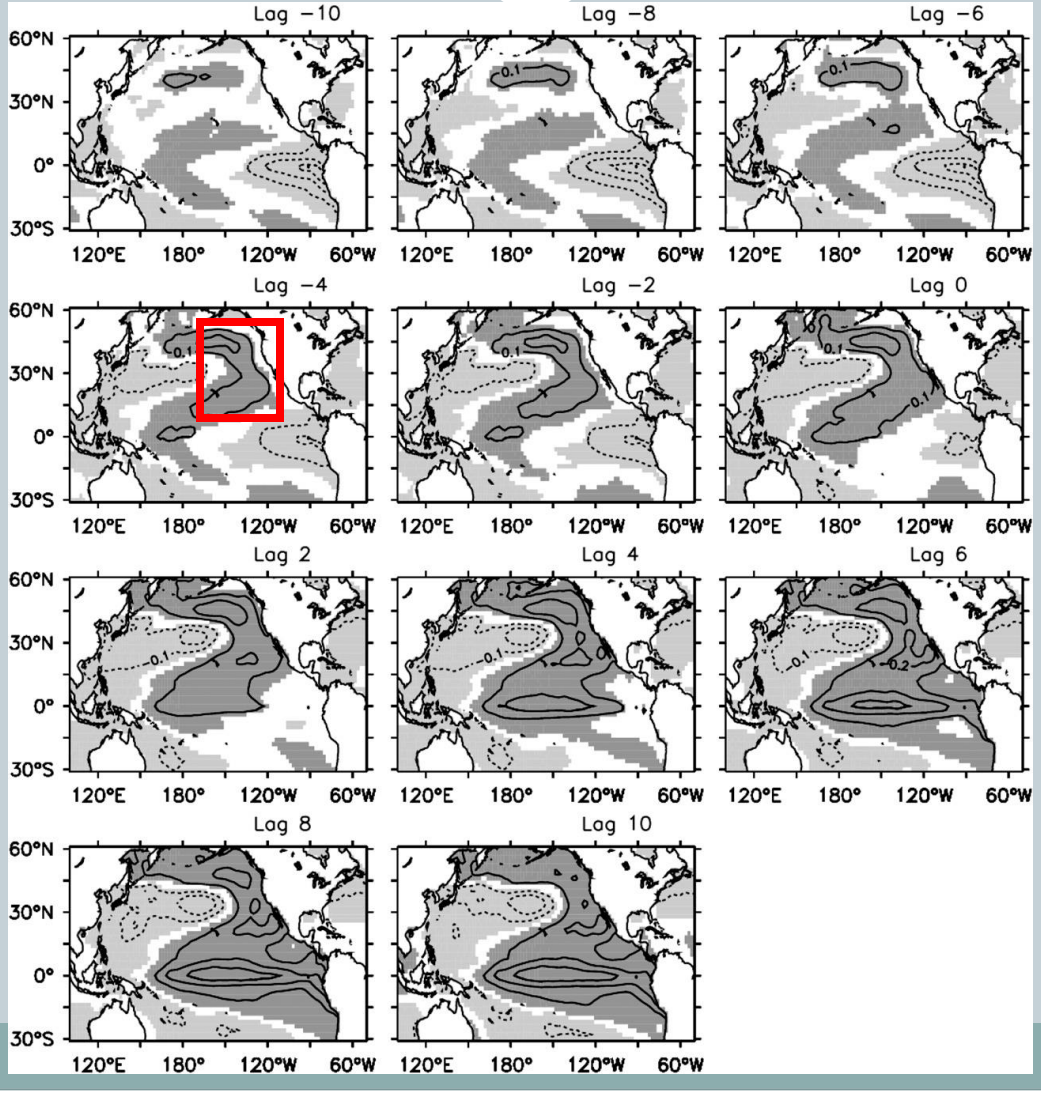


NTA SST

- **linked to central Pacific SST variability**
- **systematically better predictor than Atlantic Nino**
- **independent predictor to the Atlantic Nino**

Ham et al. (2013b)

Role of North Pacific SST anomalies



Yu and Kim (2011)

Role of mid-latitude Pacific

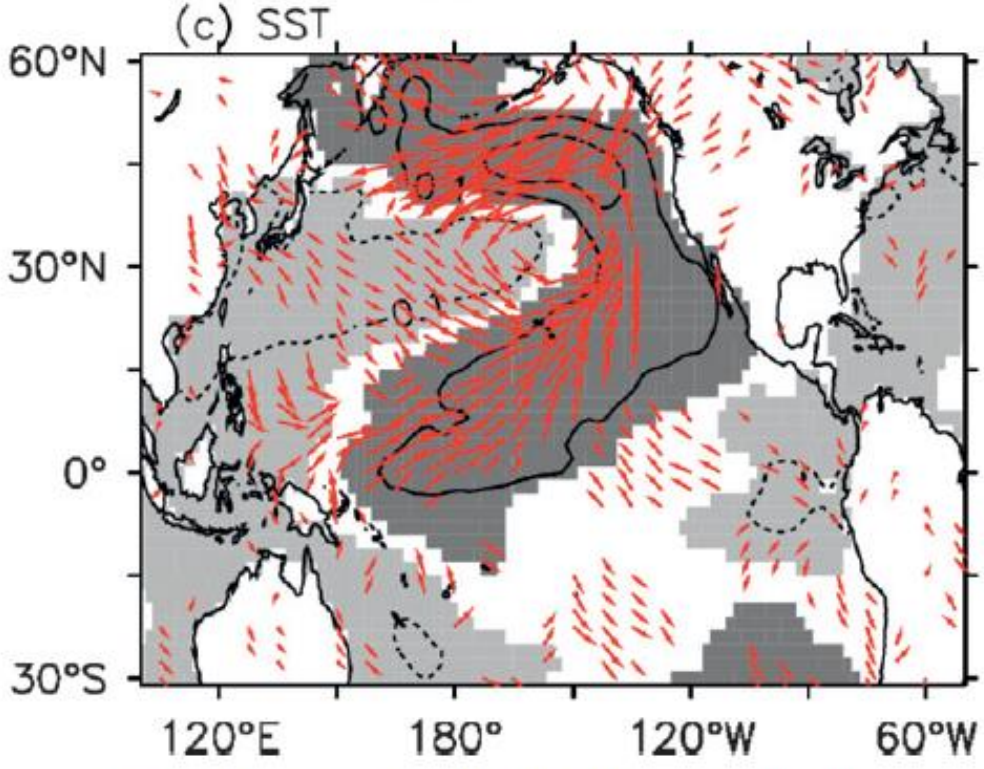


FIG. 8. As in Fig. 5, but for Pacific SLP, surface heat flux, SST, and 1000-mb wind anomalies regressed with the PC of the second EOF mode.

Yu and Kim (2011)

The positive SST over the eastern north Pacific is linked to the south-westerly, which can excite the equatorial downwelling Kelvin waves

Experimental Design for Statistical Prediction

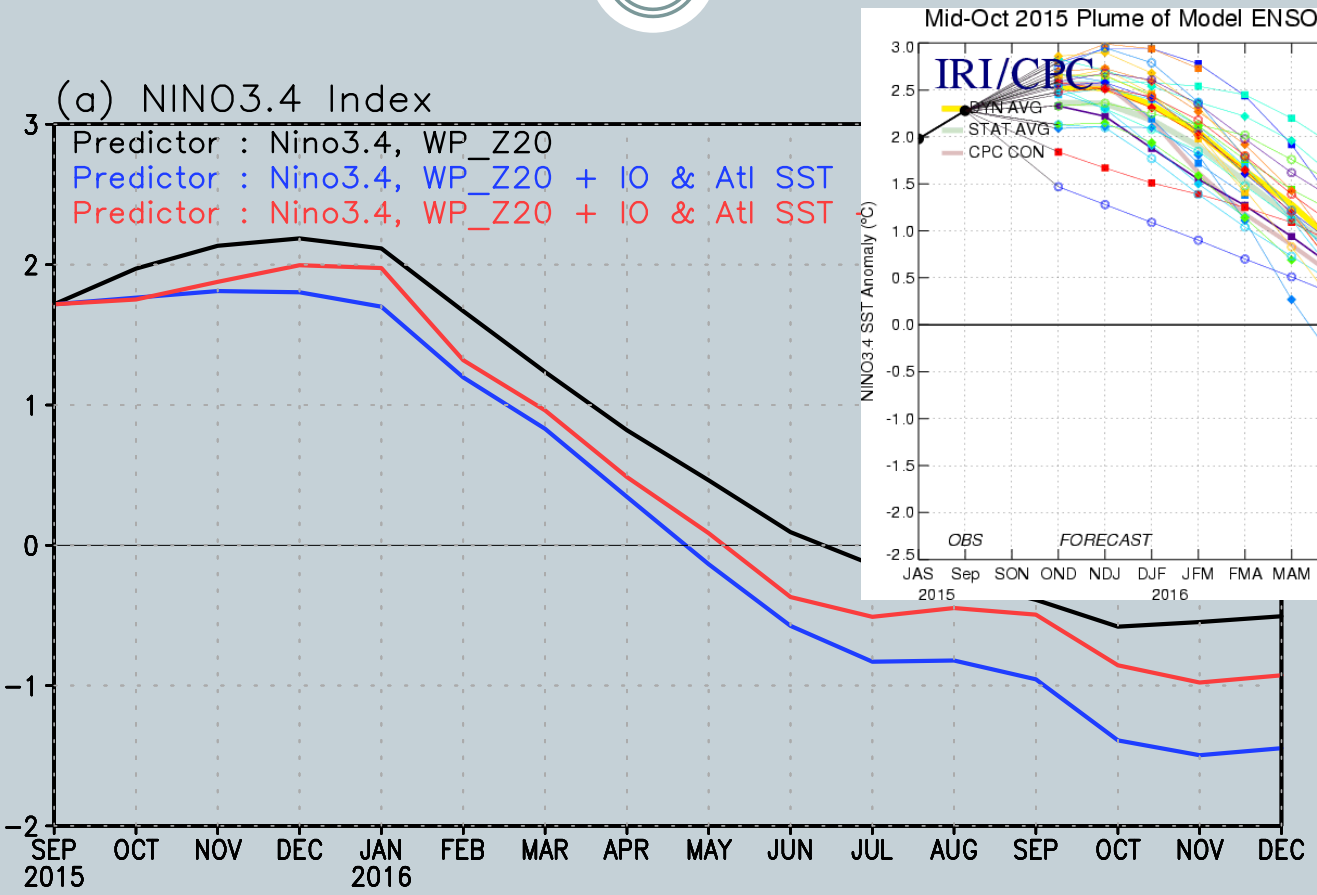
- Predictor :

1. NINO3.4 SST (170-120W, 5S-5N)
2. NTA SST (80-0W, 5-25N)
3. IO SST (40-100E, 15S-10N)
4. eastern NP SST (150-90W, 10-30N)
5. WP Z20 (120-180E, 10S-10N)

- Predictand : NINO3.4 from sep2015

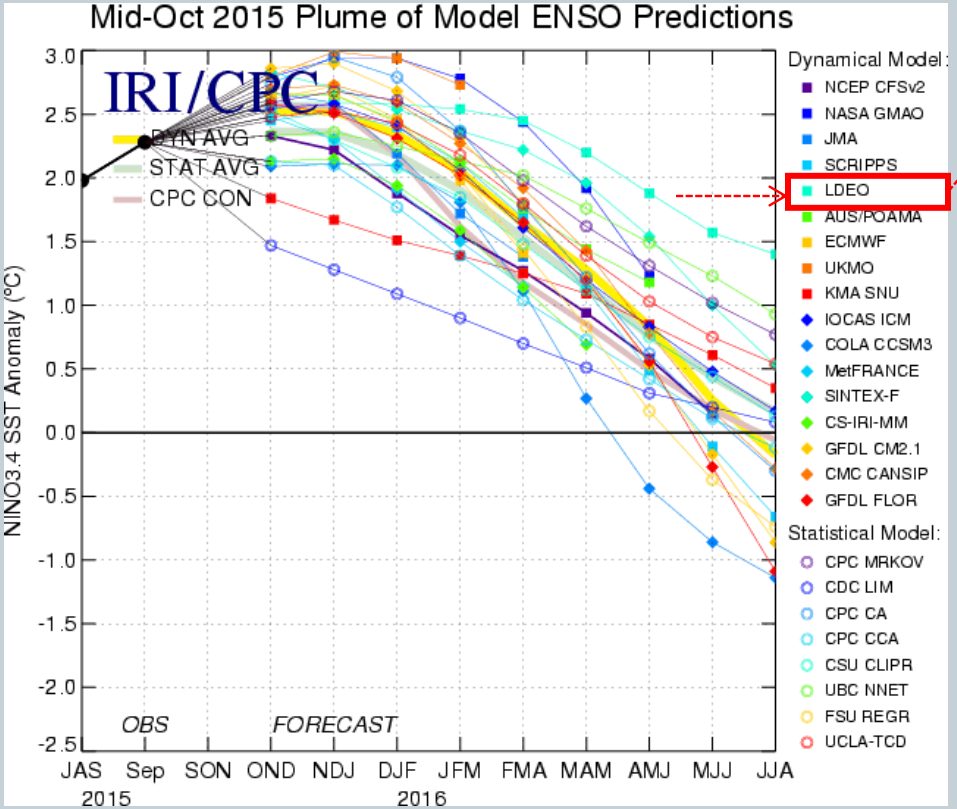
- Training period : sep1980-sep2015

Statistical Prediction of future El Nino evolution



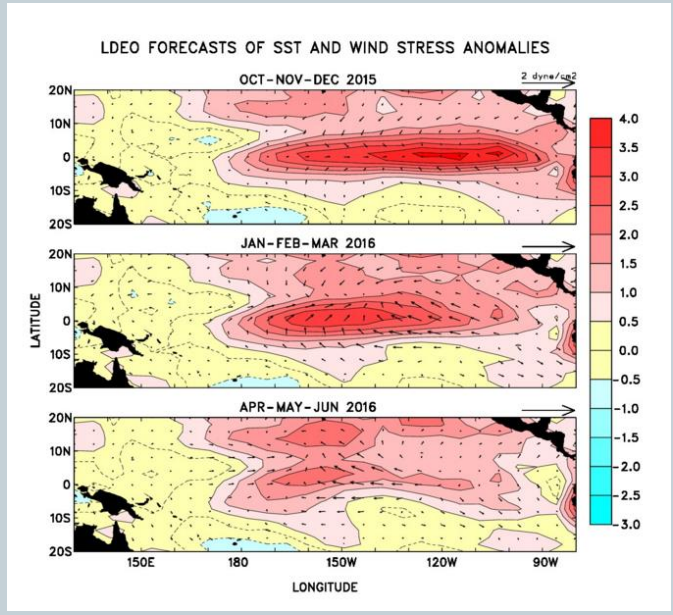
The SST anomalies over the Indian Ocean and Atlantic : lead fast transition
The SST anomalies over the North eastern-Pacific : lead slow transition

Discussion : which model simulate slow ENSO transition?



Transition speed is slowest

LDEO 15/16 SST anomaly map



The model simulates slowest 2015/16 El Nino transition (i.e. LDEO) uses CZ-type model whose domain is defined only over the equatorial Pacific
→ Role of SST anomalies outside of the equatorial Pacific is missing!

Summary and Conclusion

- 2015/16 El Nino can be one of strongest El Nino events in the history.
- The Indian Ocean, and North Tropical Atlantic SST warming acts to lead the fast phase-transition of 2015/16 El Nino, while the SST warming over the eastern north-Pacific can slow down the phase-transition speed.
- The statistical prediction using three SST pre-cursors (i.e. IO, NTA, North Pacific) shows that the weak La Nina event is expected at the end of 2016. However, the future evolution of SST anomalies outside of the equatorial Pacific is worthwhile to be monitored for next few months.

Thank you!