

The Role of Air-Sea Coupling in the Intraseasonal Oscillation

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Cristiana Stan
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ISO = intraseasonal oscillation
ISV = intraseasonal variability
intraseasonal = 20~100 day periodicity

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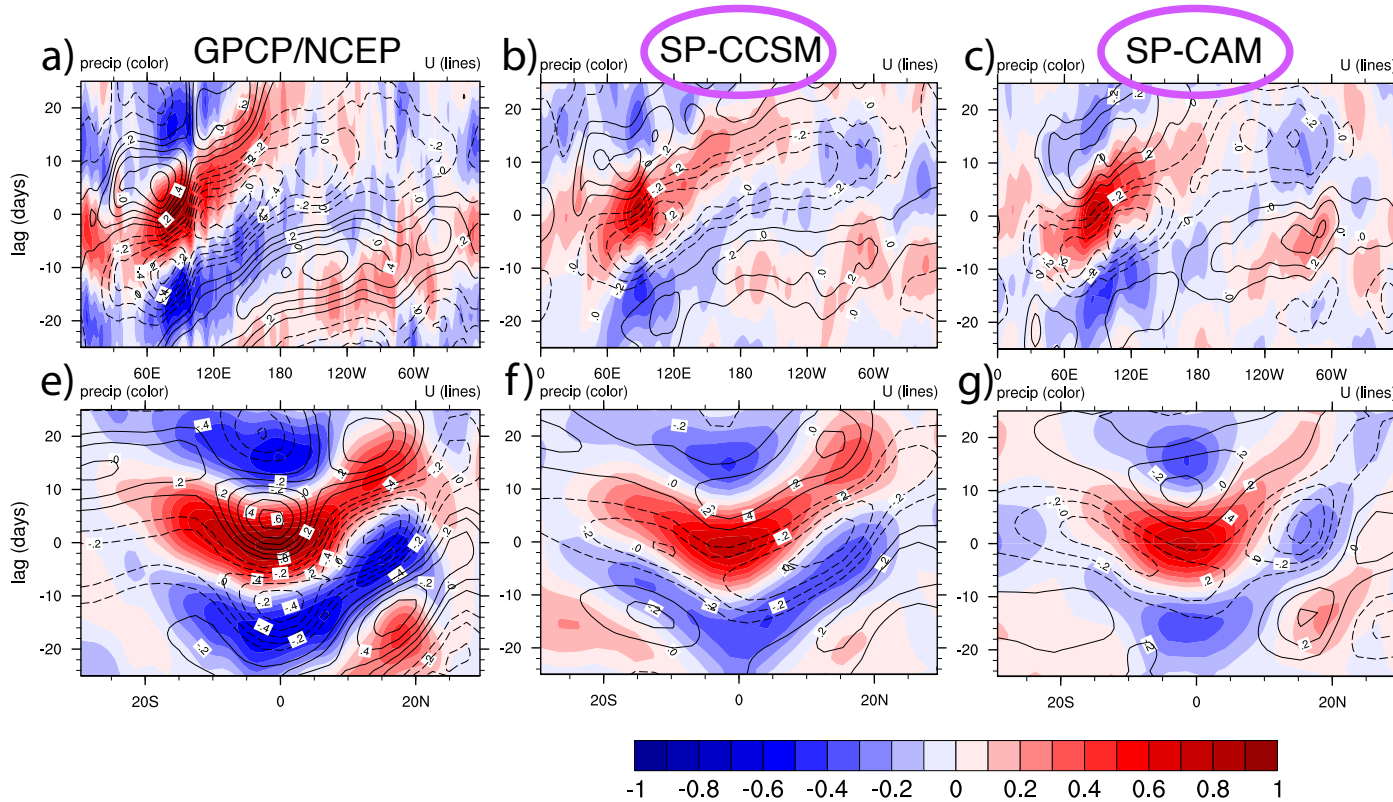
Ocean Impacts on the Atmosphere at ISO Timescales (previous findings from modeling studies)

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- Several modeling studies suggest that coupling is more important in the Indian Ocean than the West Pacific Ocean.
- The addition of coupling can improve (slow down) the phase of the ISO.
- In the absence of coupling, high frequency SSTs can improve ISV.

Questions

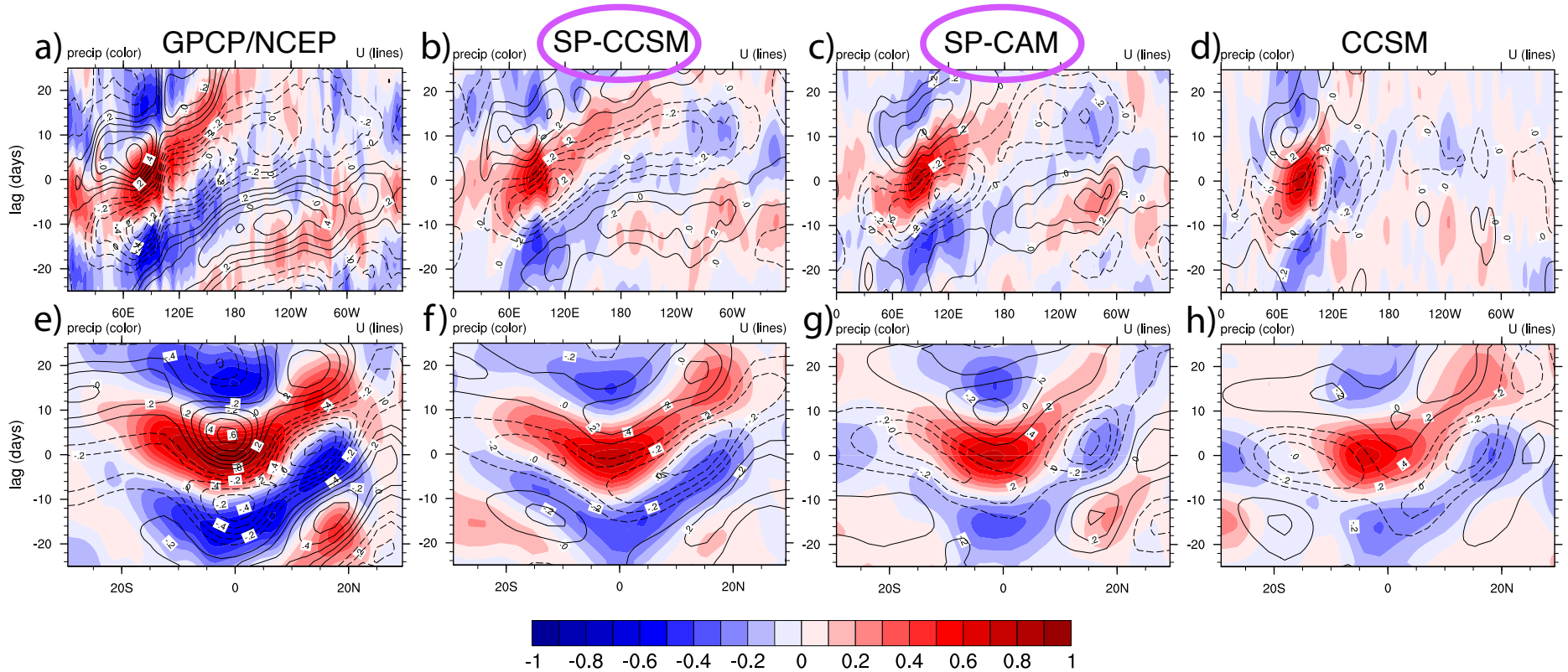
- How well-suited are our models to studying the role of SST anomalies on the ISO?
- By what mechanism(s) do SST anomalies improve the ISO?

A Typical Experimental Setup



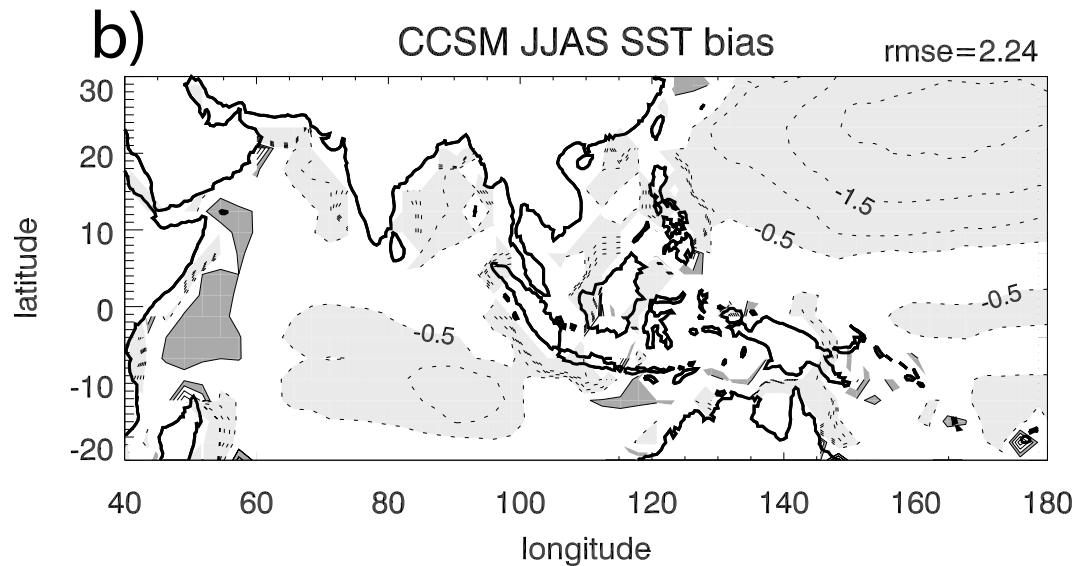
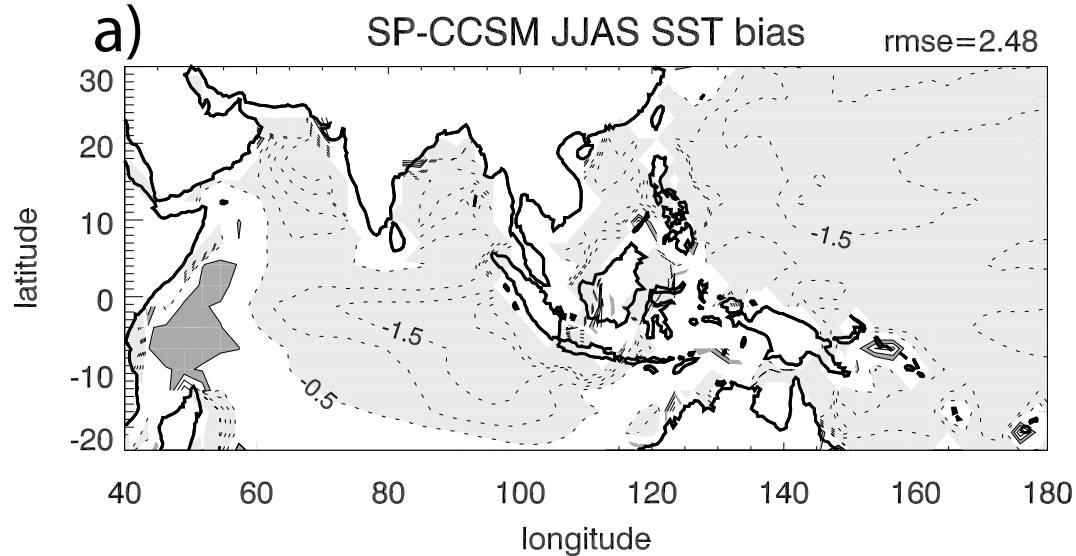
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are analyzed in terms of their ISO simulation

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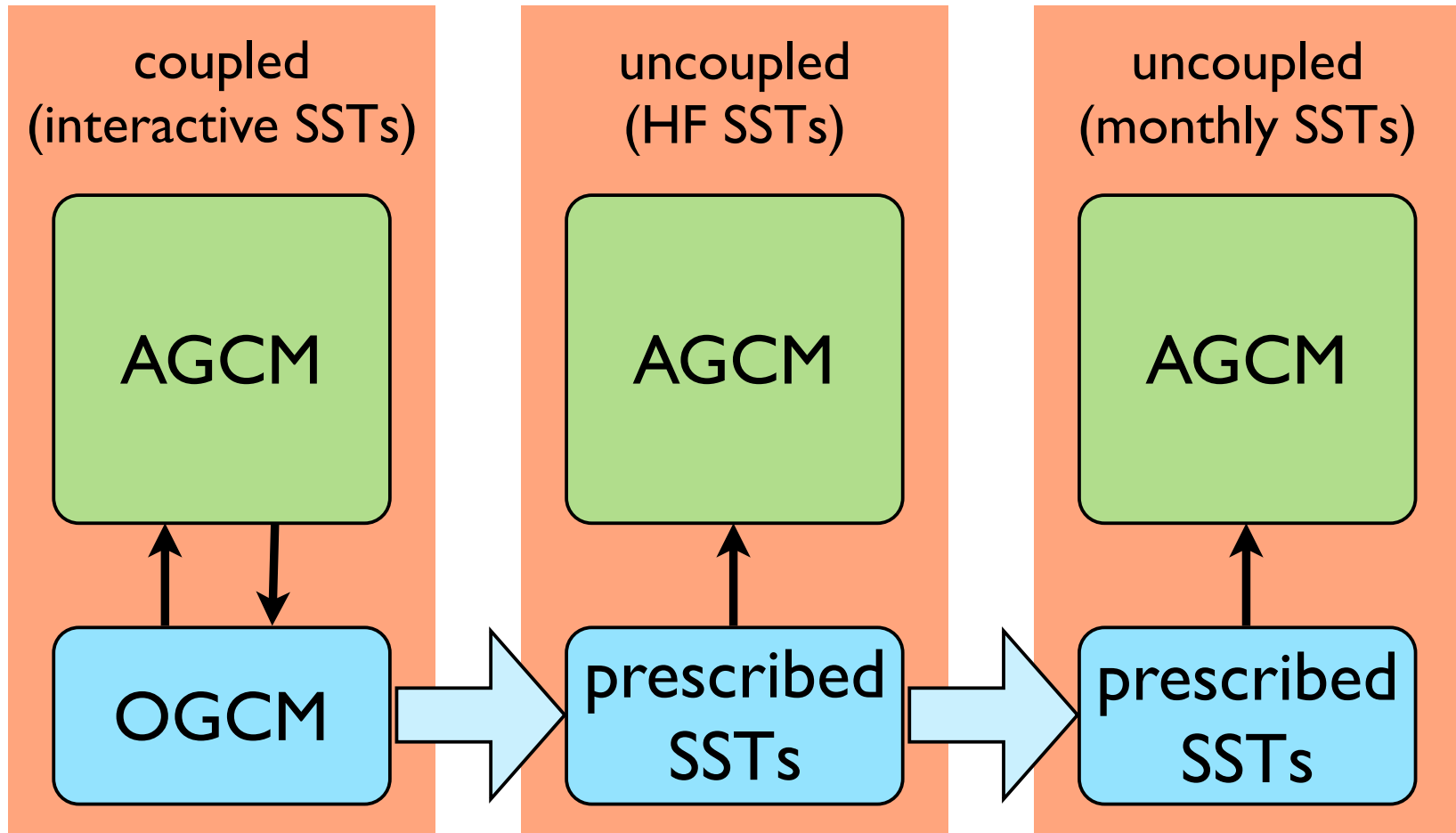
Caveat to the Typical Experimental Setup



Coupled models often result in cold SST biases, leading to **different mean climate states** than their uncoupled counterparts.

Does improved ISV arise from coupling, or from mean state changes?

A More Rigorous Experimental Setup



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Or does the ISO simply need variable SSTs?

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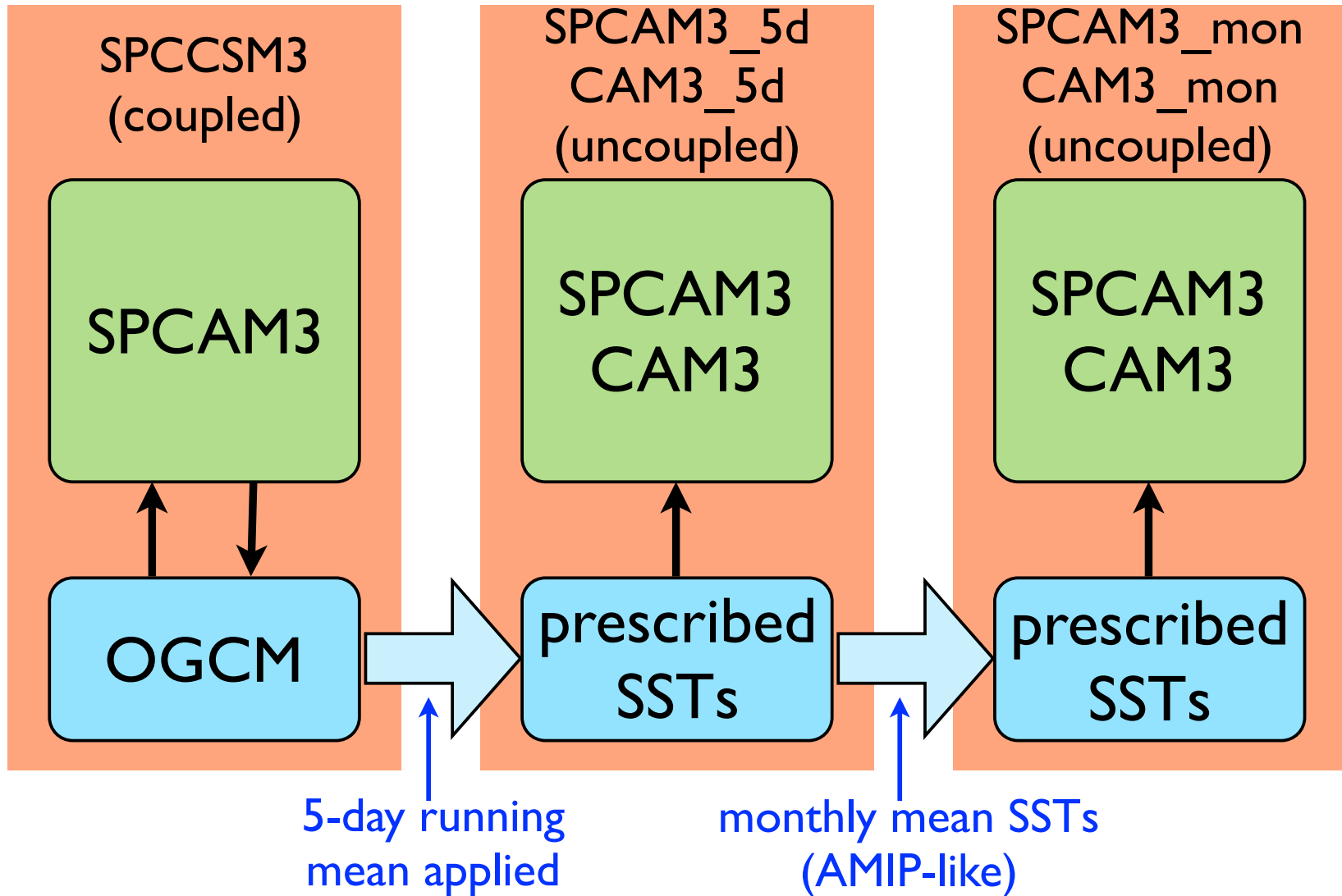
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Can we trust models to answer these
questions?

Our Experimental Setup



How do the following effect the simulated ISO?

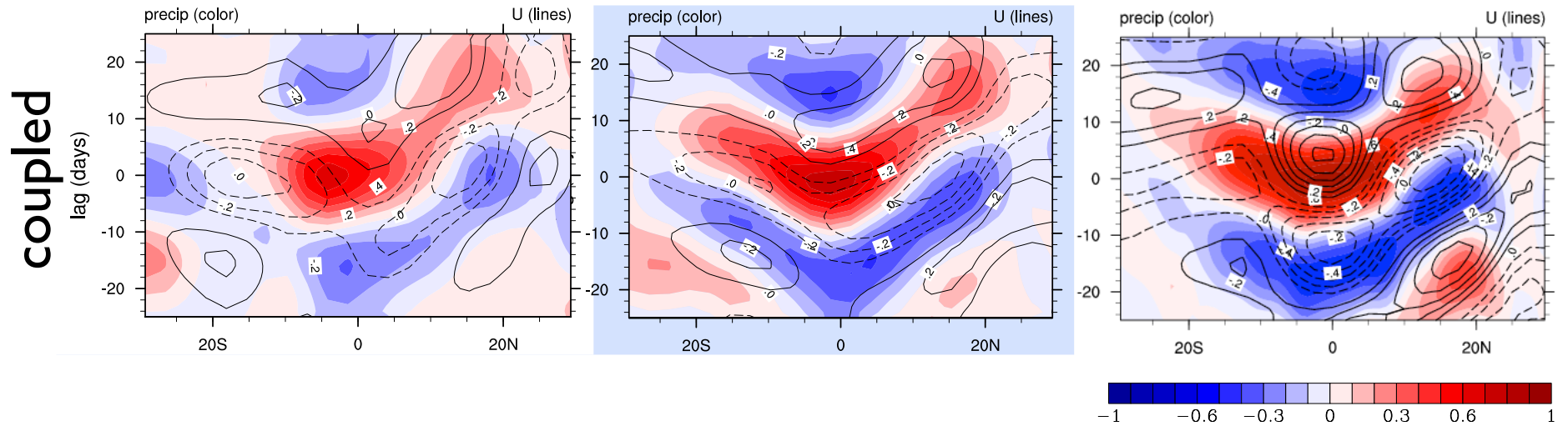
- Super parameterization (cloud treatment)
- Mean state
- Coupling
- Intraseasonally varying SST anomalies

Indian Ocean Northward Propagation (NP): May-Oct

CCSM3/CAM3

SPCCSM3/SPCAM3

Observations



Indian Ocean Northward Propagation (NP): May-Oct

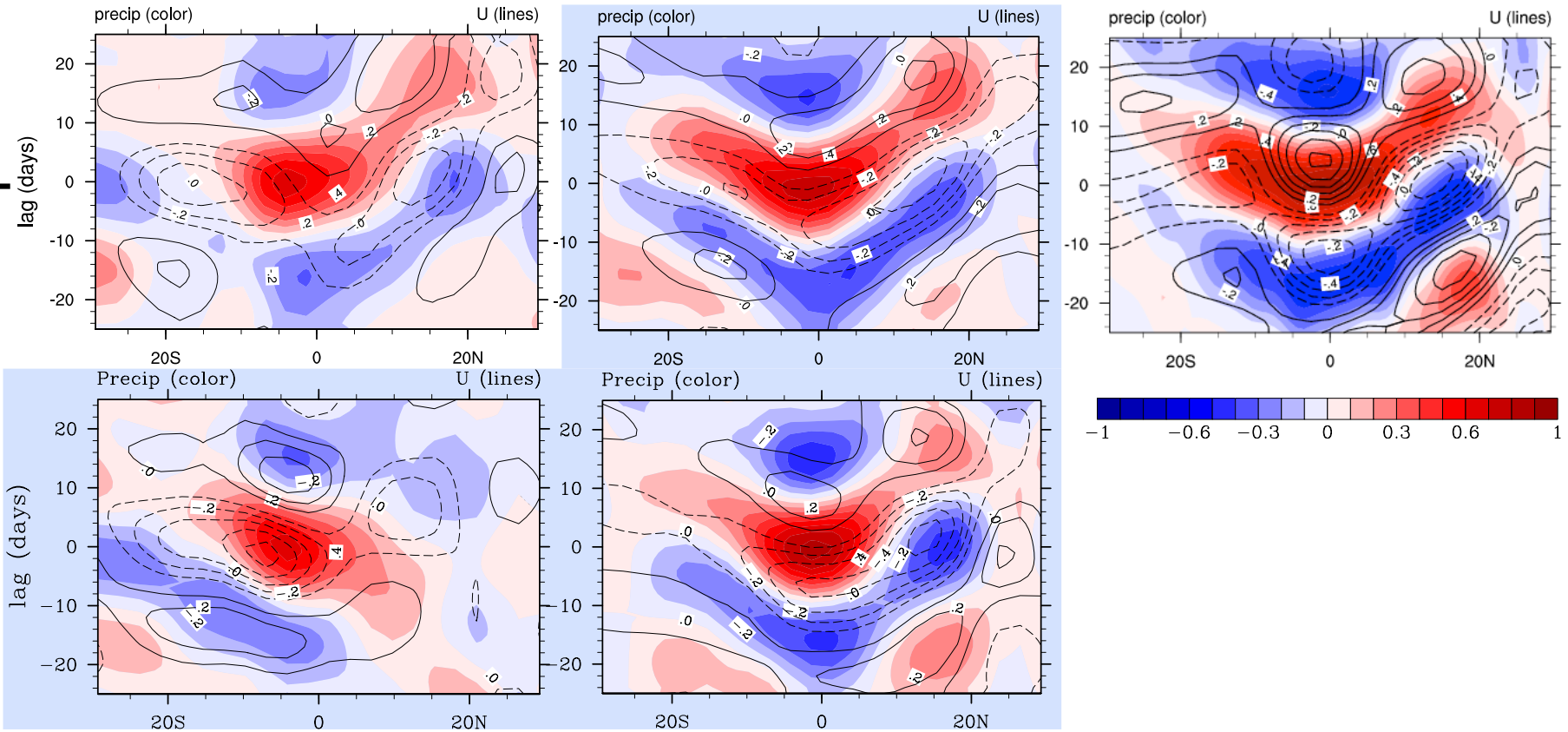
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coupled

5d RM SSTs



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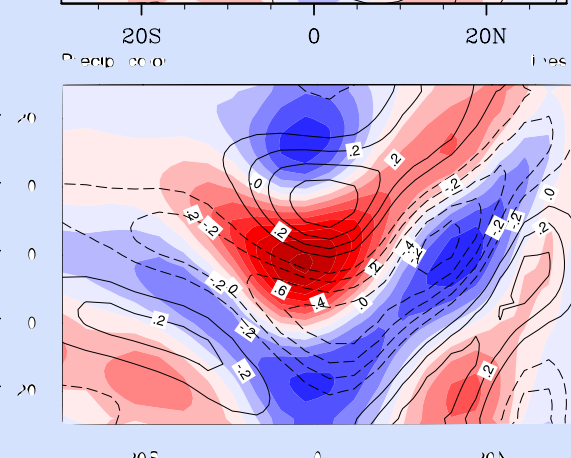
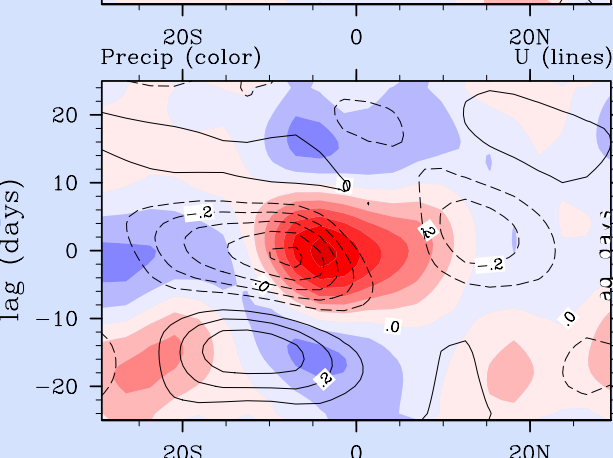
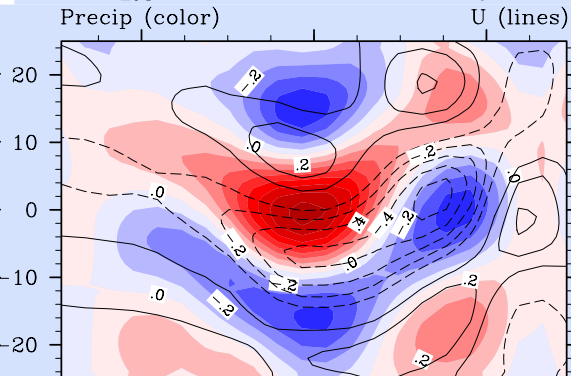
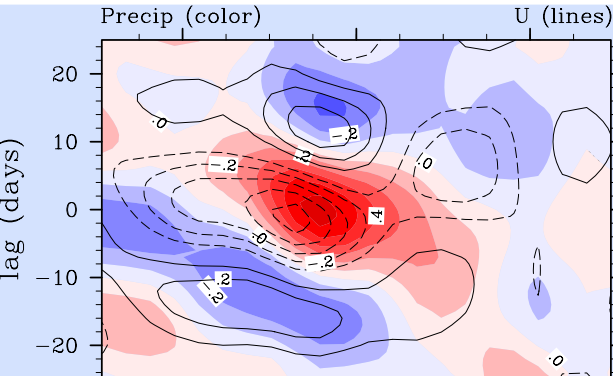
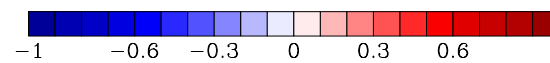
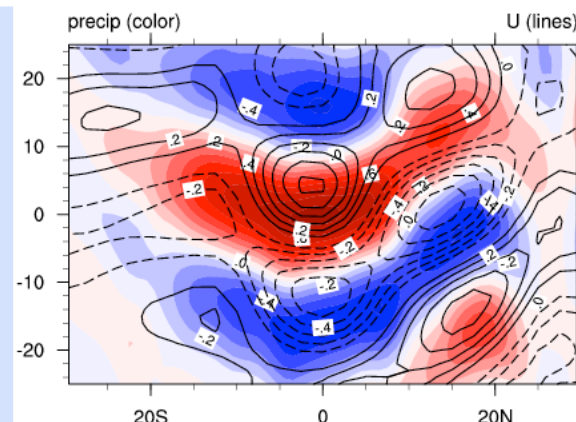
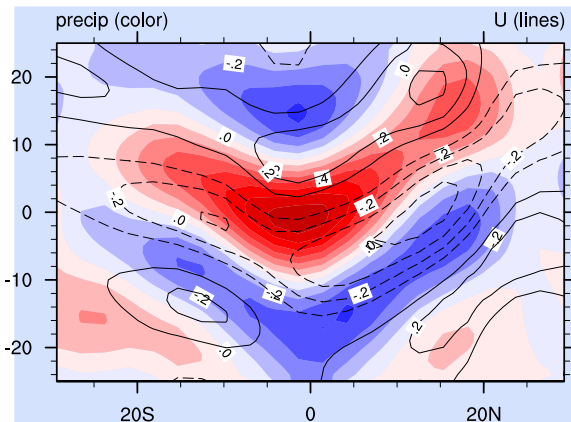
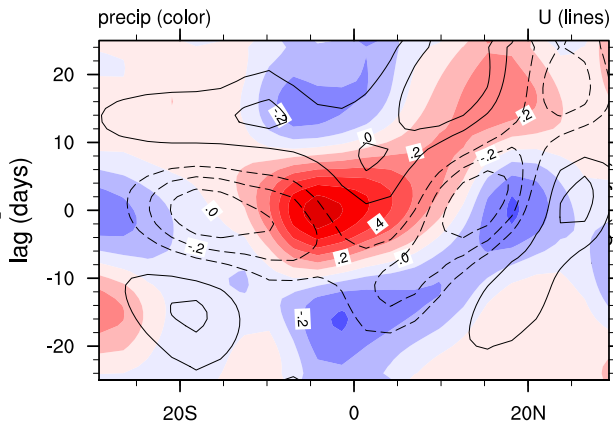
SPCCSM3/SPCAM3

Observations

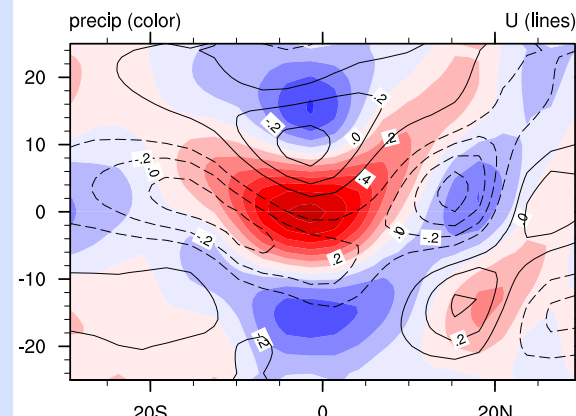
coupled

5d RM SSTs

monthly SSTs



SPCAM3-AMIP



Equatorial Eastward Propagation (EP): Nov-Apr

CCSM3/CAM3

SPCCSM3/SPCAM3

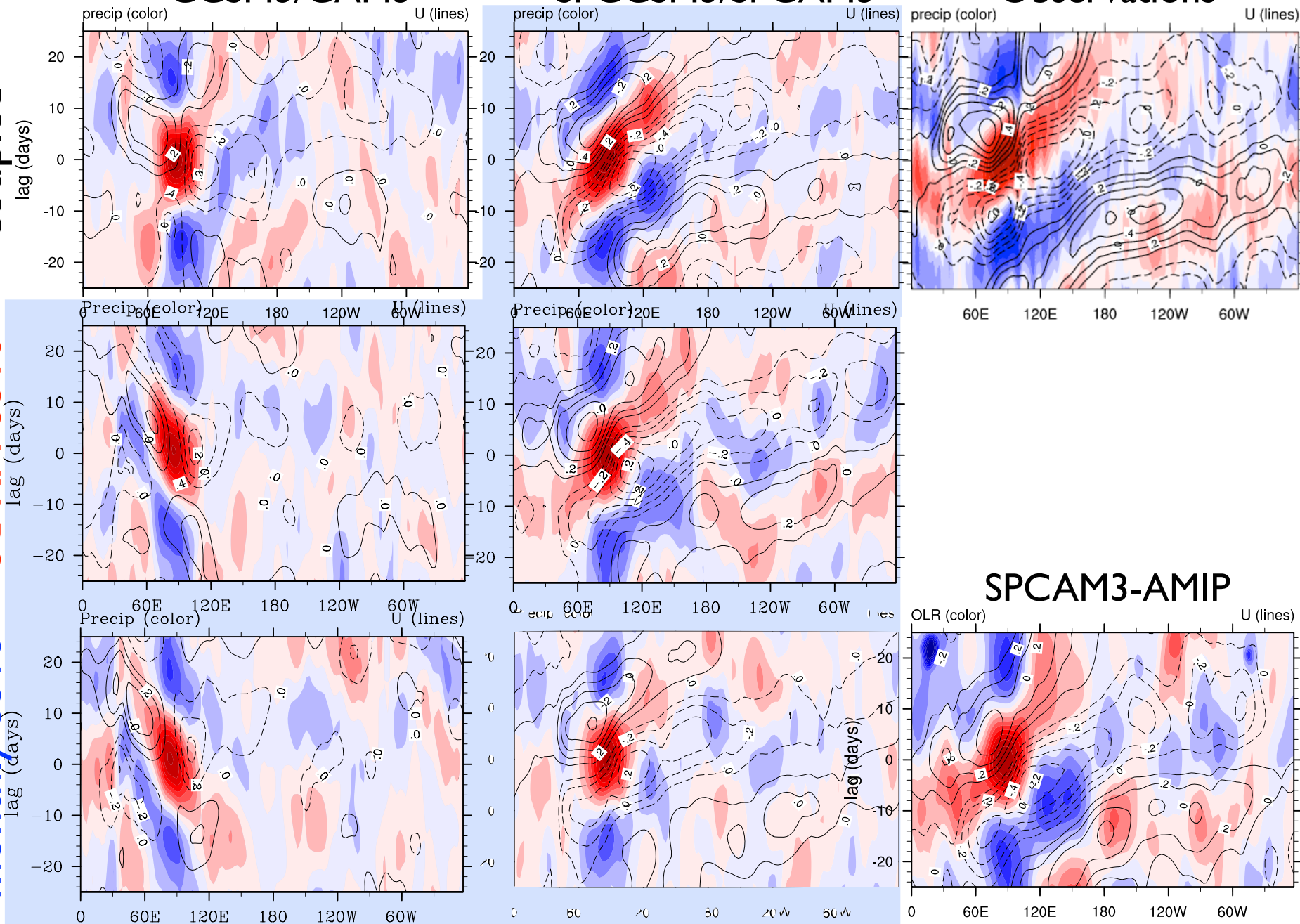
Observations

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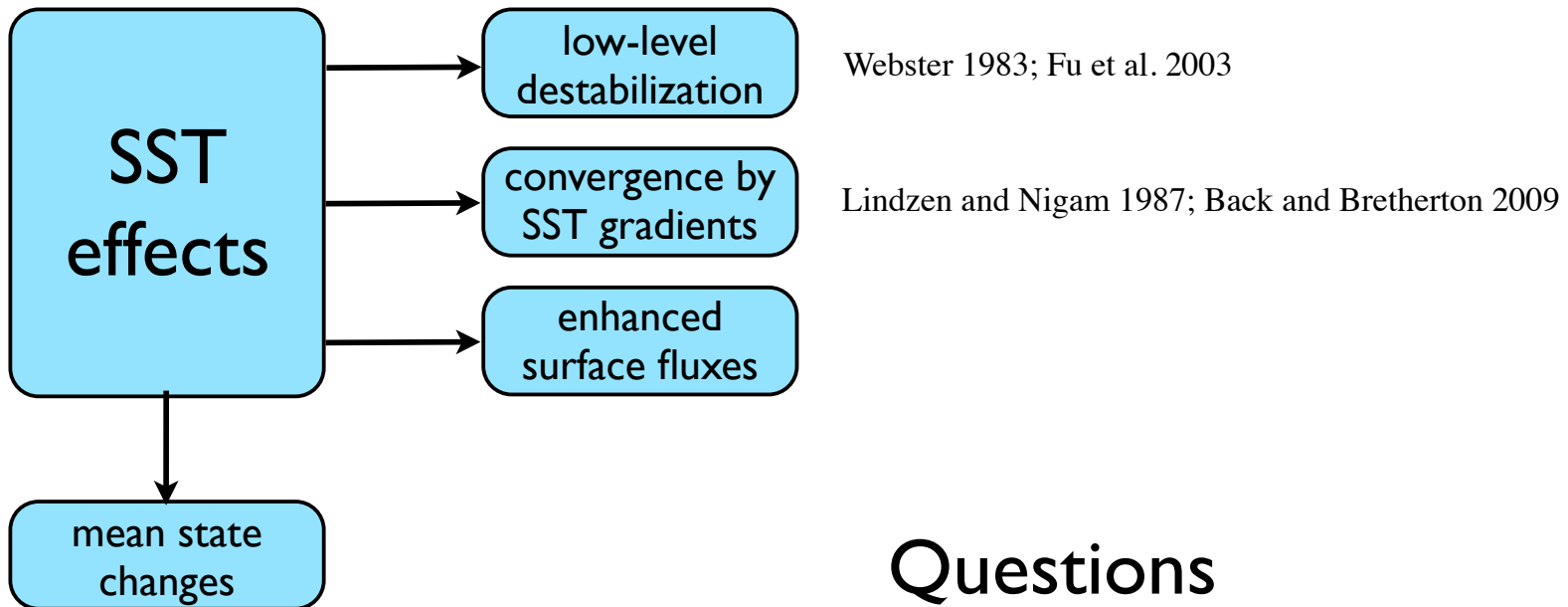
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Propagation and periodicity are not sufficient to assess the role of coupling.

The resulting intraseasonal ISO should also exhibit spatial structure and evolution similar to that in observations.

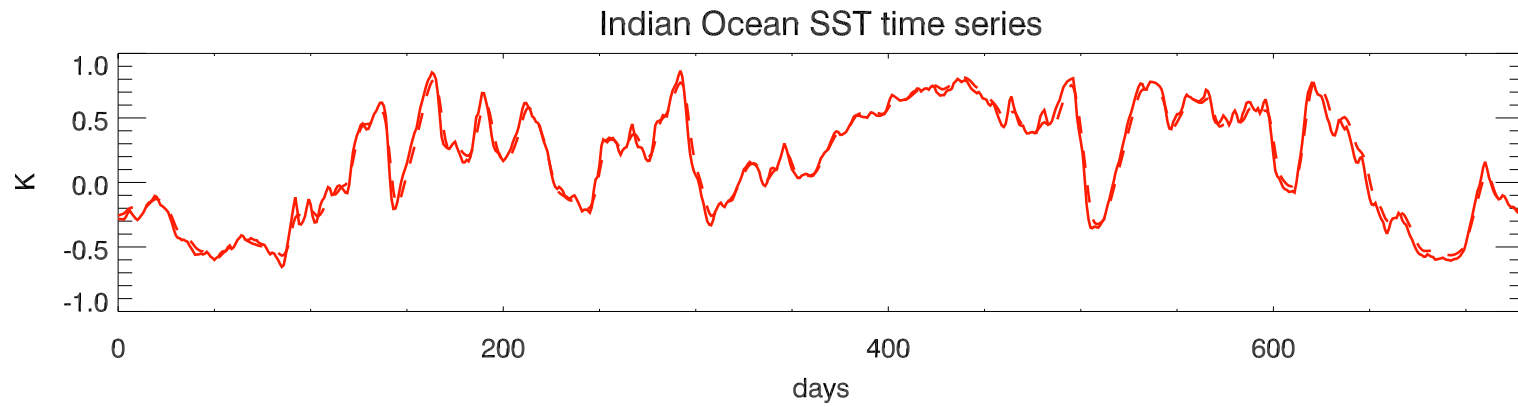
So what exactly is the role of air-sea coupling for the ISO? What are the mechanisms?



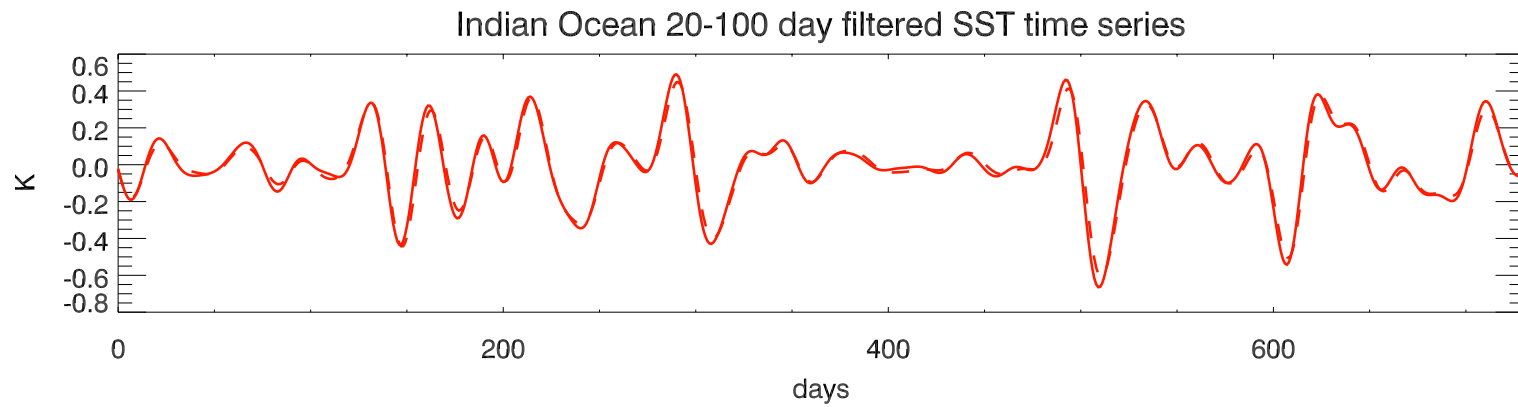
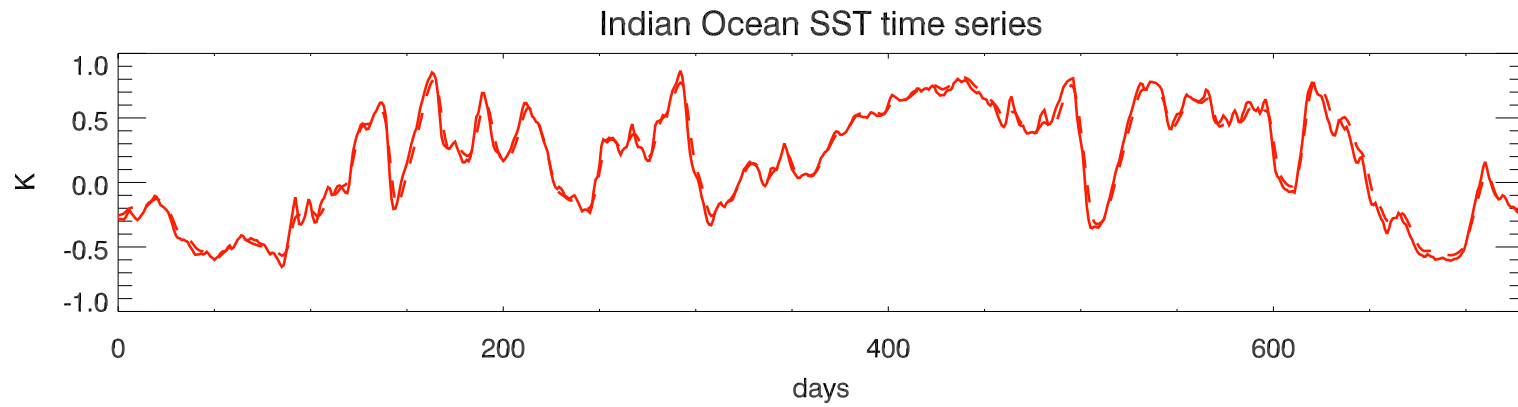
Questions

- Which of these processes is most important for ISO simulation?
- How does convective treatment influence the results?

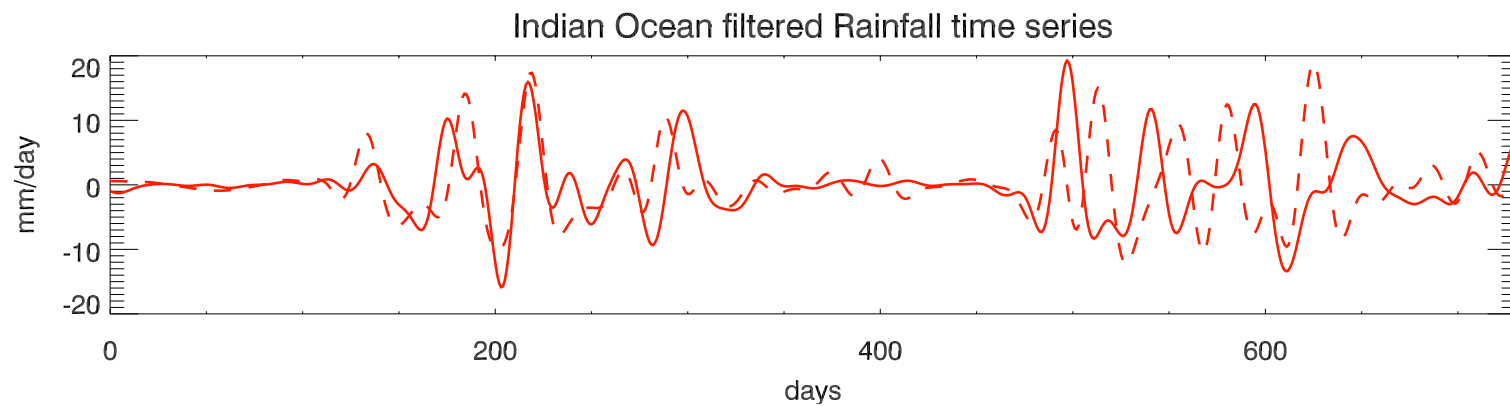
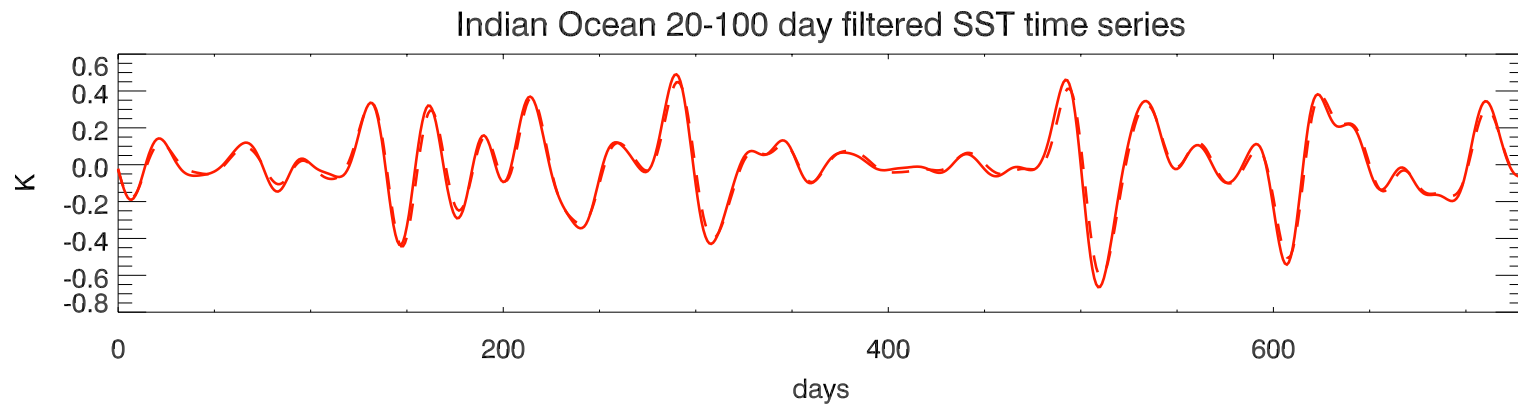
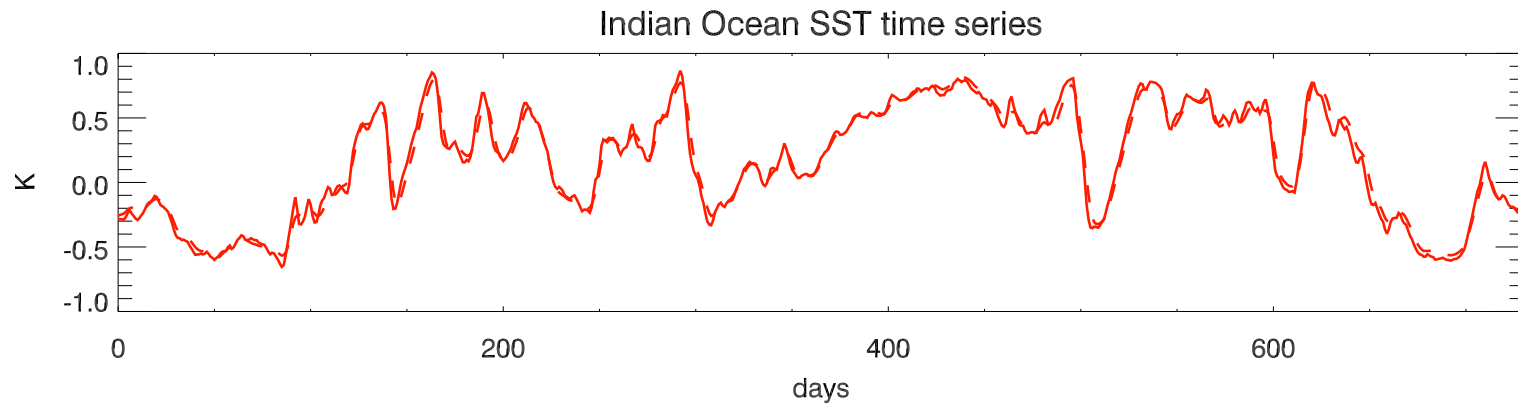
Rainfall & SST in Coupled and “5d” simulations



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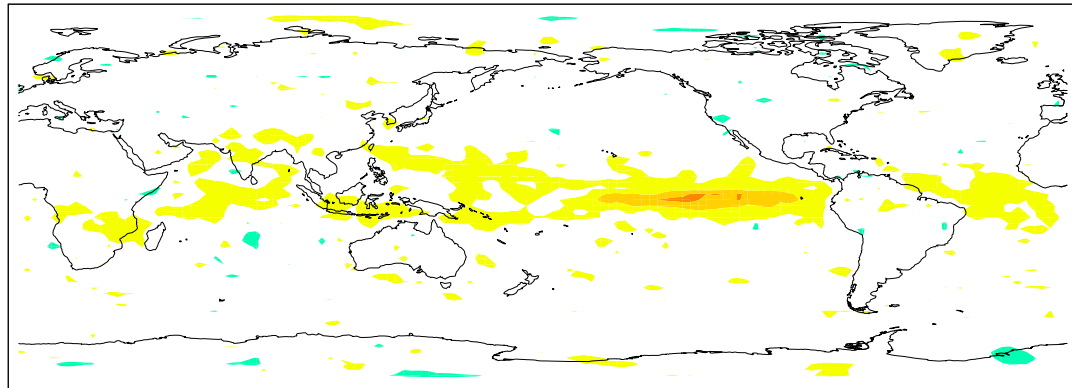
Rainfall & SST in Coupled and "5d" simulations



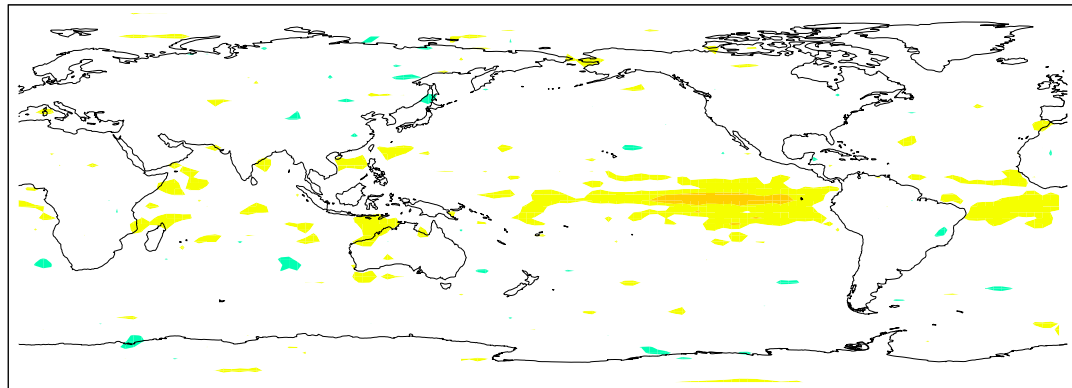
Rainfall in Coupled and “5d” simulations

at intraseasonal timescales, SST anomalies do not appear to temporally influence precipitation anomalies in SPCAM3.

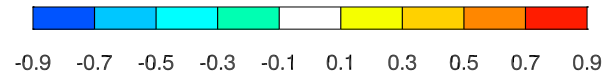
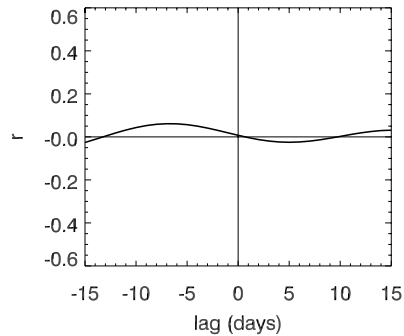
20-100 day Rainfall correlation: SPCCSM3 v SPCAM3_5d



20-100 day Rainfall correlation: SPCAM3_5d v CAM3_5d



IO Rainfall vs. Rainfall, SPCCSM3 vs. SPCAM3_5d

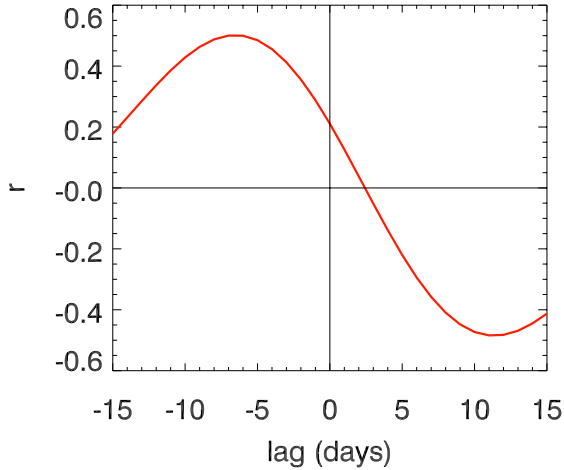


IO and WPac Rain-SST lag-correlation

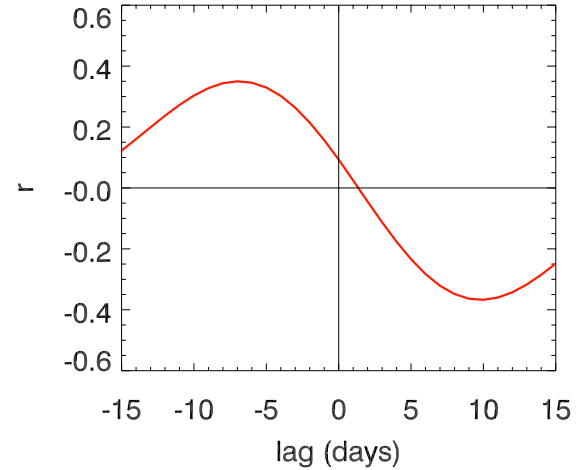
— coupled - - - - - 5d - · - · - · - monthly

SP

IO Rainfall vs. SST w/SP

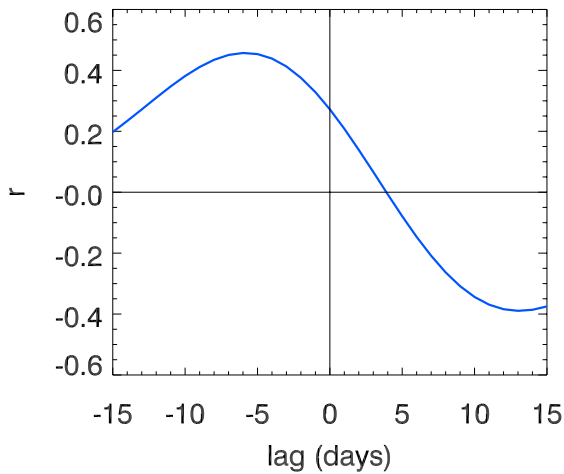


WPac Rainfall vs. SST w/SP

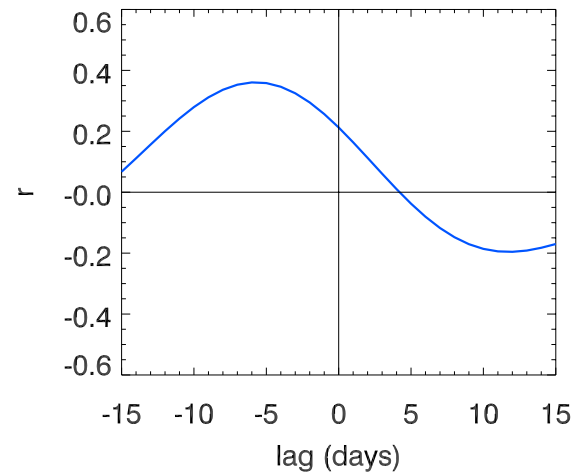


no SP

IO Rainfall vs. SST w/o SP



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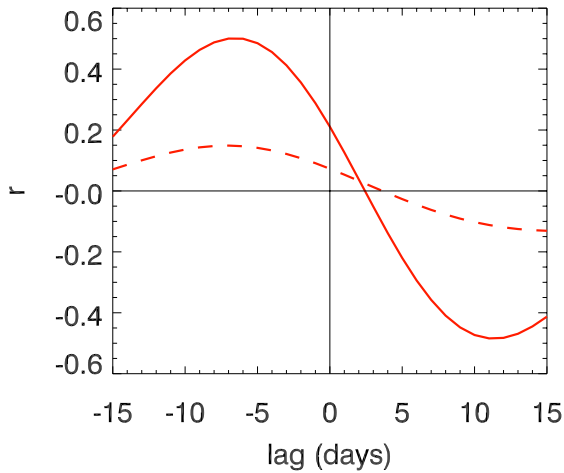


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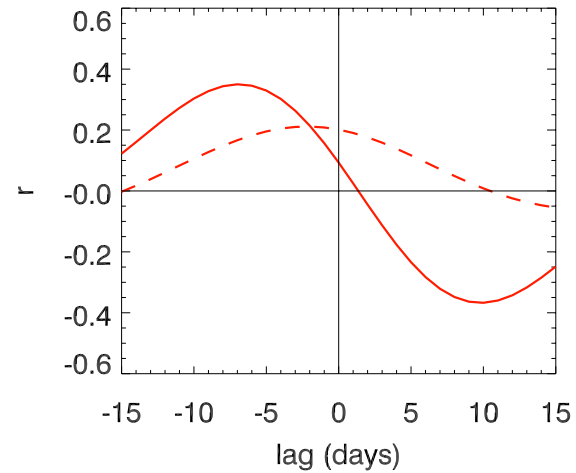
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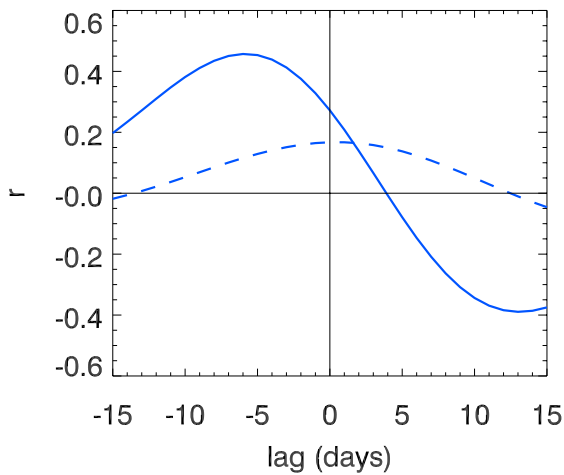


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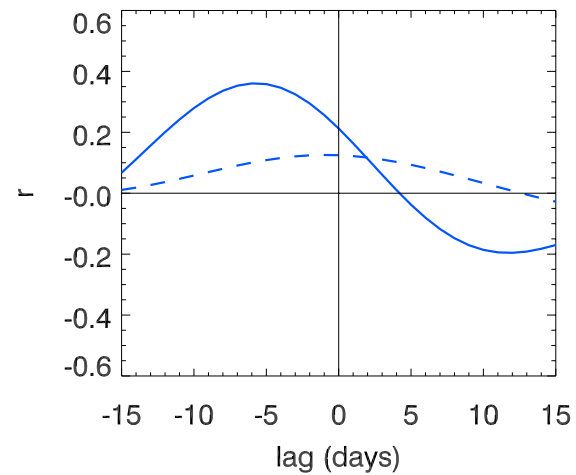


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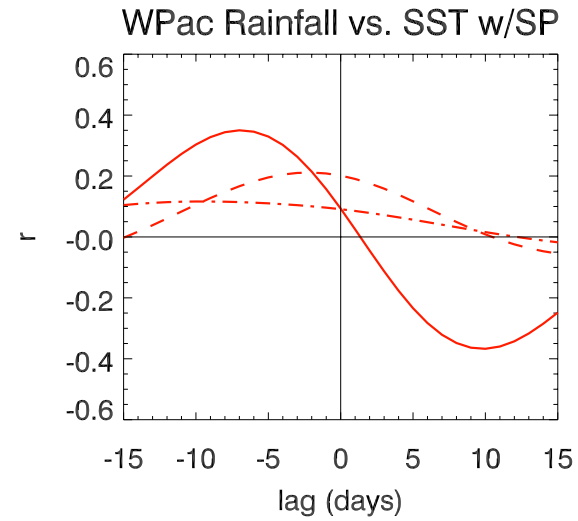
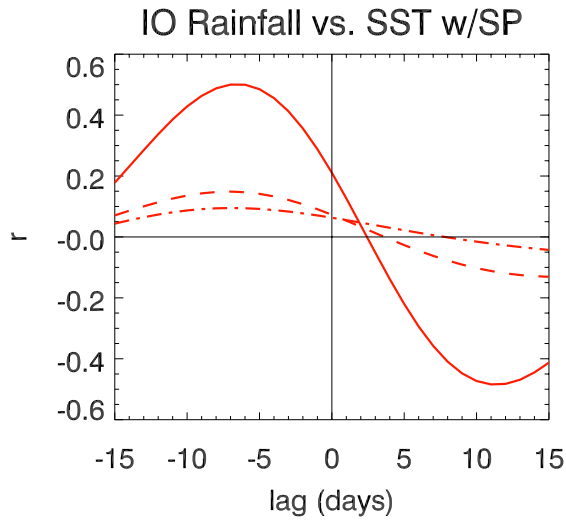
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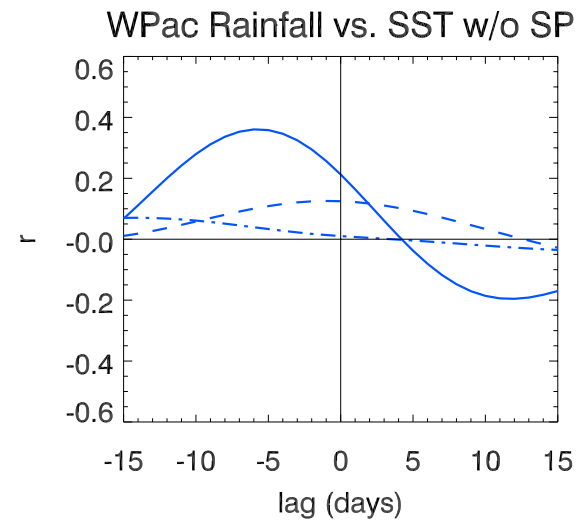
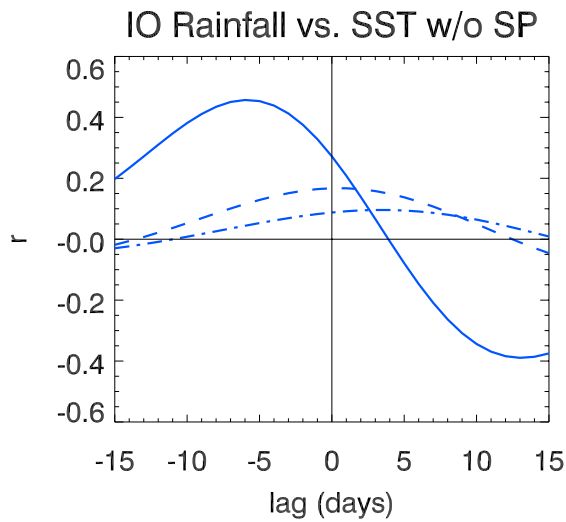
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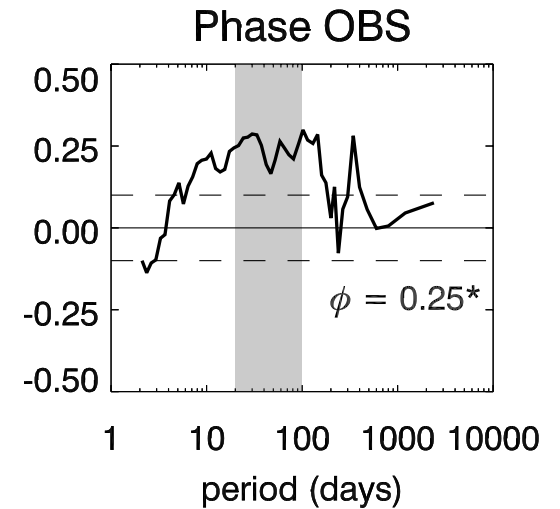
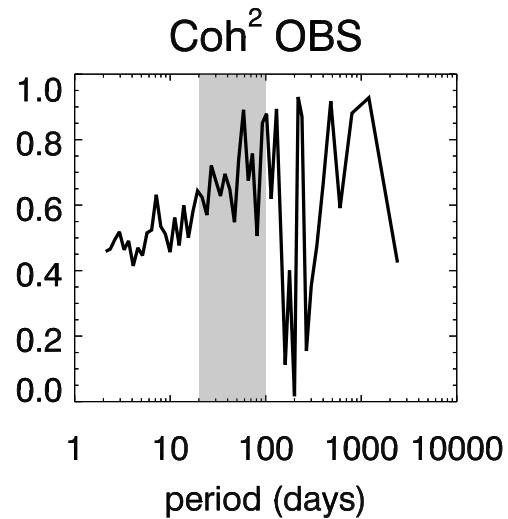
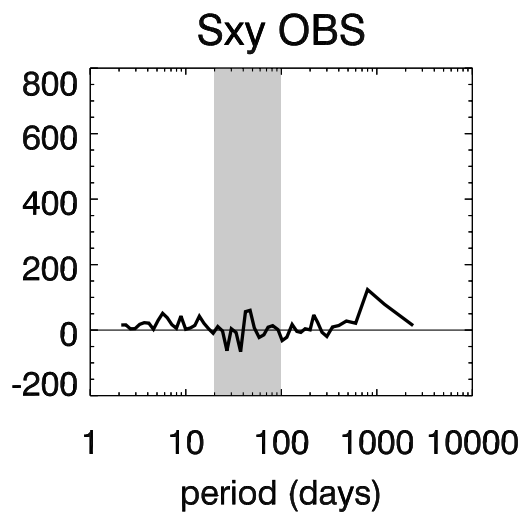
SP



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Observations: Equatorial WPac Precip'-SST' cross spectra



$$\phi = \tan^{-1} \left(\frac{1}{n} \sum_{i=0}^n S_{xy}(i) \right)$$

20-100 day Rainfall-SST anomaly Coh^2 and Phase Angle

