

The Asian Monsoon in SpCCSM

with comparisons to CCSM and SpCAM

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Outline

- Model description
- Mean precipitation and SST
- Variability: ENSO, MJO, Asian monsoon
- Comparison to AR4 AOGCMs
- Covariability of SST and precipitation
- Current efforts

Model Descriptions

- Uncoupled Simulations: CAM, SpCAM (14-year AMIP)
- Coupled Simulations: CCSM, SpCCSM (23 years)

T42 resolution in atmosphere

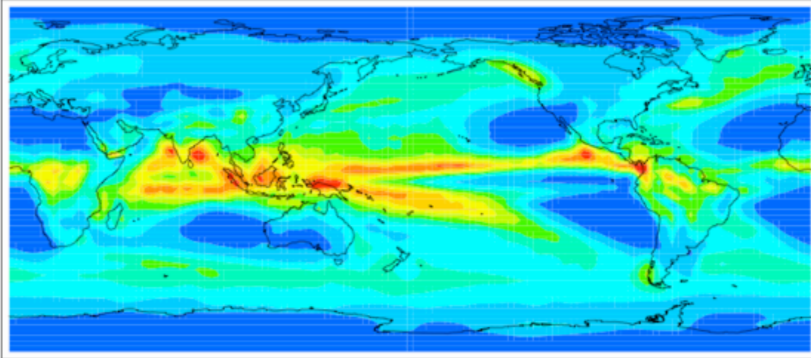
- *semi-Lagrangian dynamical core for atmosphere*
- *gx3x5 POP ocean model*
- *CLM3 land model*
- *CSIM ice model*
- *ocean initialized at rest*
- *years 4-23 analyzed*

Mean State

Annual Rainfall

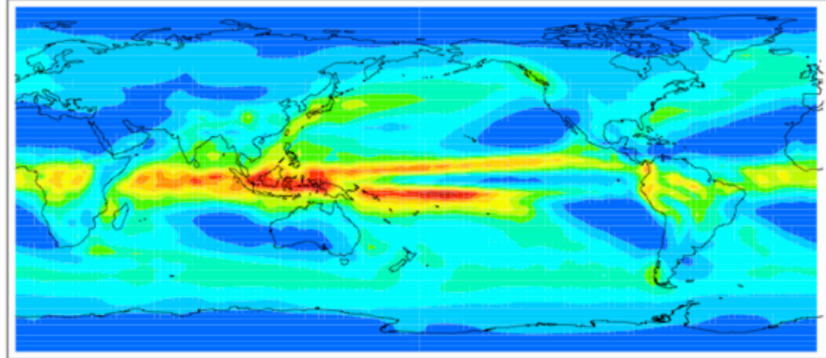
CAM

CAM PRECT ANN mean=2.83



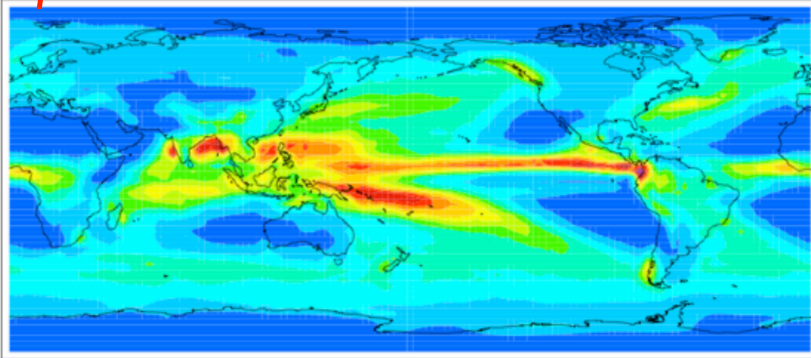
CCSM

CCSM PRECT ANN mean=2.74



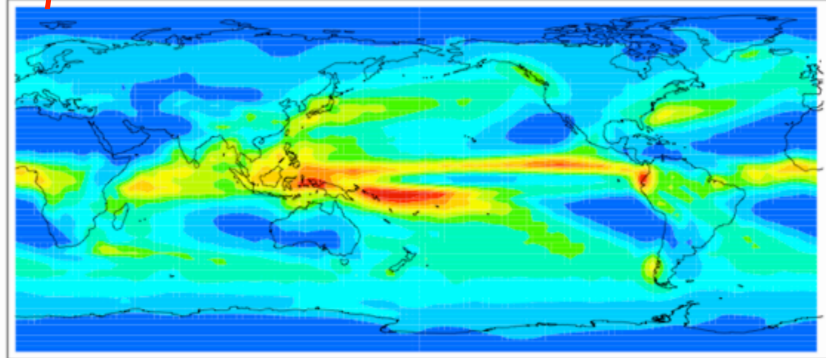
SpCAM

MMF PRECT ANN mean=2.80



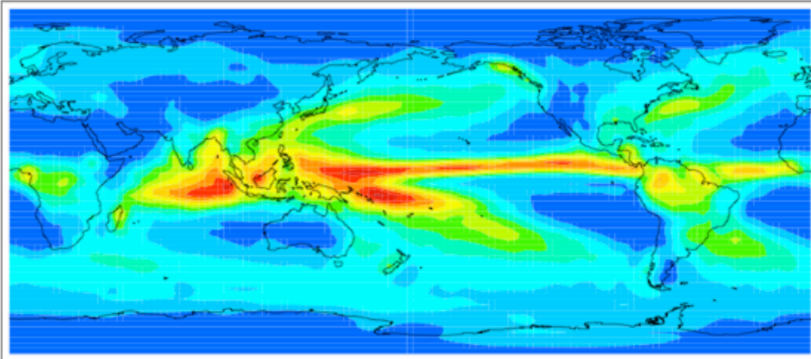
SpCCSM

CMMF PRECT ANN mean=2.79



OBS

CMAP PRECT ANN mean=2.69



SST

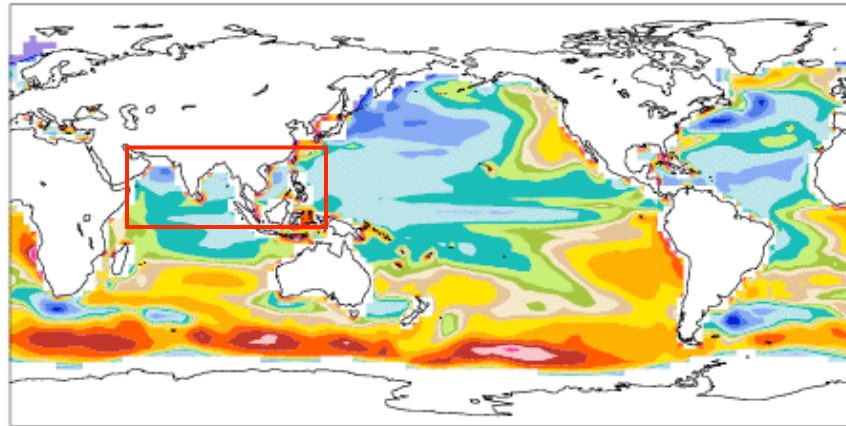
SpCCSM

SpCCSMT423 - HadISST

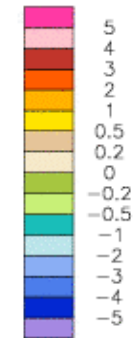
mean = 0.07

rmse = 2.08

C



Min = -8.54 Max = 22.36



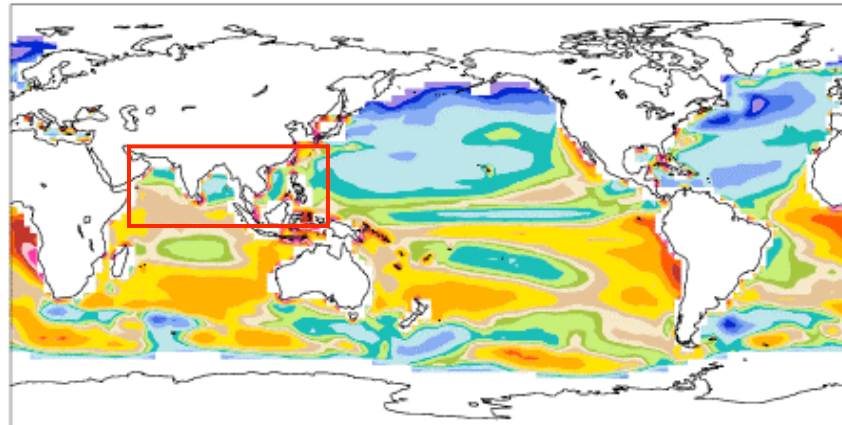
CCSM

CCSMT42sld1 - HadISST

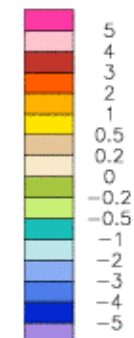
mean = 0.05

rmse = 2.14

C



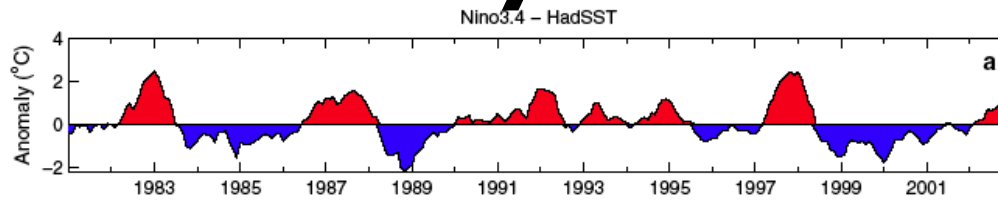
Min = -8.30 Max = 22.96



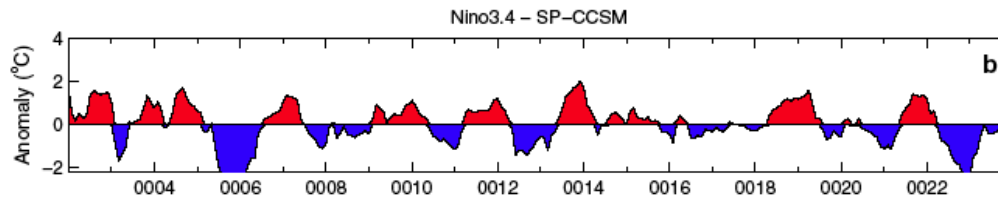
Variability

Variability: ENSO

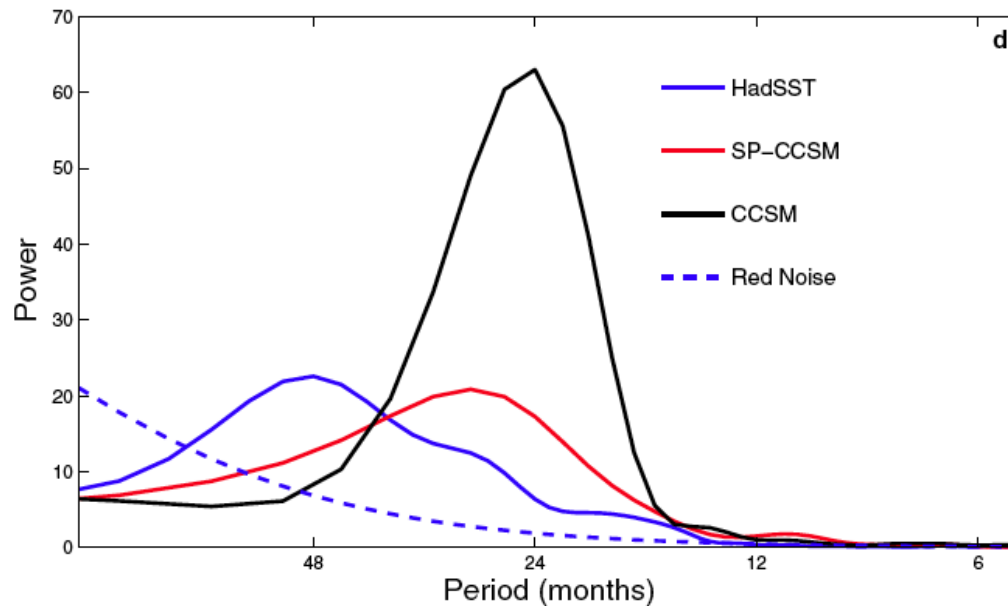
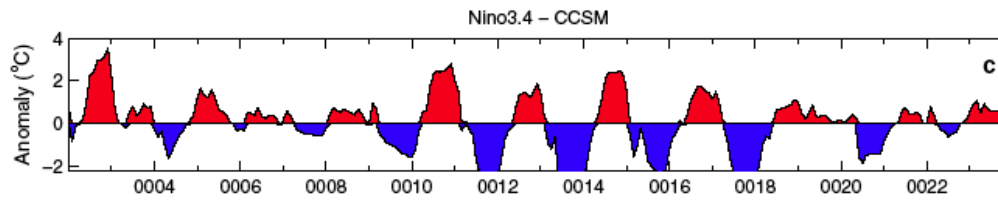
OBS



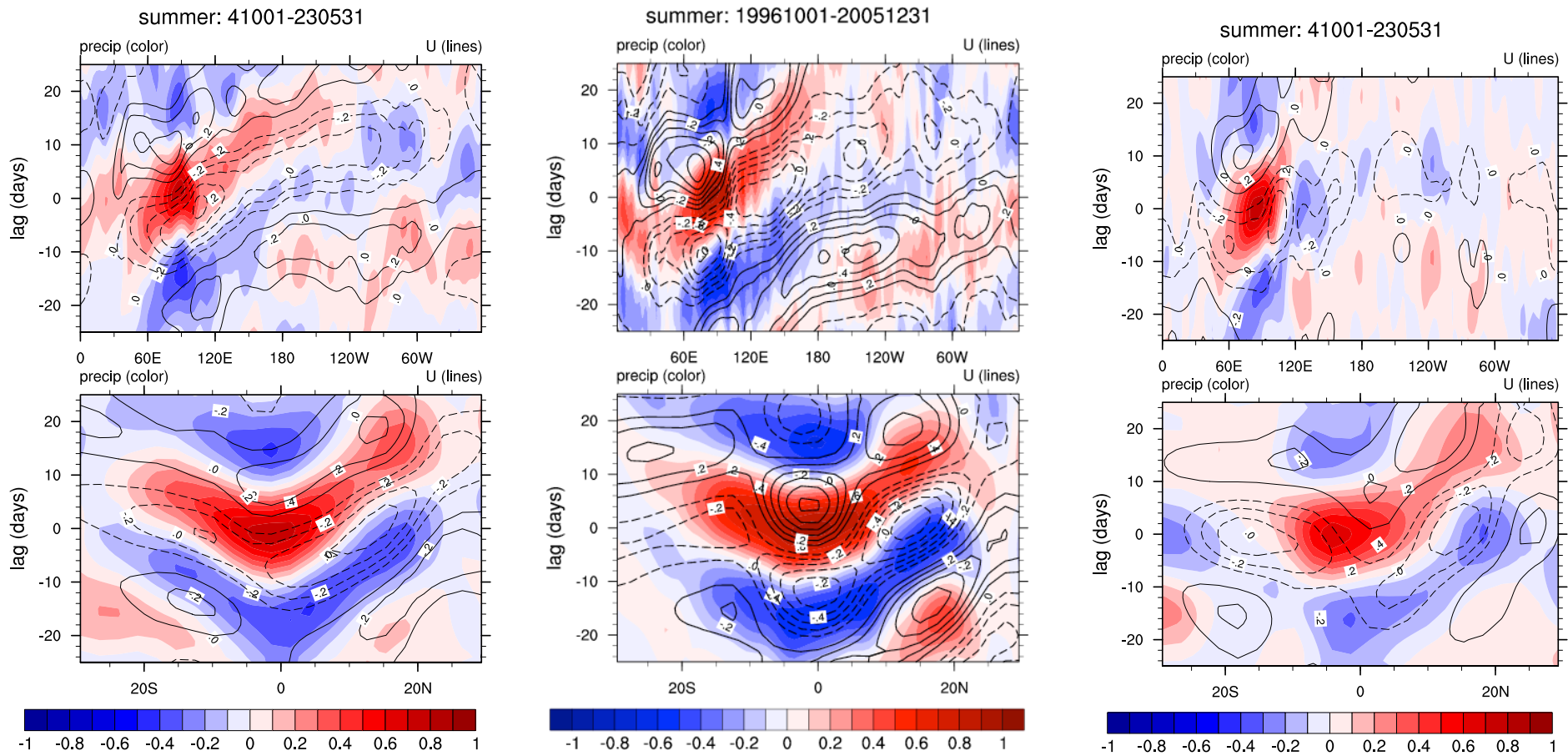
SpCCSM



CCSM



Variability: summer MJO



SpCCSM

OBS

CCSM

Asian Monsoon

Boreal Summer Intraseasonal Oscillations

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Subseasonal Variability Associated with Asian Summer Monsoon Simulated by 14 IPCC AR4 Coupled GCMs

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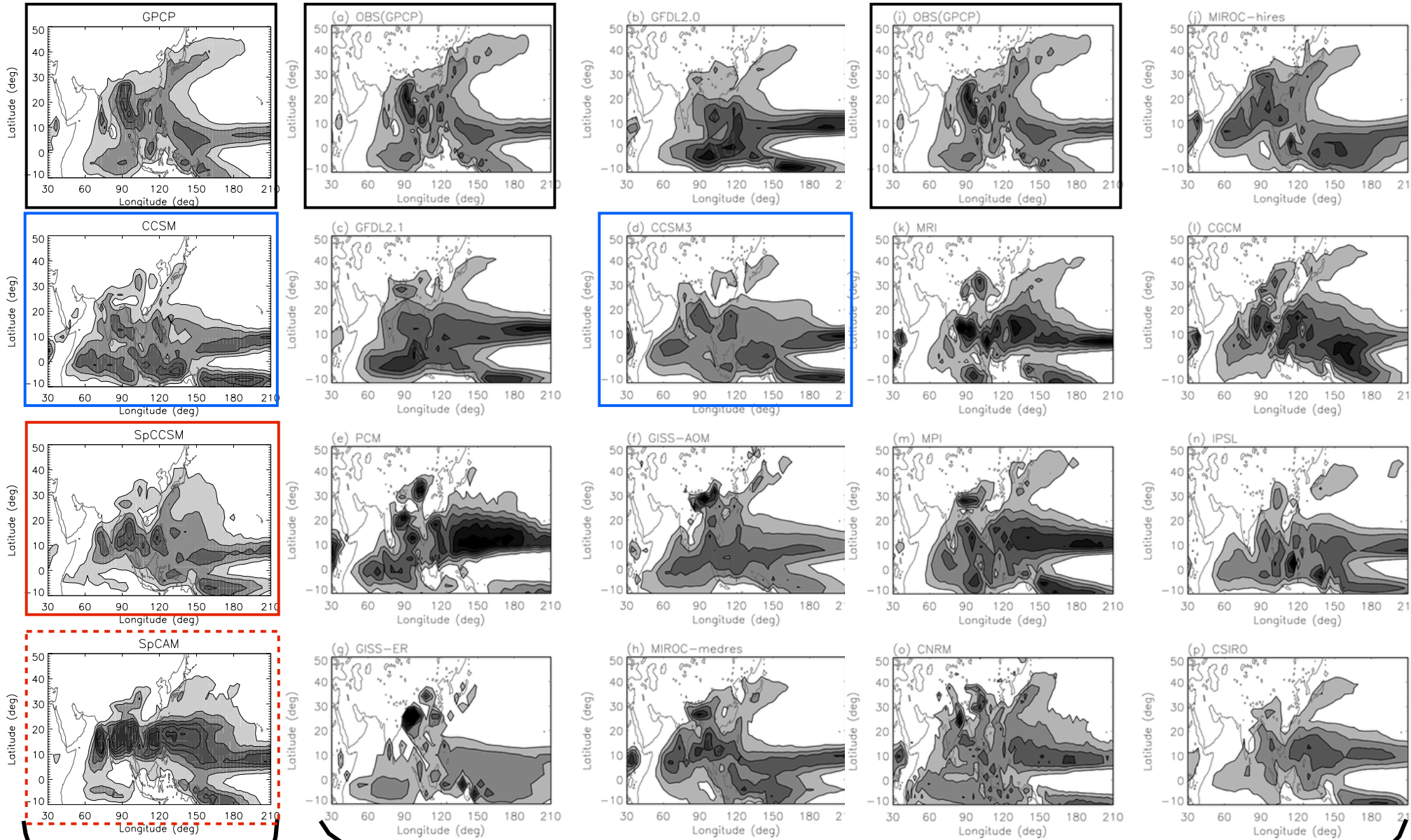
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GPCP
CCSM

May-October mean precipitation

SpCCSM, SpCAM

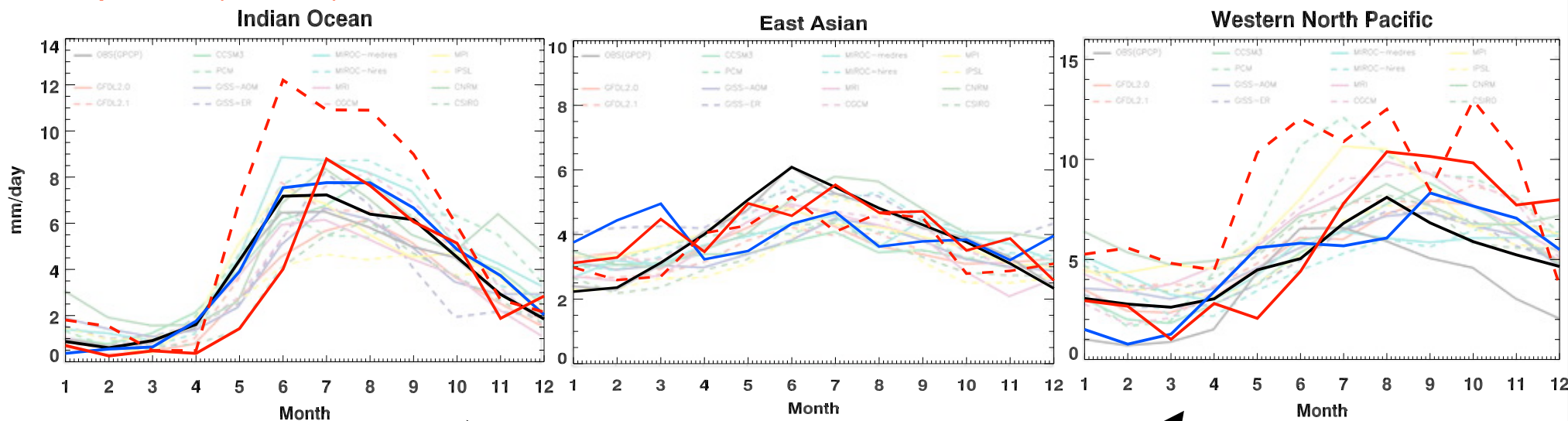


our analysis

from Lin et al, 2008

Annual cycle of precipitation

GPCP
 CCSM
 SpCCSM
 SpCAM (dashed)

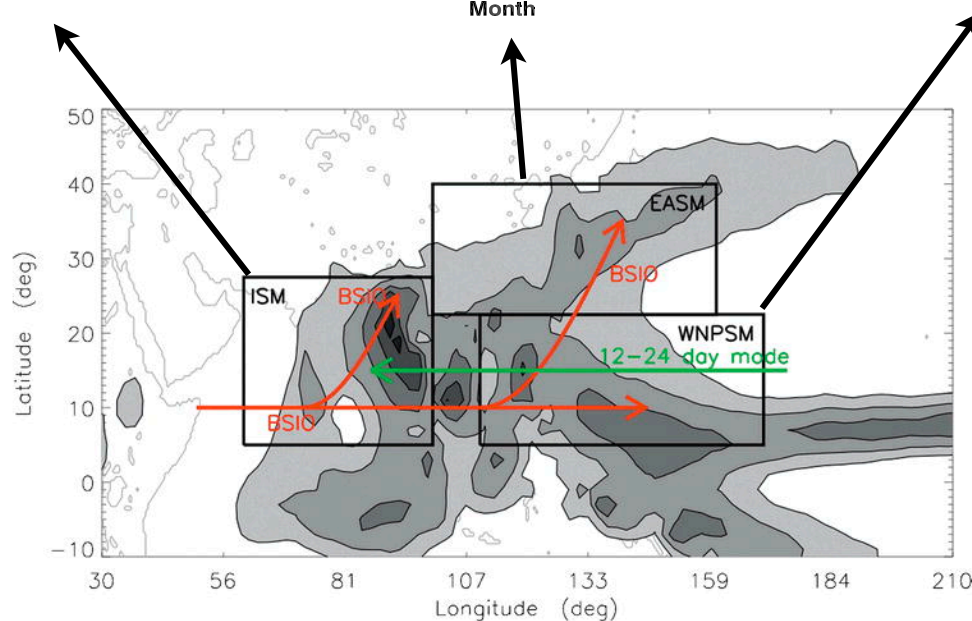


BSIO = Boreal Summer Intra-seasonal Oscillation

ISM = Indian Summer Monsoon

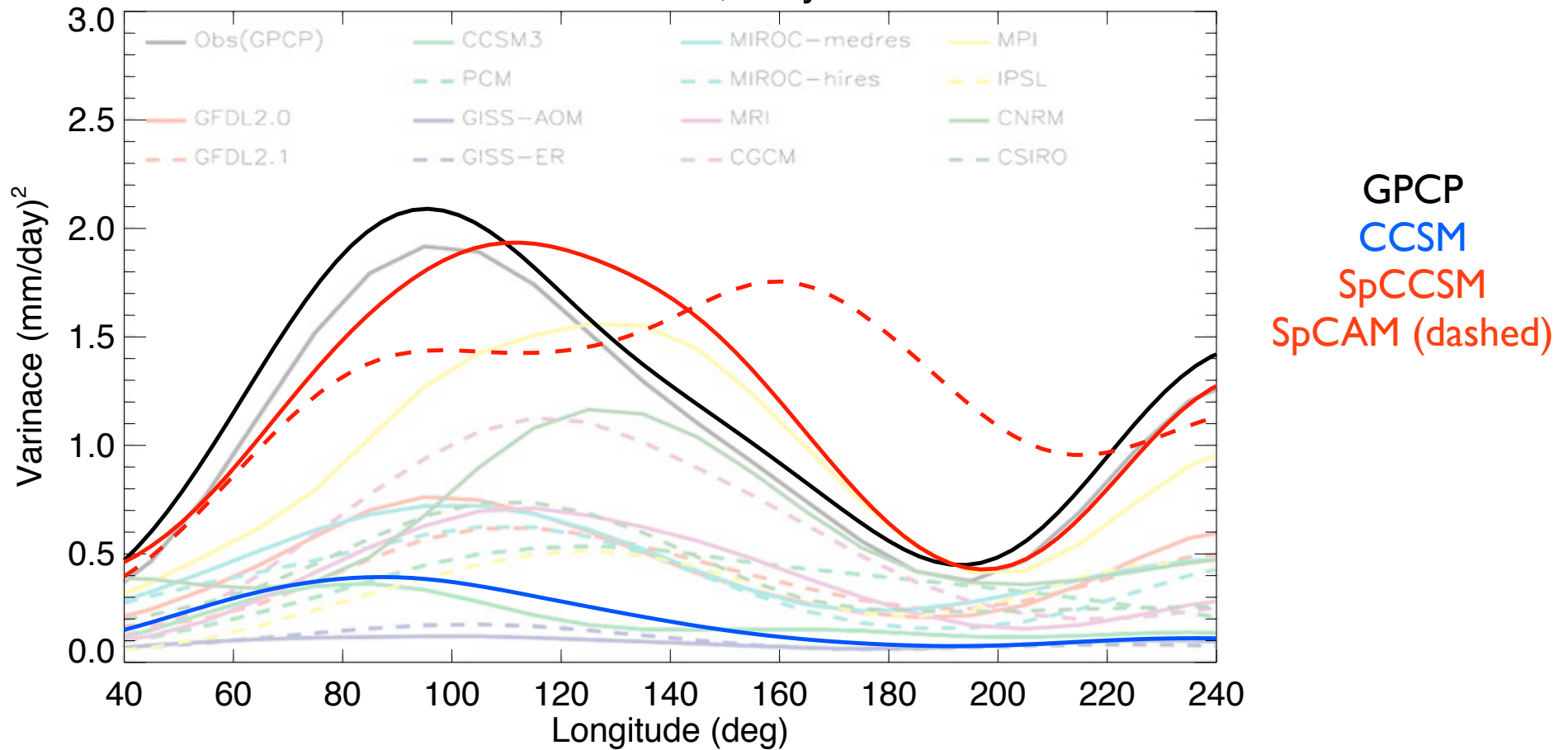
EASM = East-Asian Summer Monsoon

WNPSM = western North Pacific Summer Monsoon



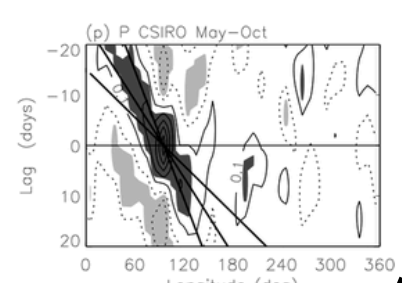
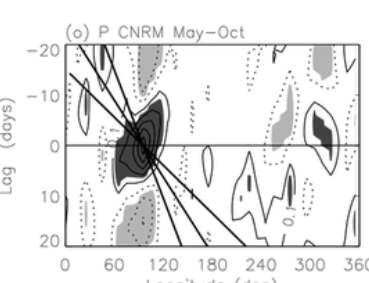
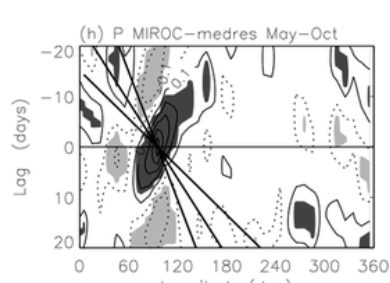
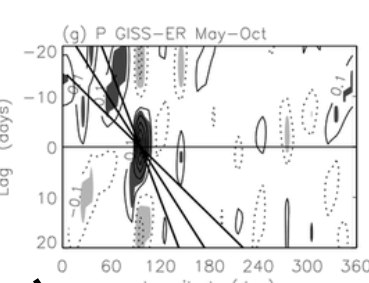
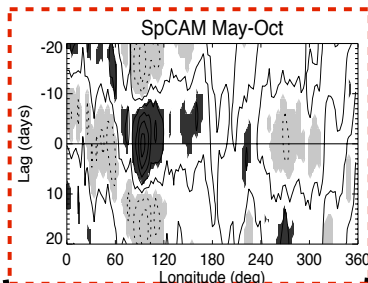
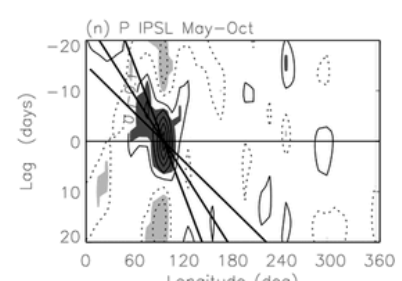
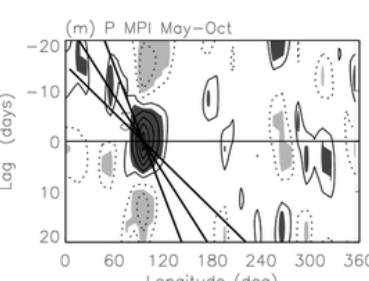
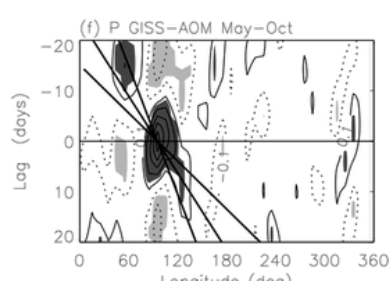
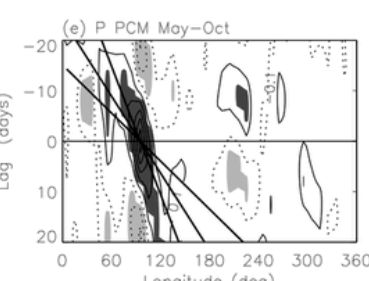
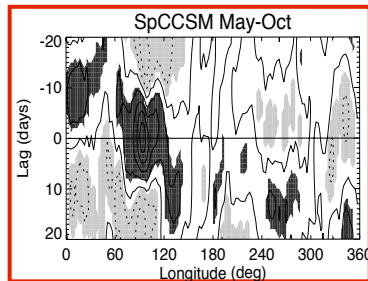
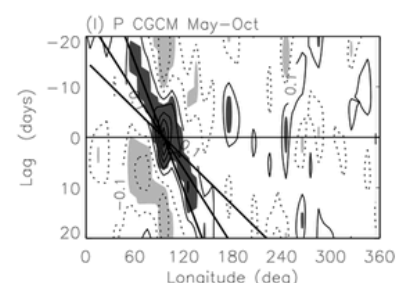
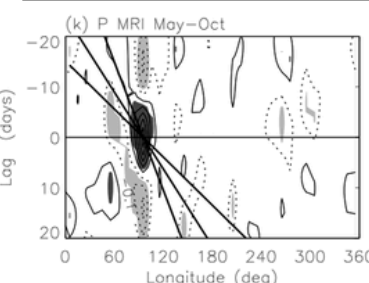
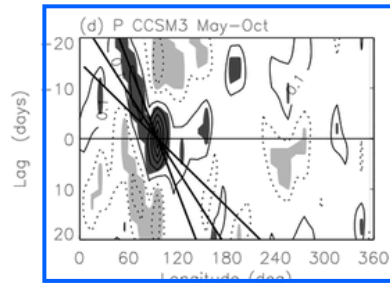
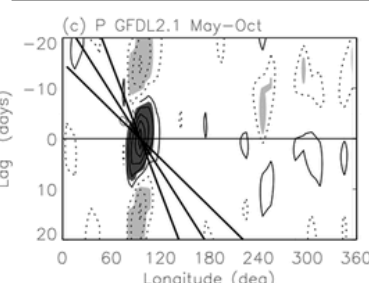
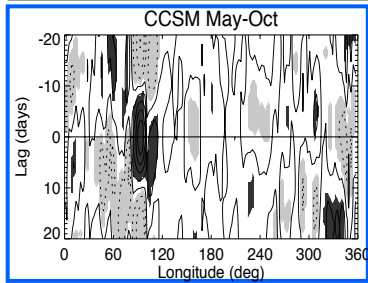
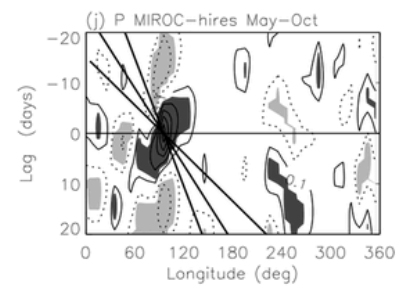
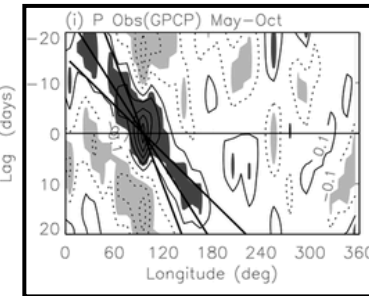
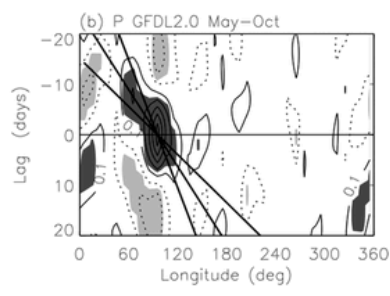
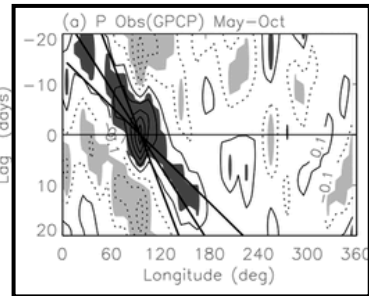
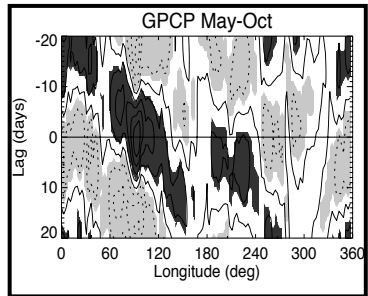
Eastward-propagating precipitation

Variance BSIO, May-Oct



5N-25N, wave #s 1-6, periods 24-70 days

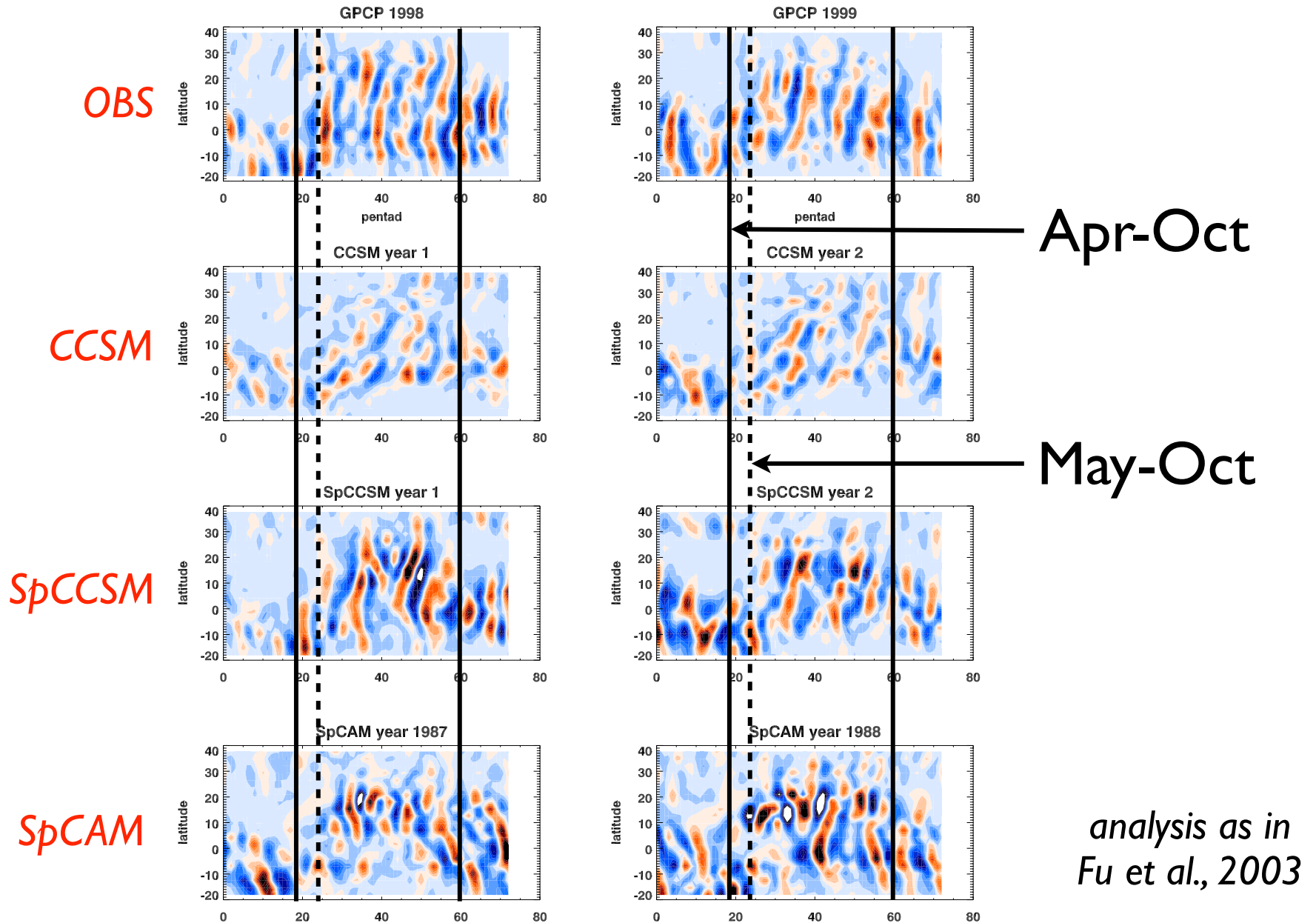
May-October precipitation lag-correlations



our analysis

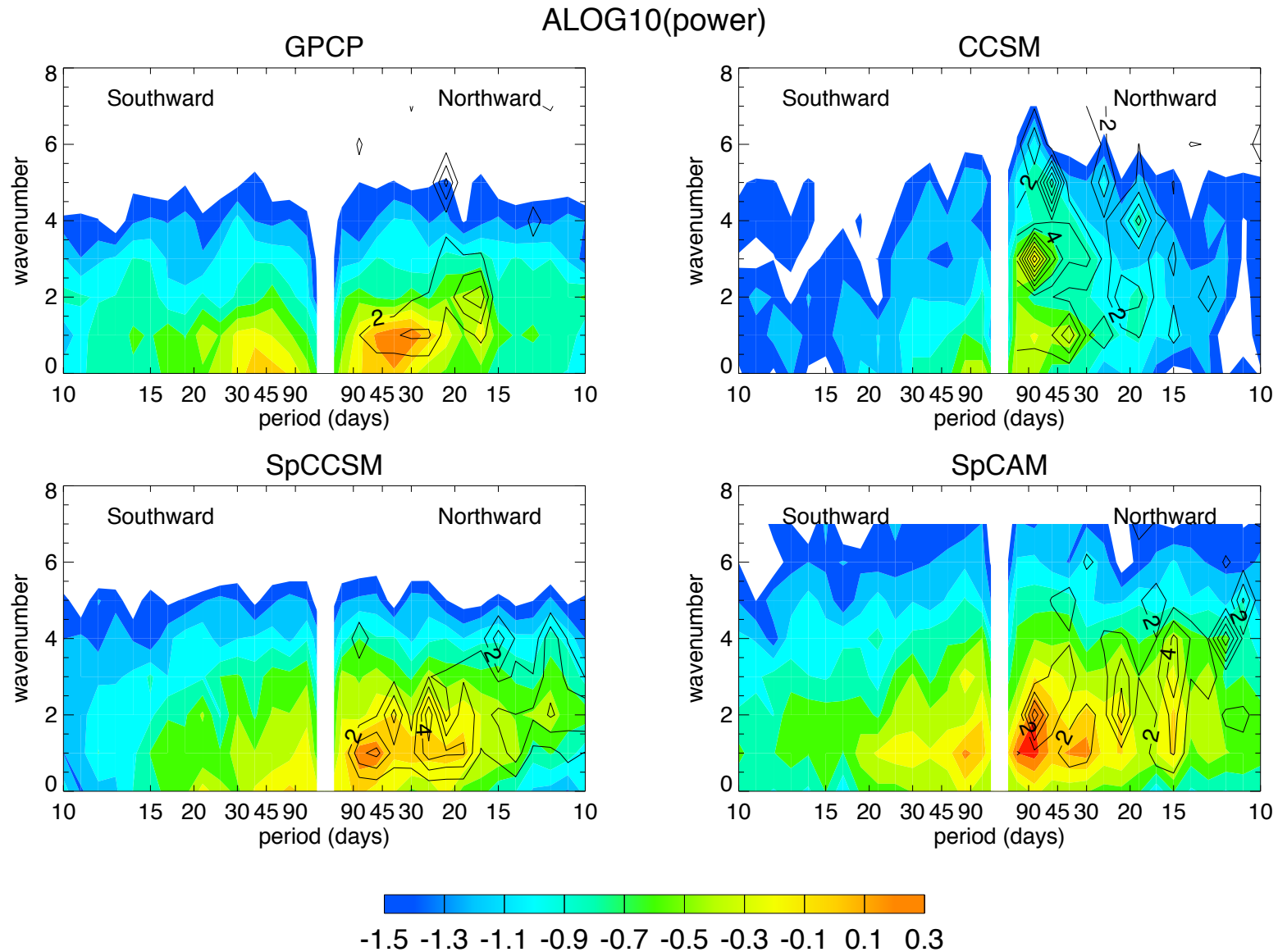
from Lin et al, 2008

Northward-propagating precipitation



*analysis as in
Fu et al., 2003*

Poleward-propagating precipitation



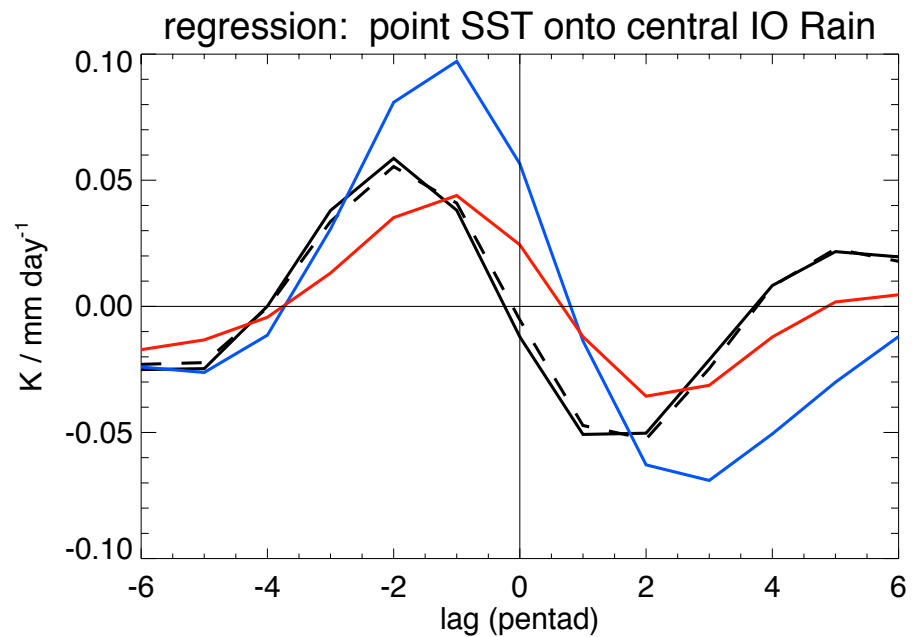
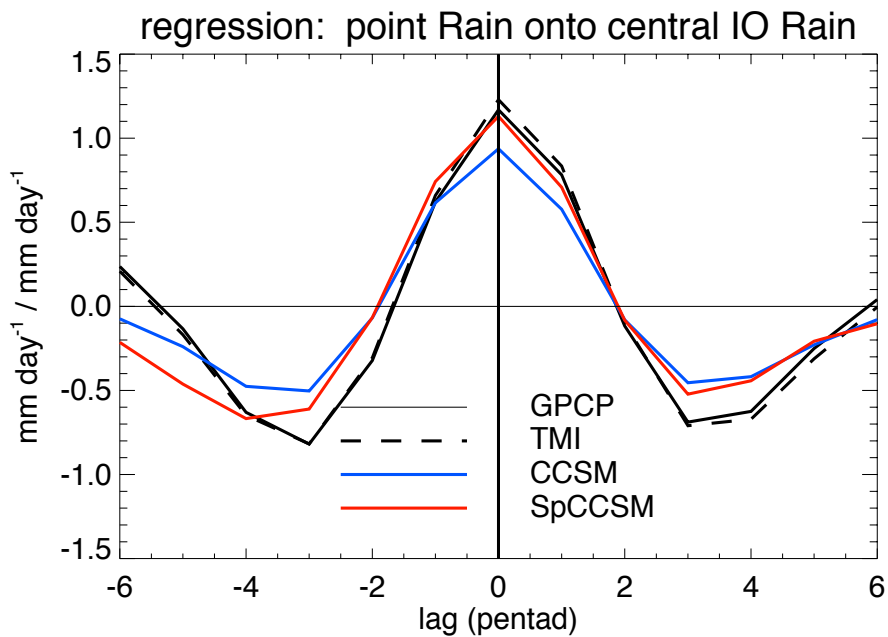
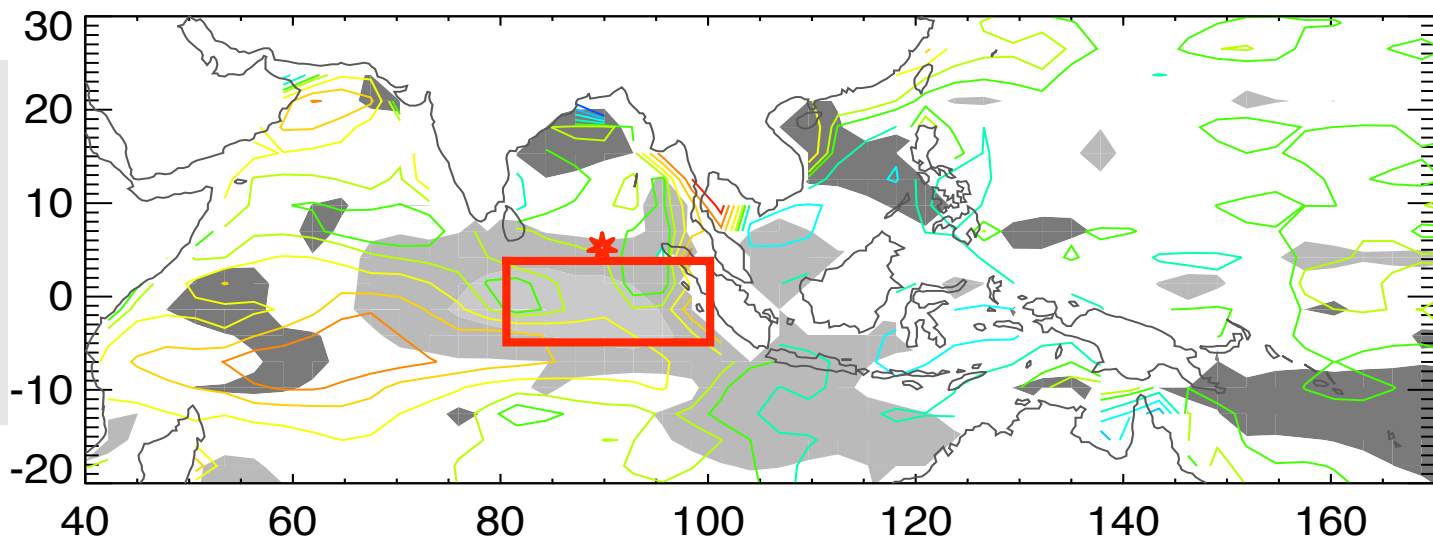
Colors: $\text{Log}_{10}(\text{power})$

Contours: ratio of N to S power, interval=2,3,4...

Covariability of Precipitation and SST

May-October SST'-precip' lag-regressions

1. Compute filtered mean rainfall anomaly time series in box.
2. Regress precip', SST' at each point onto area-averaged time series.



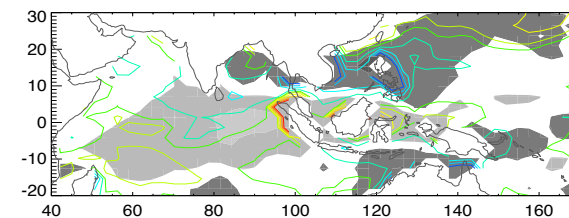
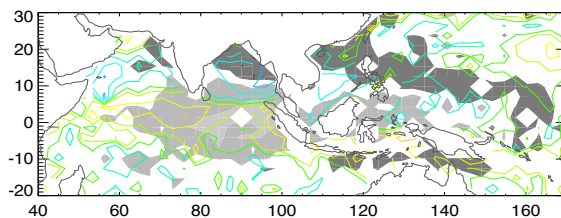
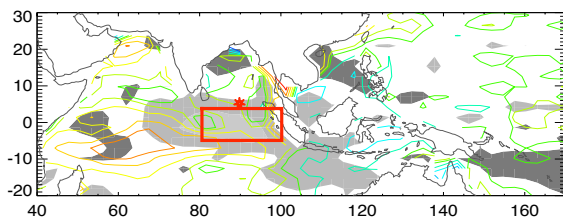
analysis as in Fu et al., 2007

CCSM

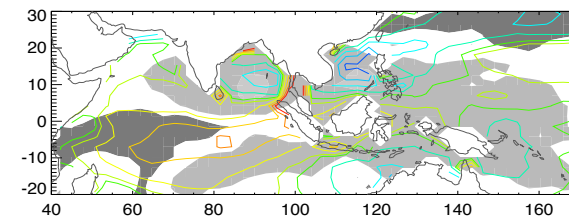
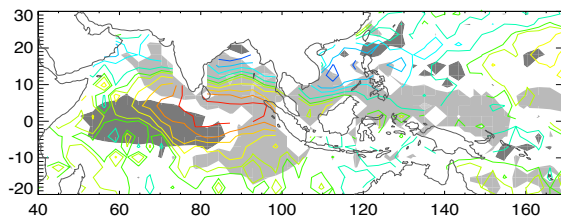
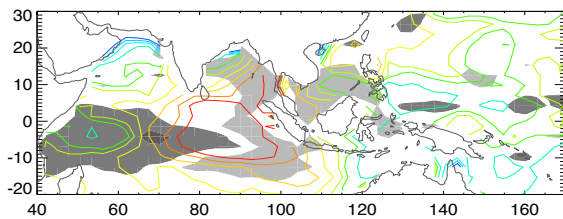
TMI

SpCCSM

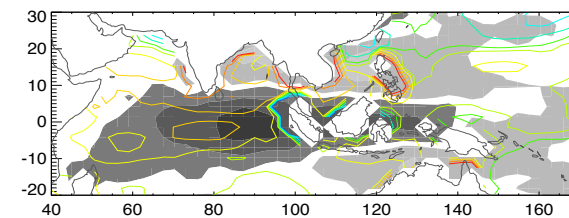
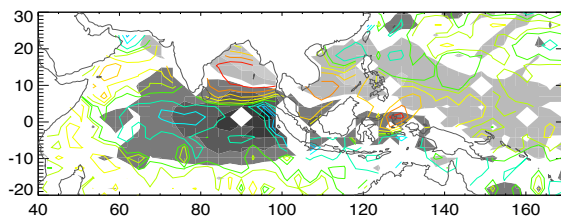
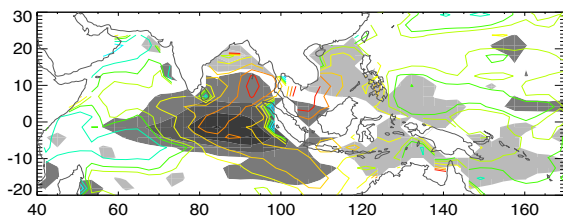
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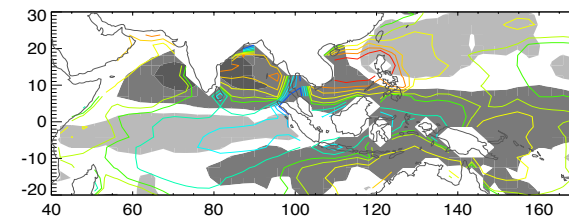
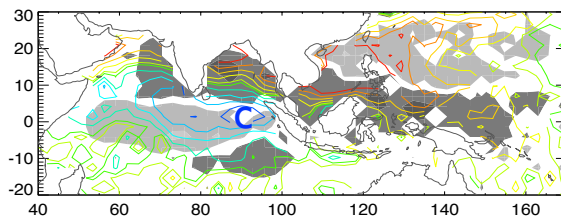
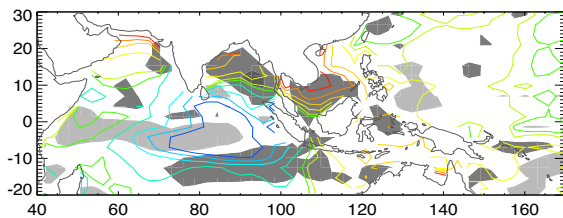
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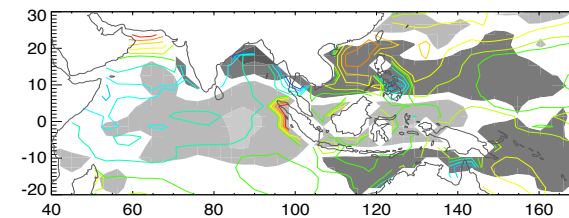
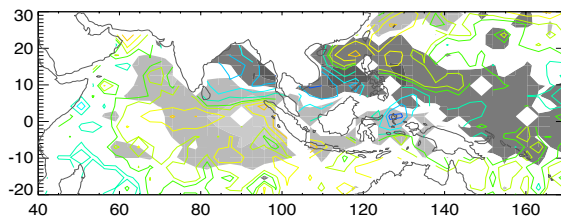
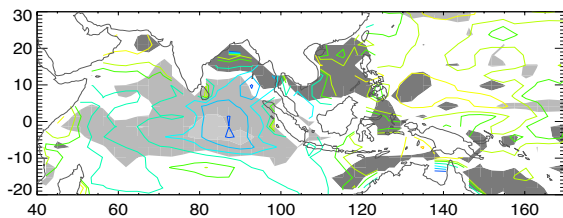
lag= 0



lag= 2



lag= 4



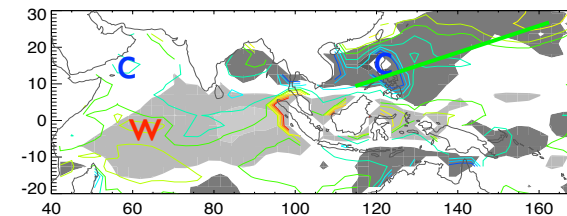
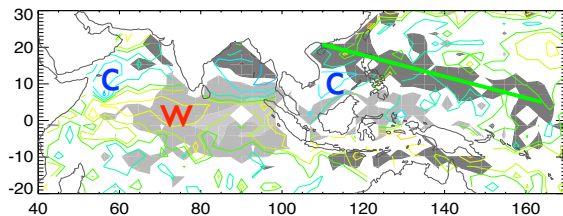
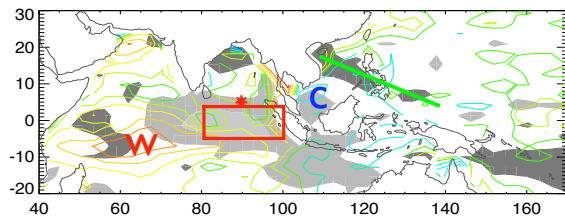
Positive anomalies: dark shading (P'), warm colors (SST')
Negative anomalies: light shading (P'), cool colors (SST')

CCSM

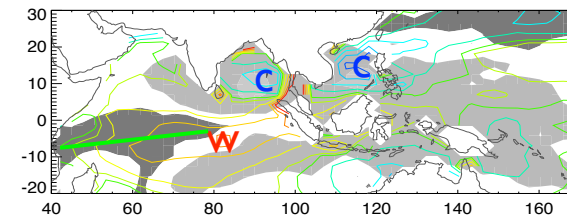
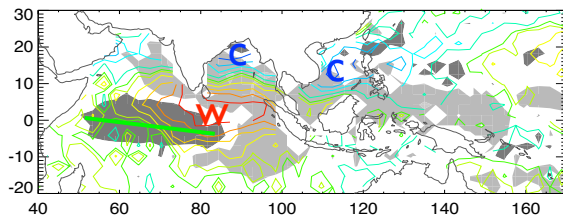
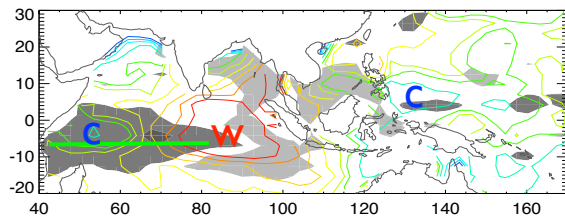
TMI

SpCCSM

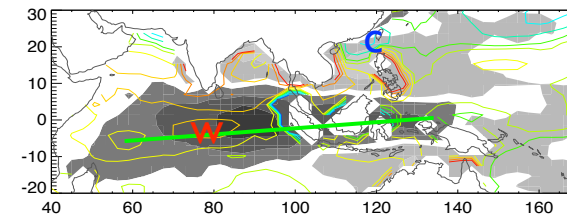
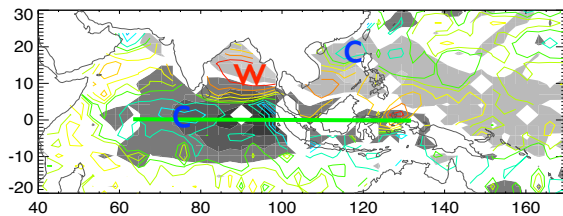
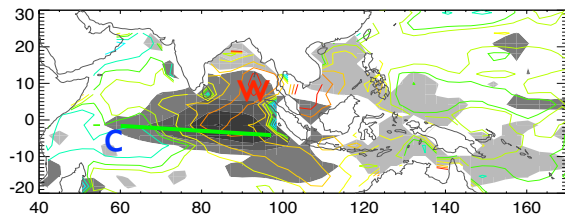
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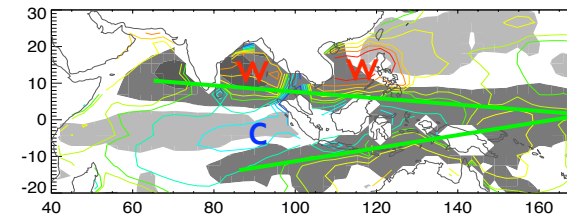
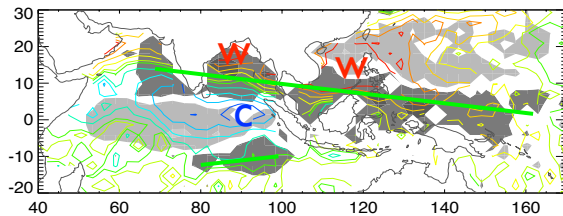
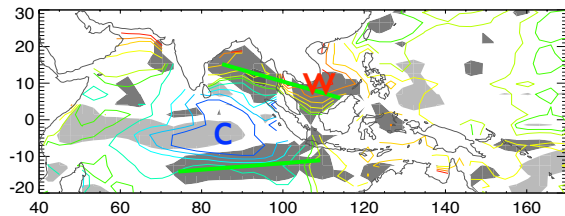
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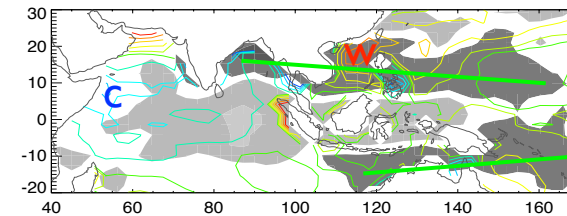
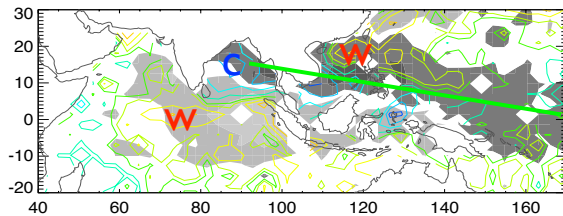
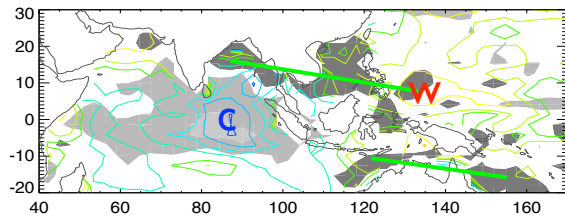
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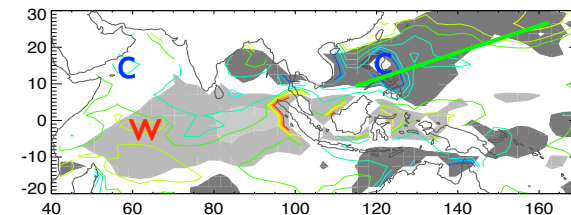
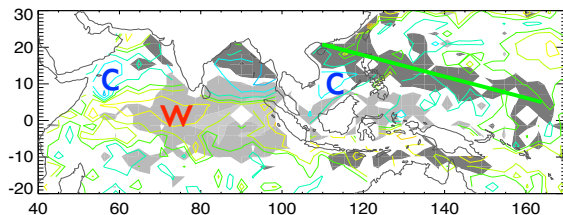
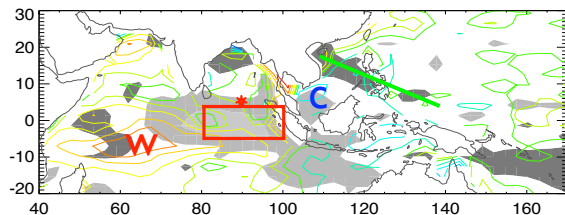
Positive anomalies: dark shading (P'), warm colors (SST')
Negative anomalies: light shading (P'), cool colors (SST')

CCSM ✓✓✓

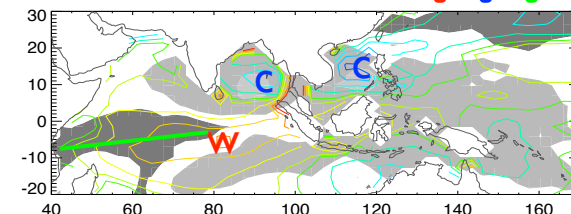
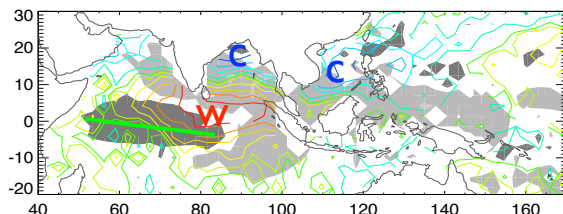
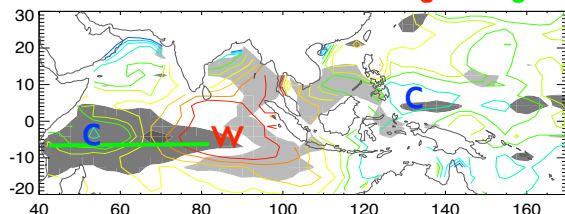
TMI

SpCCSM ✓✓✓

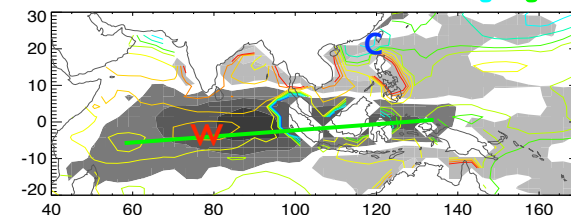
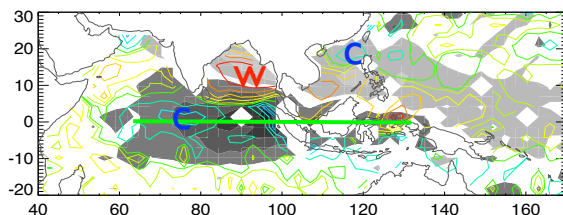
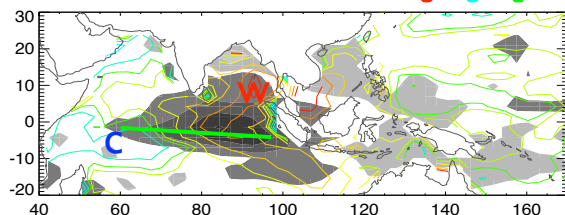
lag=-4



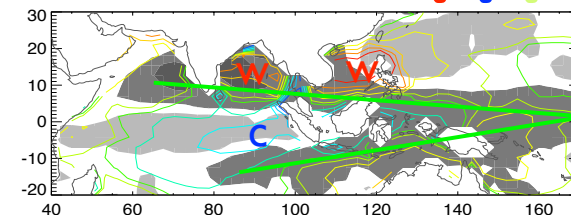
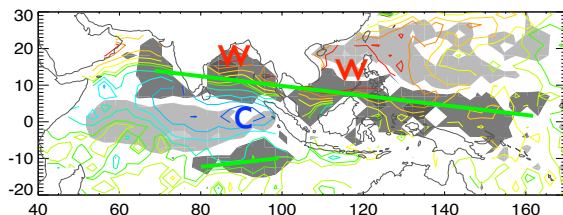
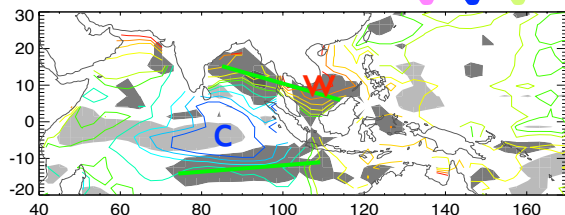
lag=-2



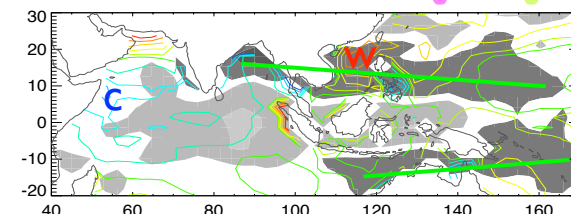
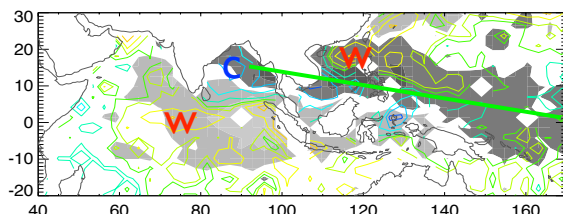
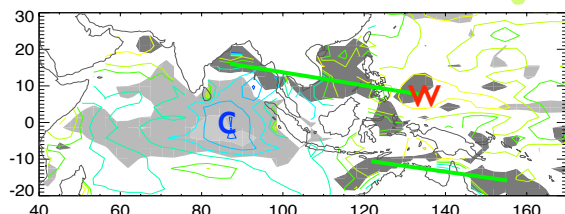
lag=0



lag=2



lag=4



Positive anomalies: dark shading (P'), warm colors (SST')
 Negative anomalies: light shading (P'), cool colors (SST')

Summary of Results

- SpCCSM improves Asian monsoon simulation
 - mean and annual cycle of precipitation
 - eastward and poleward propagation periodicity
 - spatial scale (meridional wave number)
 - SST-precipitation covariability

Questions

- By what processes does the SpCCSM improve the simulation?
- Are the processes simulated in SpCCSM similar to those in observations?

Current Efforts

- Surface energy budget component composites
- Vertical moistening and heating composites
- High-frequency analysis of convection and SST
 - re-running May-Aug saving 3-hourly output
- SST'-precip' feedback parameters
 - Bjerknes feedback (SST gradient & wind)
 - SST & latent heat flux feedback
 - SST & surface shortwave flux feedback
- Double ITCZ behavior