

Indian Summer Monsoon: Delayed Global Teleconnection Could Provide Better Seasonal Outlook

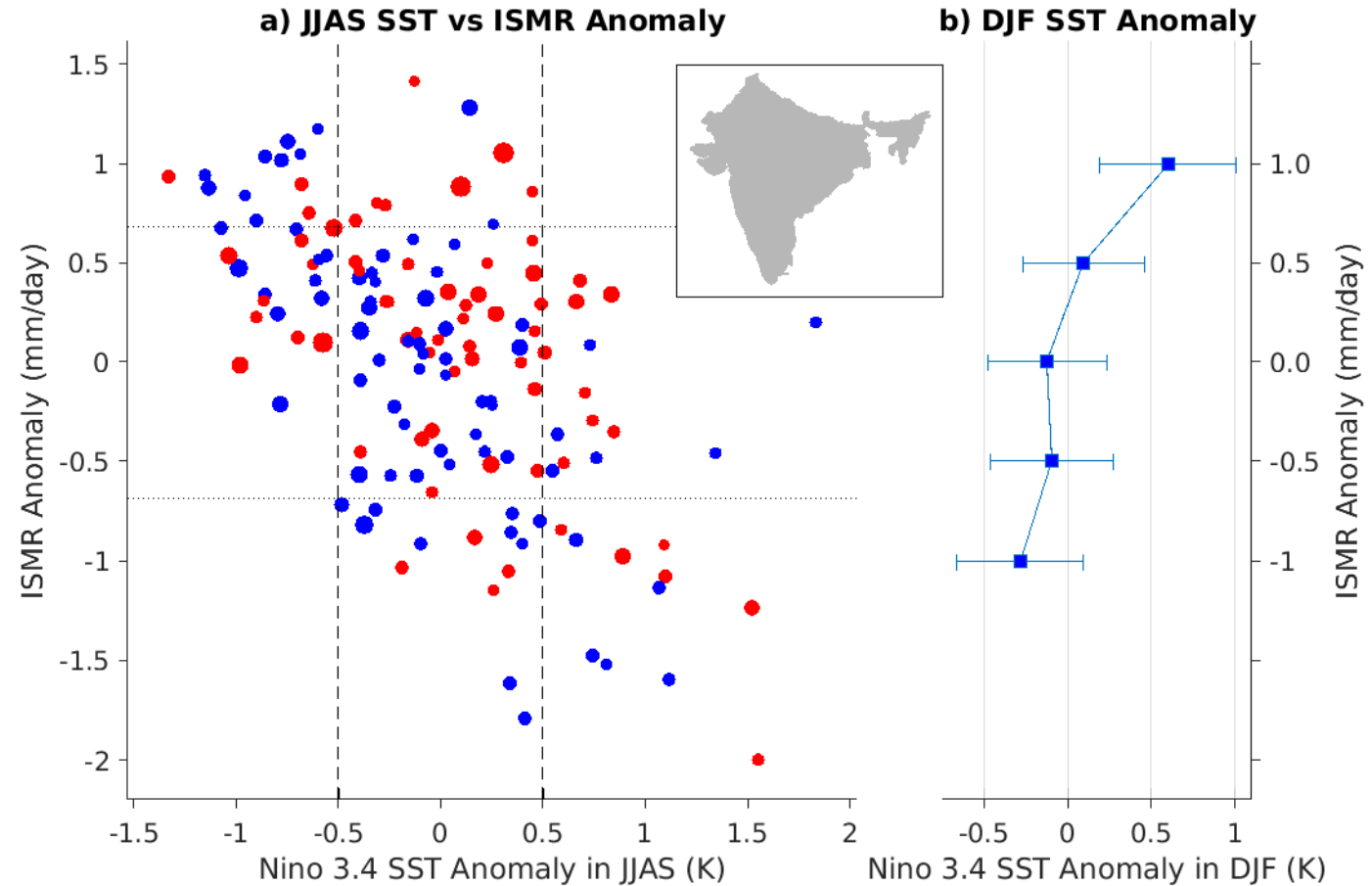
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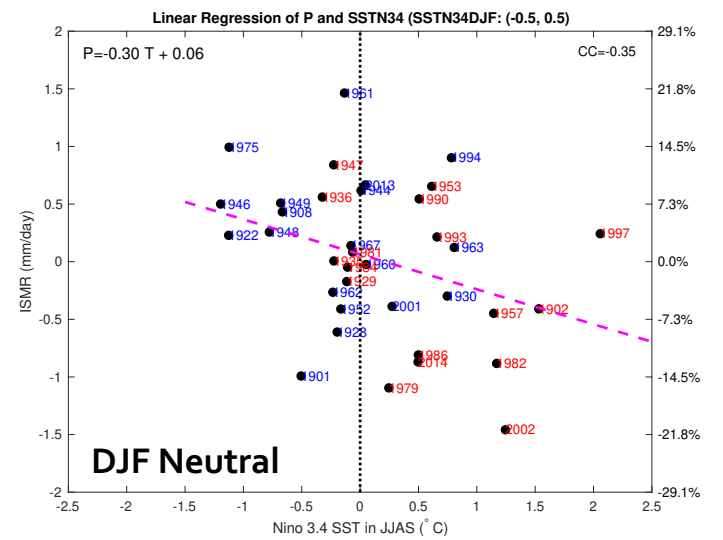
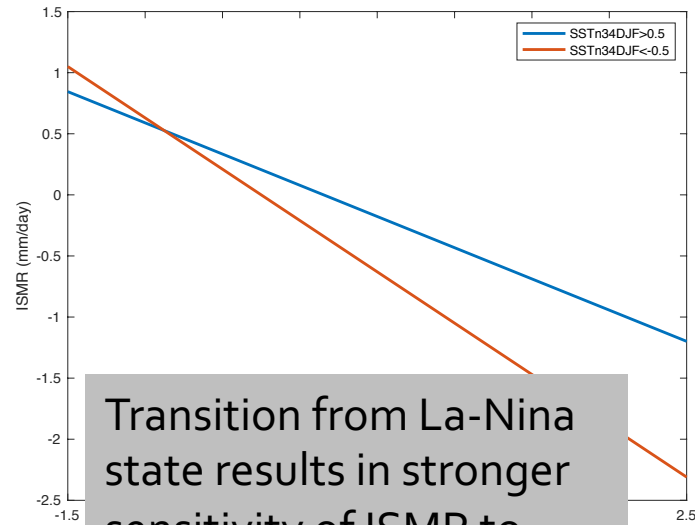
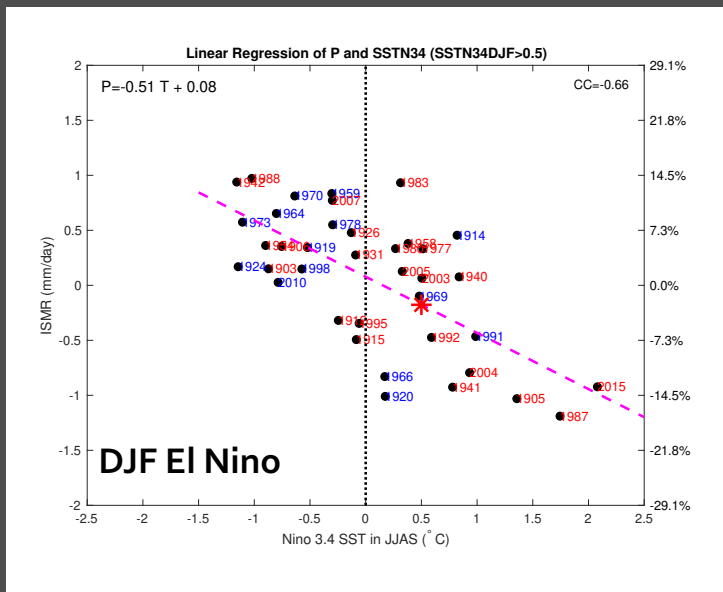
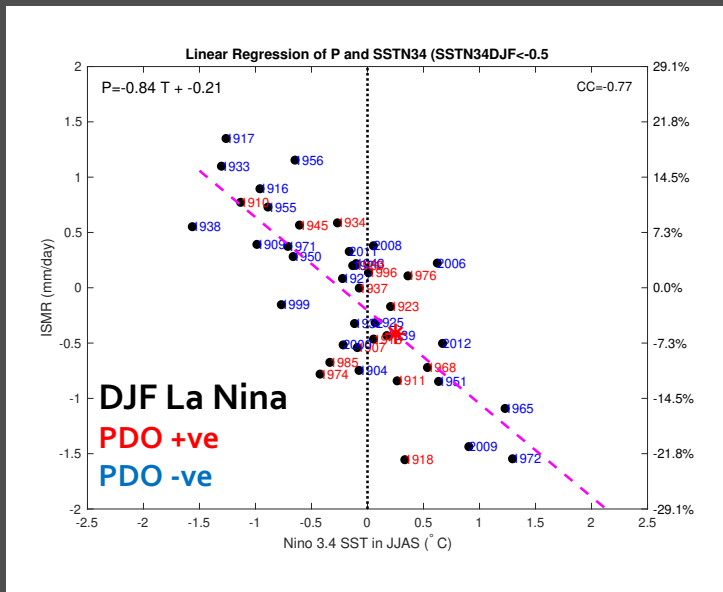
Indian Institute of Science

Bengaluru , India

Understanding the 'scatter' between Nino 3.4 SST Anomaly and ISMR

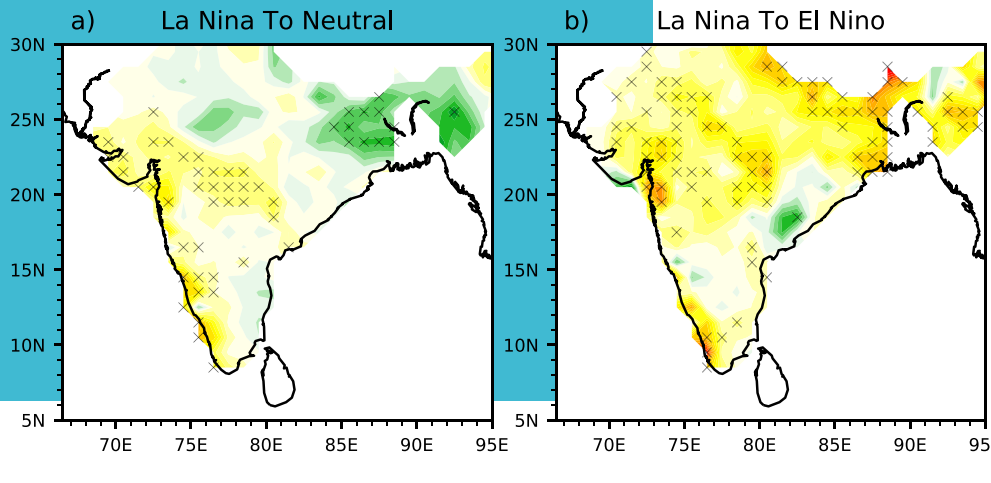
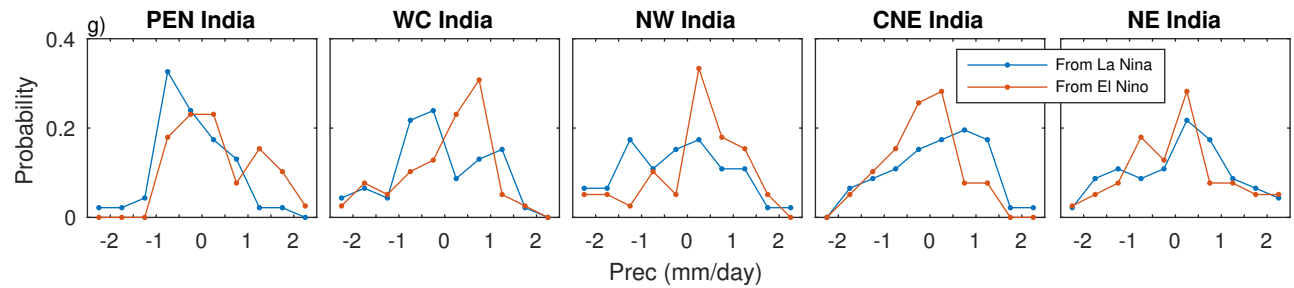
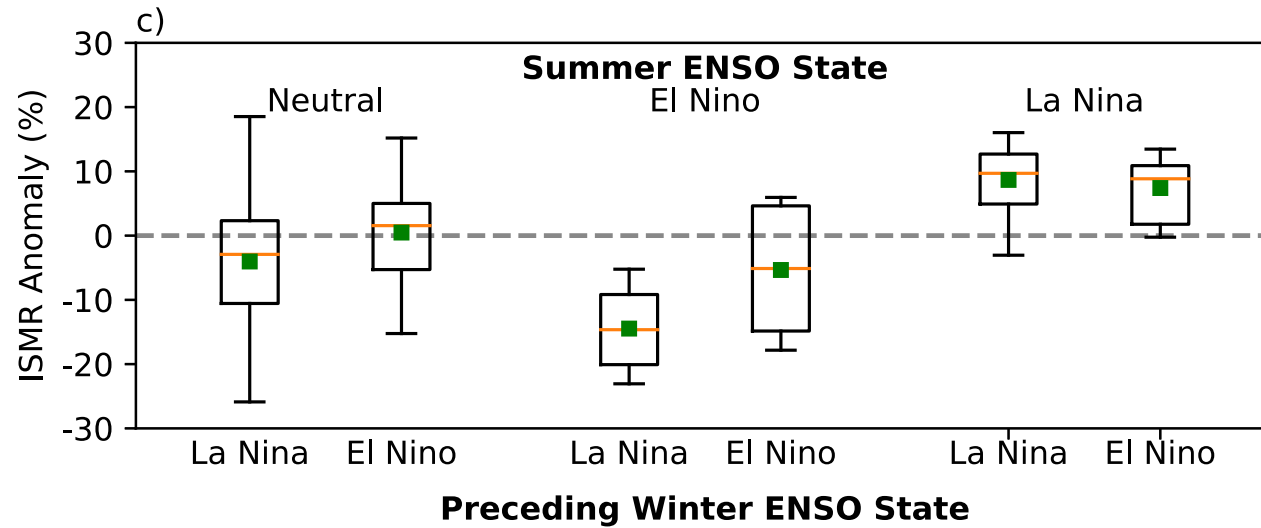


- SST over Nino 3.4 in JJAS and ISMR shows interannual correlation of -0.53. However, there seems a bearing of previous winter's Nino 3.4 SST on summer monsoon.
- Winter La Nina seems decrease summer monsoon. [Chakraborty A, 2018, Env Res Lett]



Knowing last winter's ENSO condition improves ENSO-Monsoon relationship

Regional Responses



- Detailed analysis show that preceding winter La Nina tends to reduce following summer monsoon rainfall.
- This is especially true over south and western sides of India.
- And it is more effective when summer is neutral or in El Nino condition.

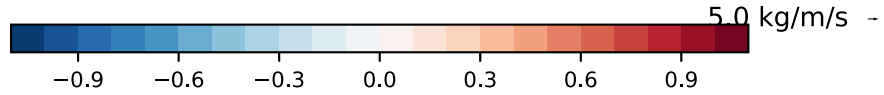
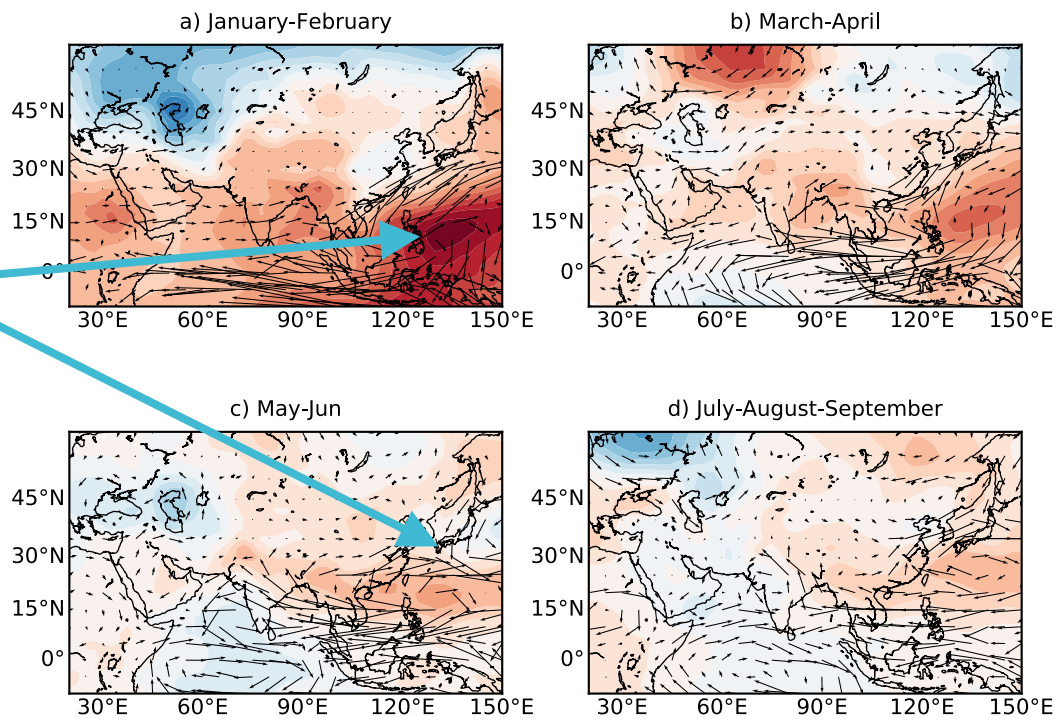
How Does It Impact?

Regression of DJF SST with Ps and Qflx

Off-equatorial high with +ve Nino 3.4 SST in winter moves to north-west Pacific Ocean in next summer.

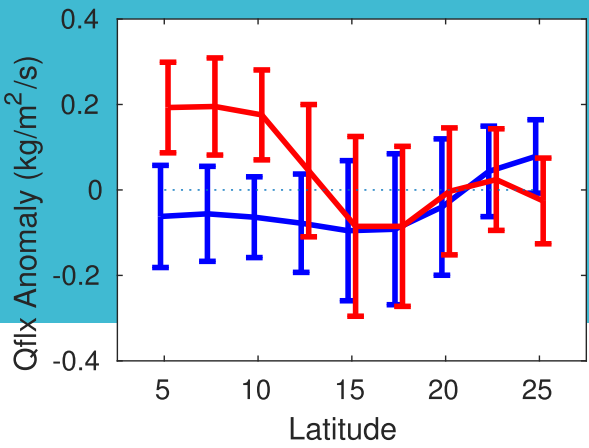
$$\text{Mass (m)} = Ps/g$$

Mass is a function of vertical temperature structure

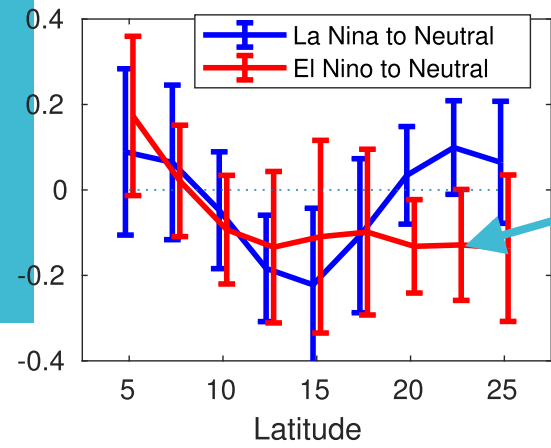


That in turn decreases eastward moisture flux over Bay of Bengal (more convergence).

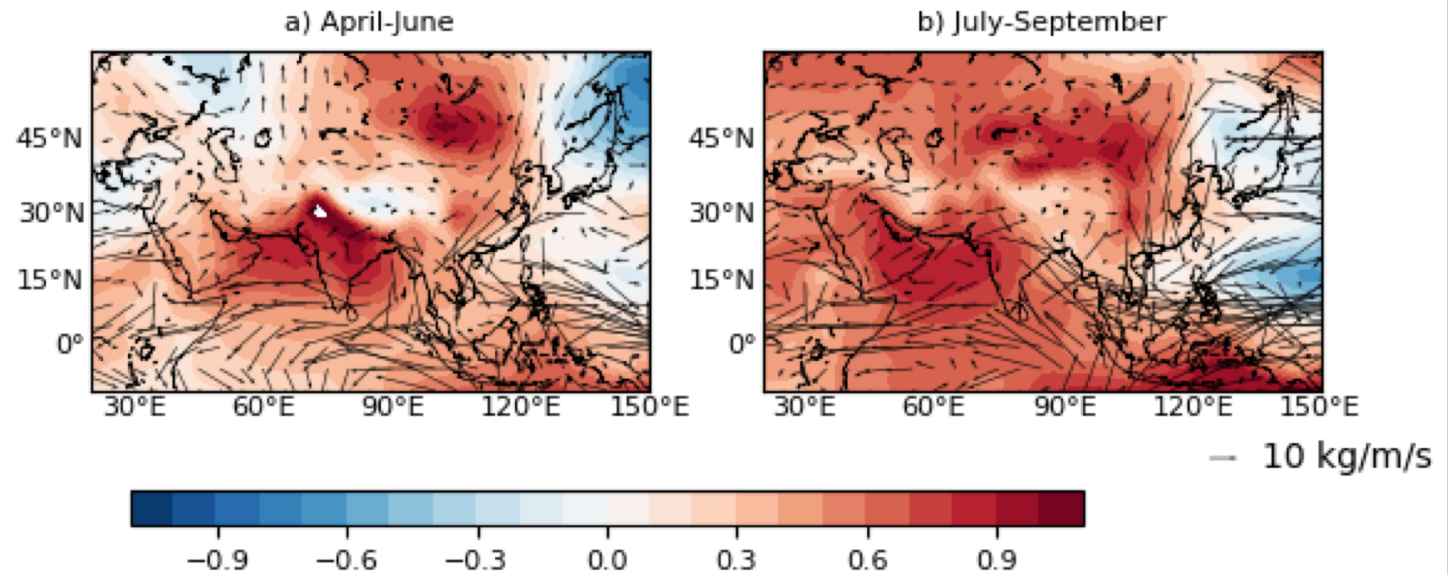
e) Eastward Moisture Flux at 70E



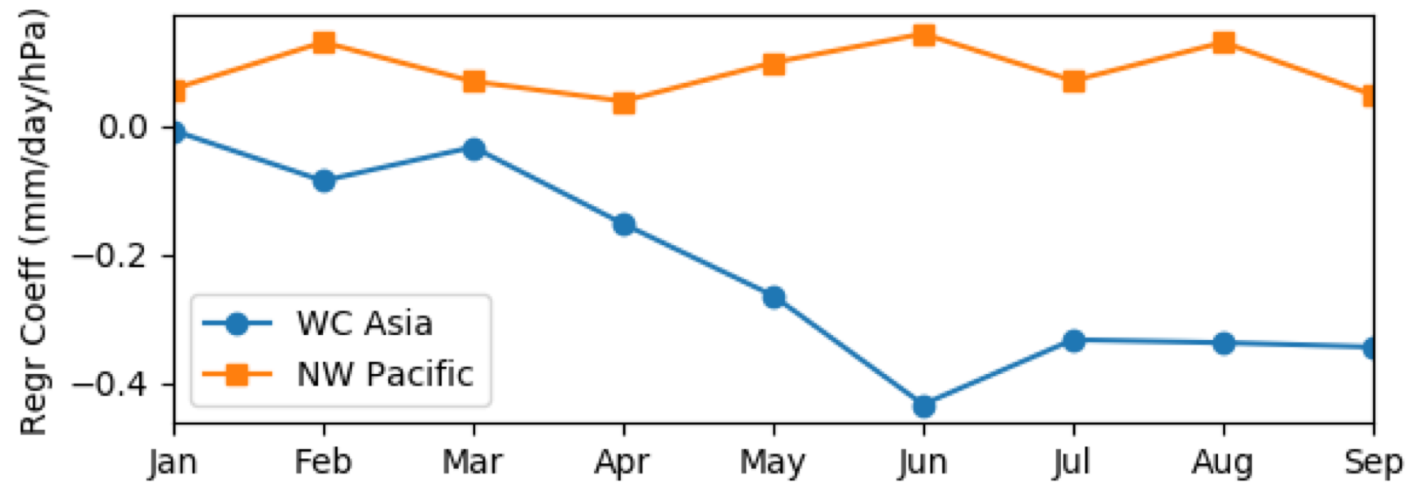
f) Eastward Moisture Flux at 85E



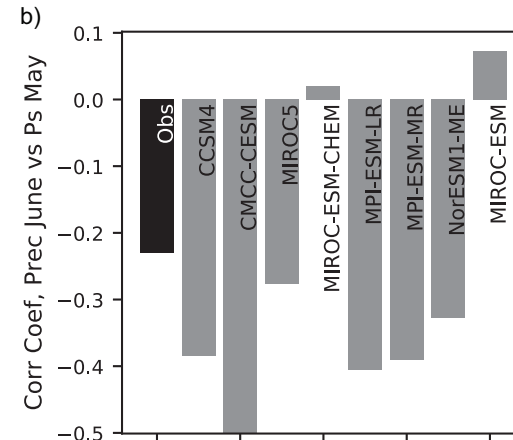
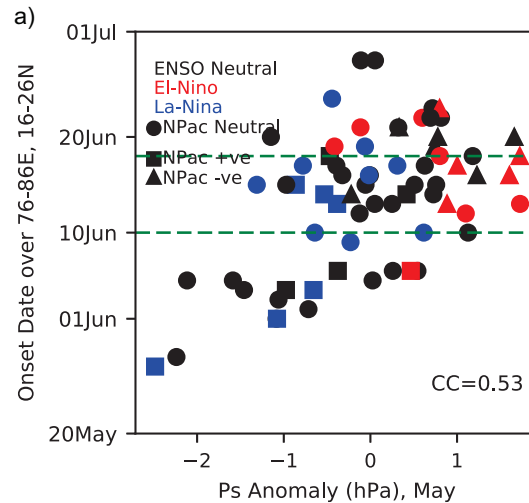
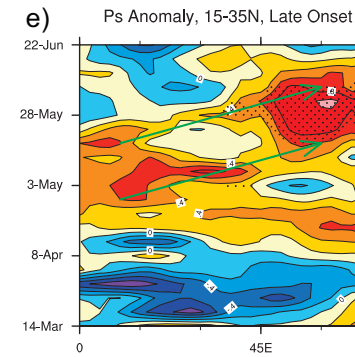
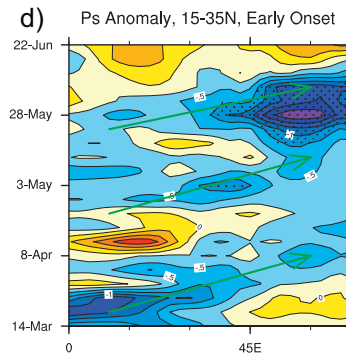
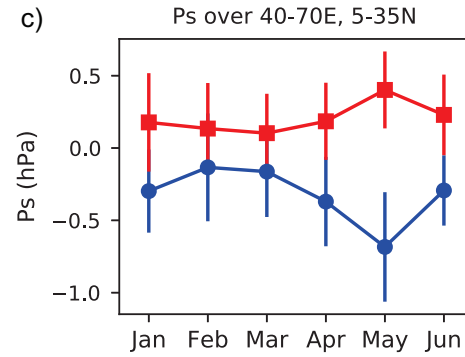
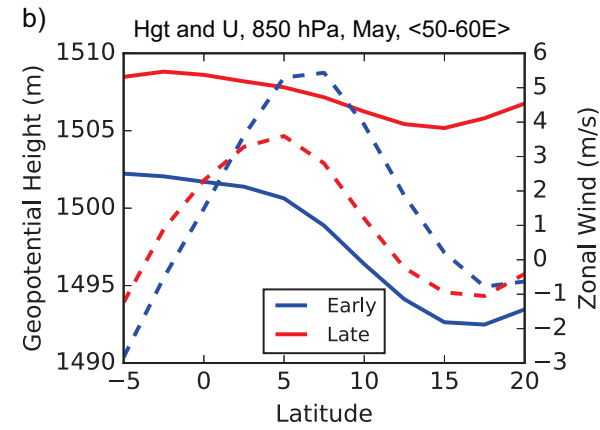
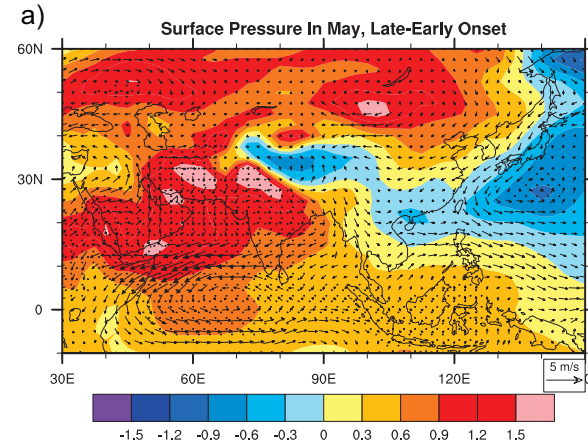
Regression of JJAS SST with Ps and Qflx



Ps vs ISMR

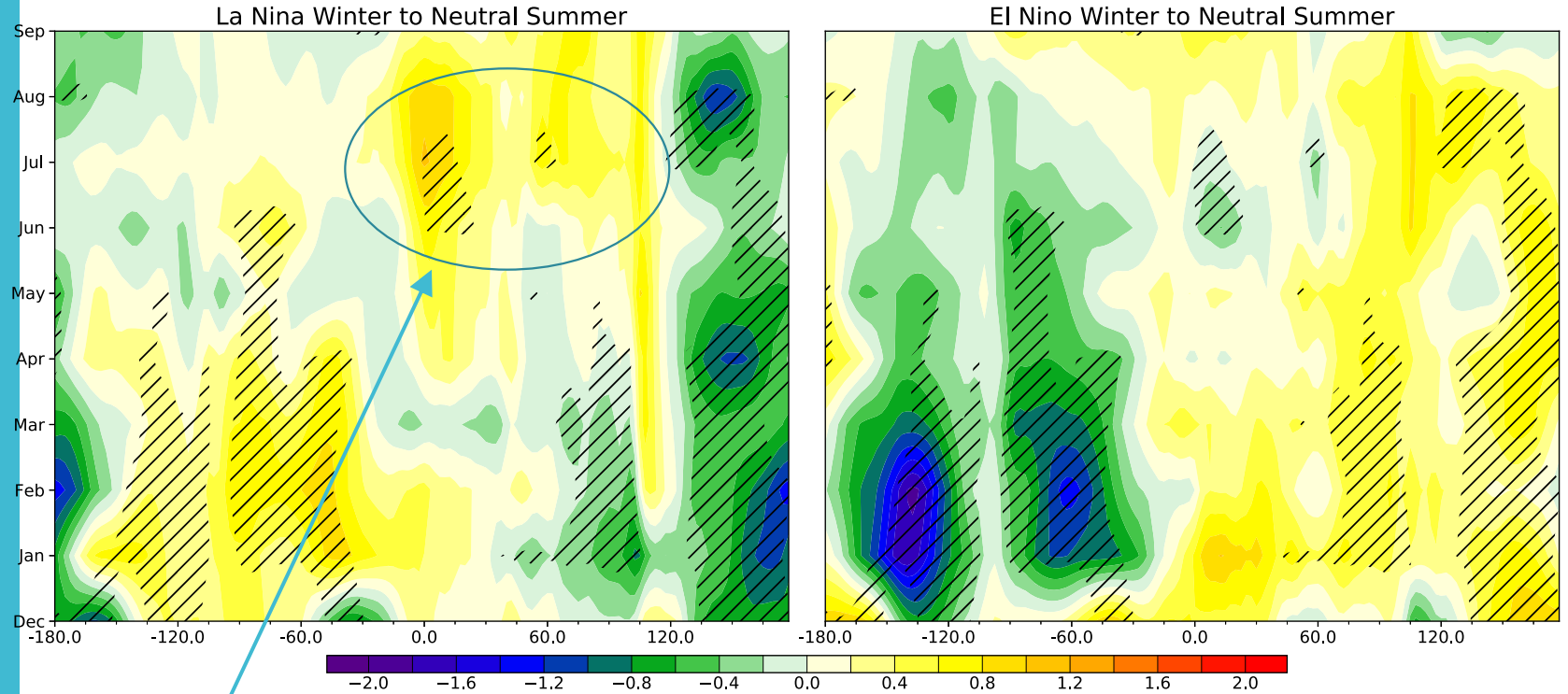


Onset of monsoon and west Asian surface pressure in May



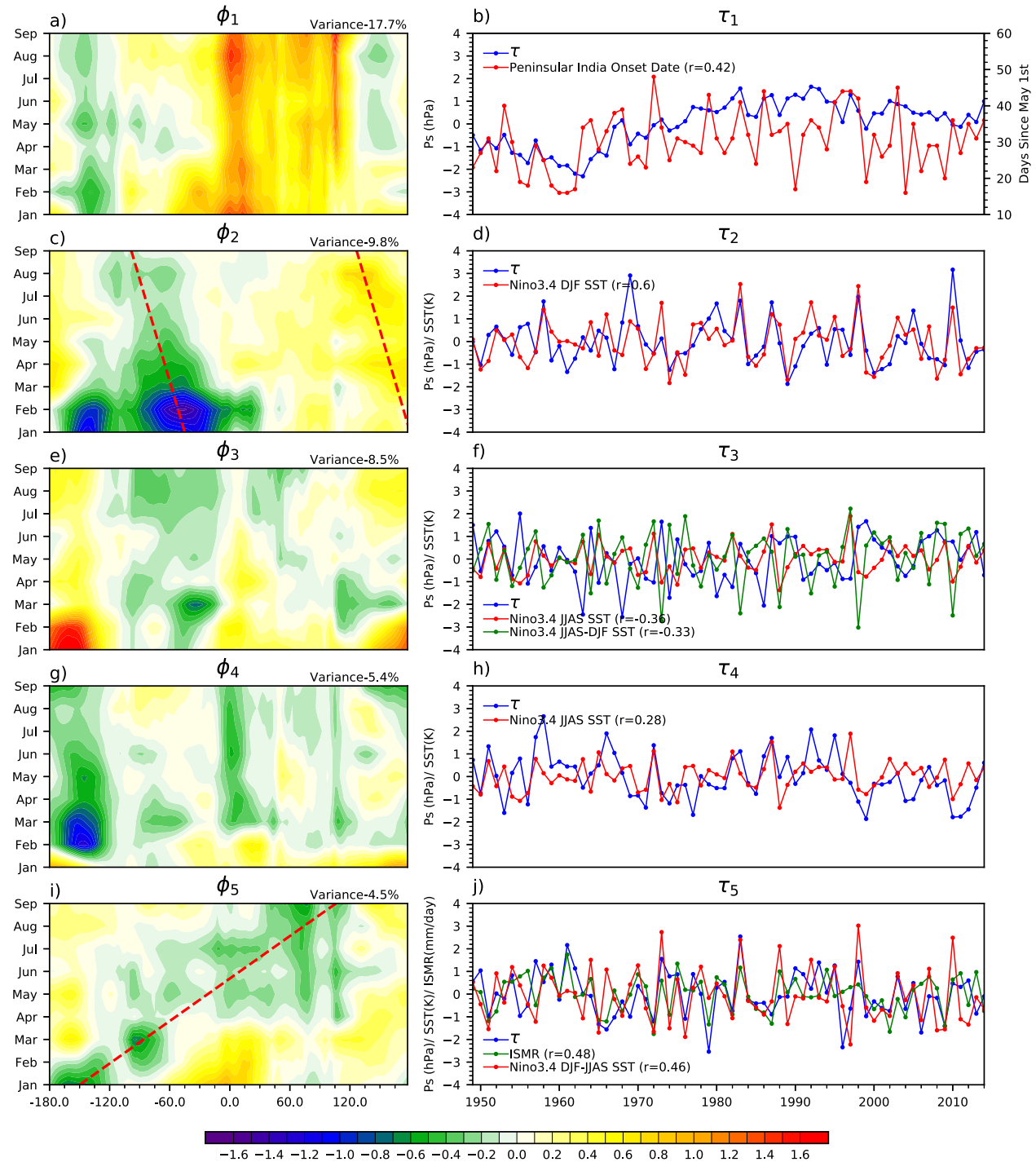
Chakraborty and Agrawal, 2017, Env Res Lett, Role of West Asian Surface Pressure on Summer Monsoon Onset over Central India.

We Observe
Signature of
Transition of
ENSO phase in
surface pressure.
**Composite of Ps
averaged
between 20-30N.**

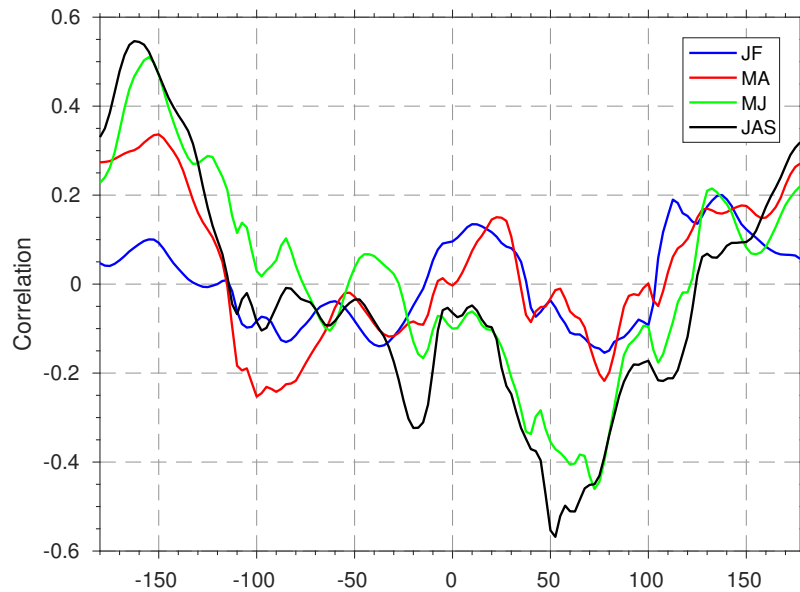


- Increase in Ps west of India for La Nina to Neutral Years.
- This decreases north-south pressure gradient.
- In turn, low-level westerlies over Arabian Sea decreases.
- That decreases moisture flux toward India.

Seasonal evolution of surface pressure anomaly along 20-30N shows dominant interannual modes

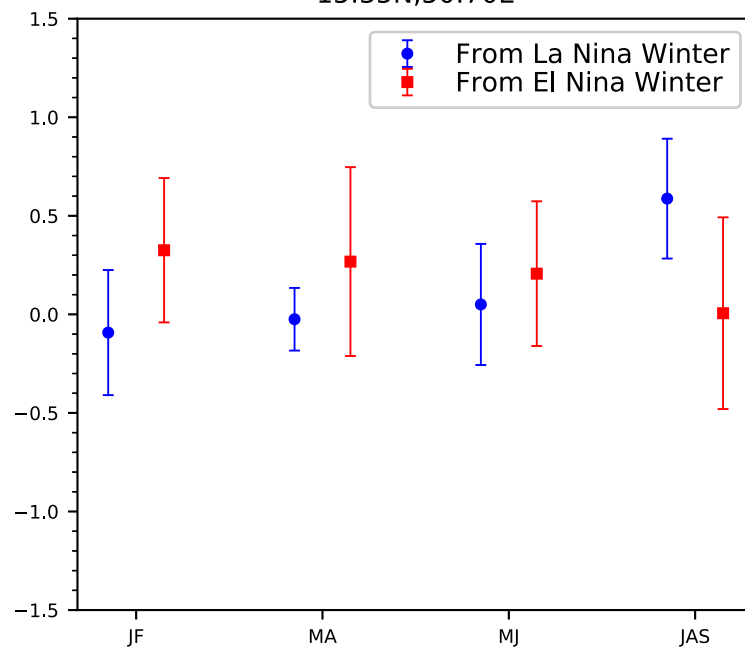


Correlation between Ps and ISMR Anomalies



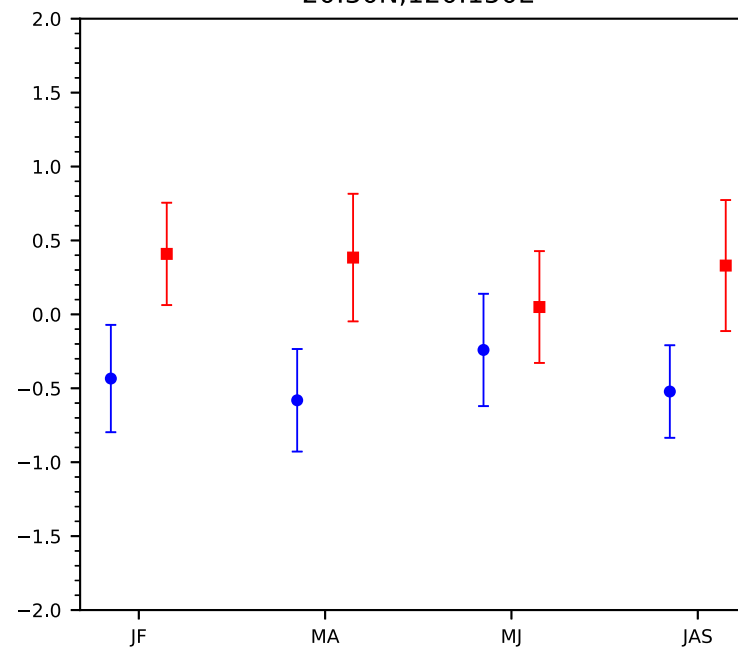
West of India

15:35N,50:70E



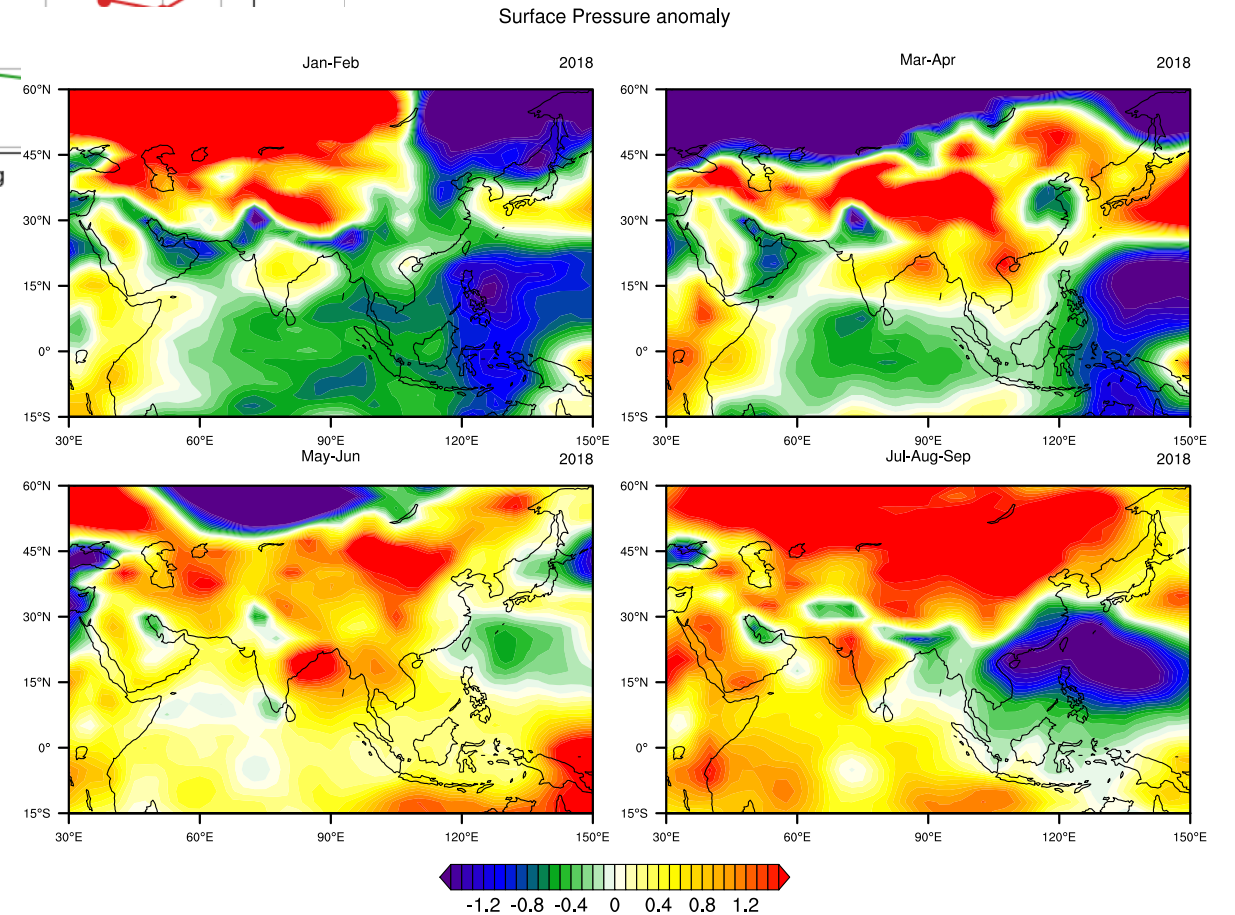
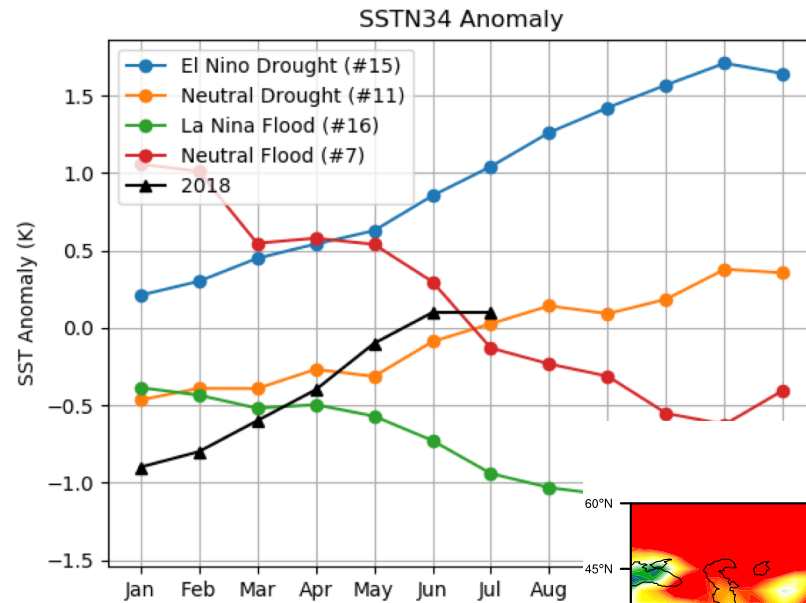
East of India

20:30N,120:150E



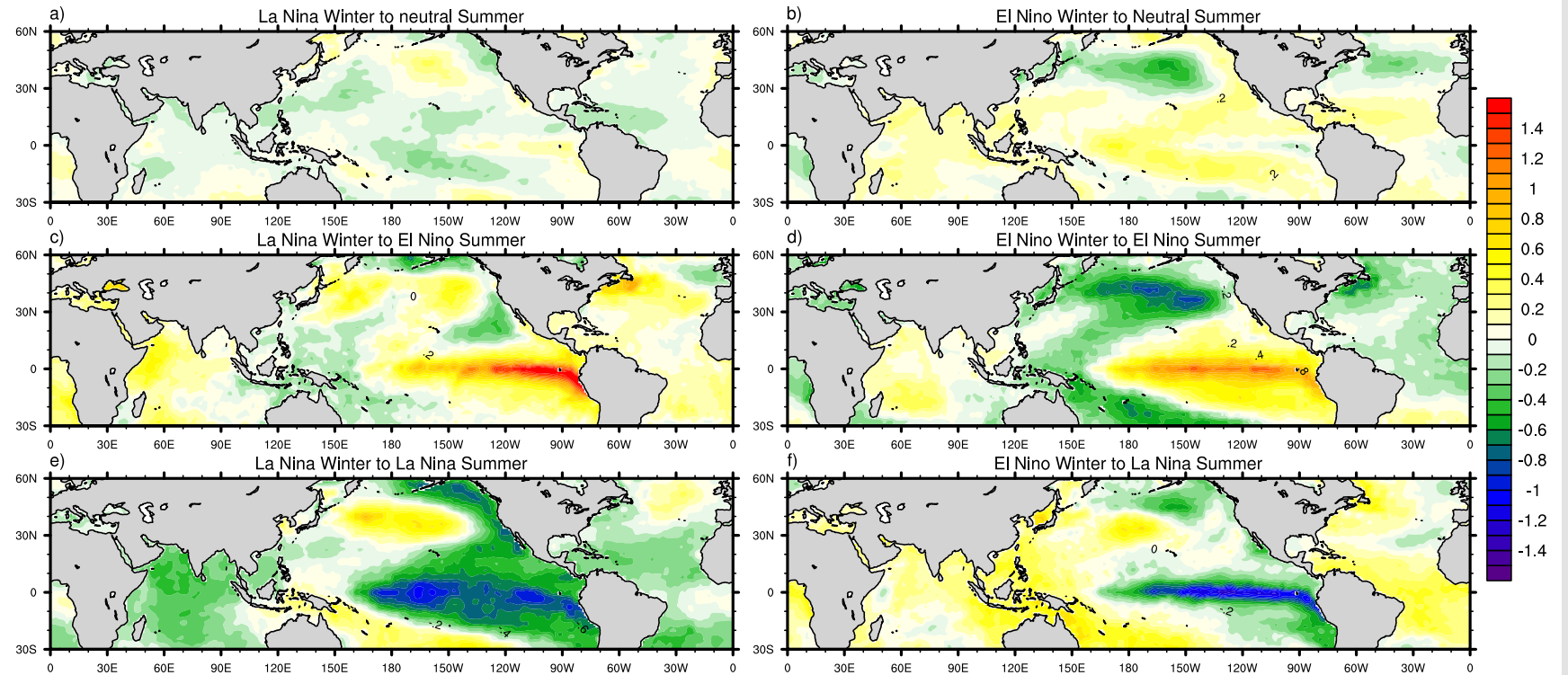
What happened in 2018?

Surface Pressure Anomaly Evolution in 2018 shows a typical sign of La Nina to Neutral Transition

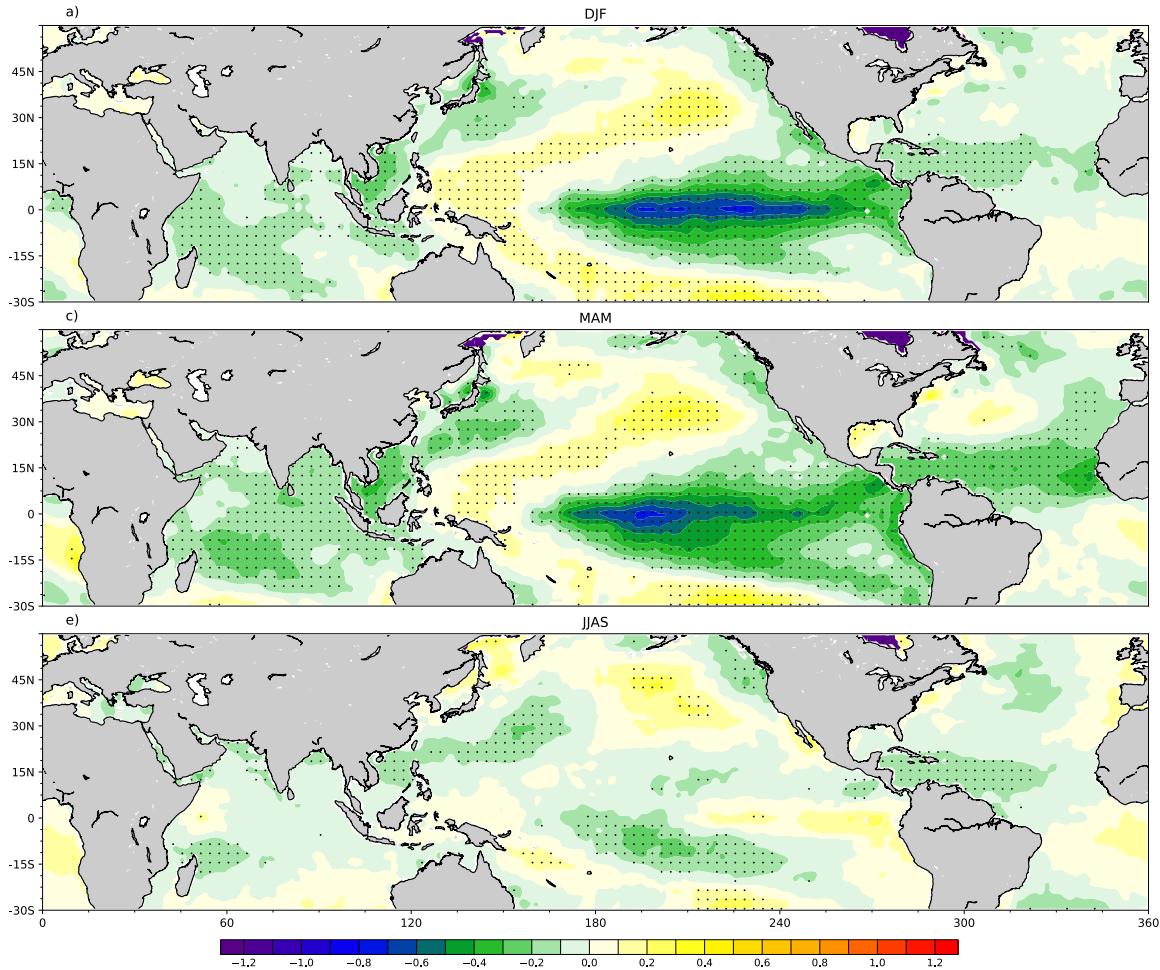


We know that mean state is important to understand teleconnection. We find here that the direction of change in state could be as important.

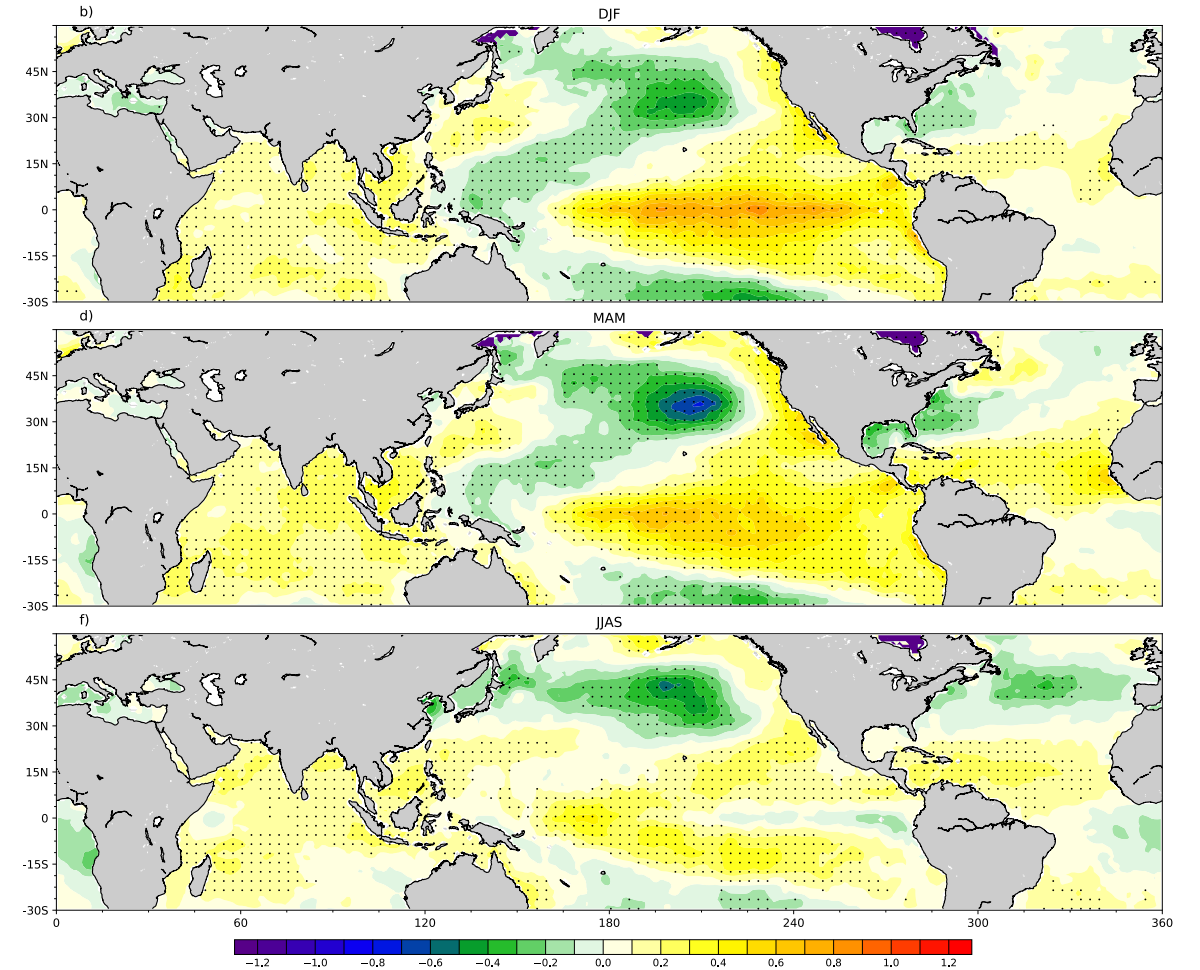
June-September Sea Surface Temperature



La Nina Winter to Neutral Summer

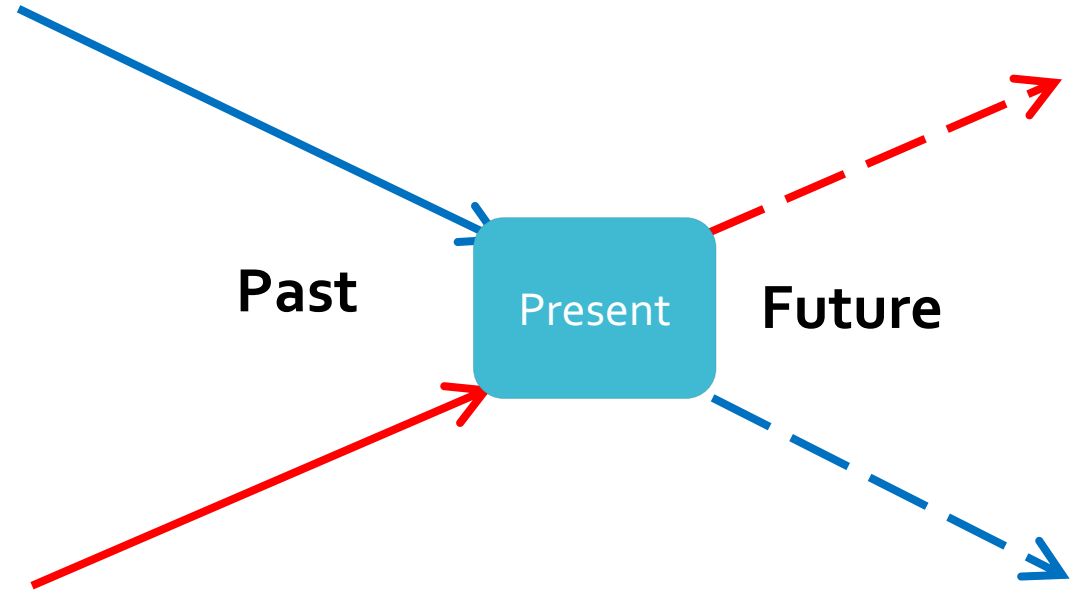


El Nino Winter to Neutral Summer



Known model of teleconnection:

$$Impact(t) \sim Forcing(t)$$



Proposed model of teleconnection:

$$Impact(t) \sim \xrightarrow{\hspace{2cm}} Forcing$$

Summary and Open Questions

- ❑ The impact of summer ENSO on ISMR is modulated by the state of ENSO in preceding winter.
- ❑ ENSO-ISMR relationship is stronger conditioned upon La Nina or El Nino in preceding winter.
- ❑ Winter La Nina decreases summer monsoon and is responsible for severe droughts when summer is El Nino.
- ❑ This provides opportunity for improved seasonal outlook of monsoon rainfall.
- ❑ Questions:
 - ❑ Do coupled climate models capture this observed evolution of climate from winter to summer?
 - ❑ When exactly should we initiate a seasonal prediction using coupled model? Too early increases forecast error due to lead-time. Too late does not capture the evolution of the climate.
 - ❑ Can a mathematical model be designed to capture the asymmetry between El Nino and La Nina?