

The Asian Monsoon in the Super-Parameterized Community Climate System Model

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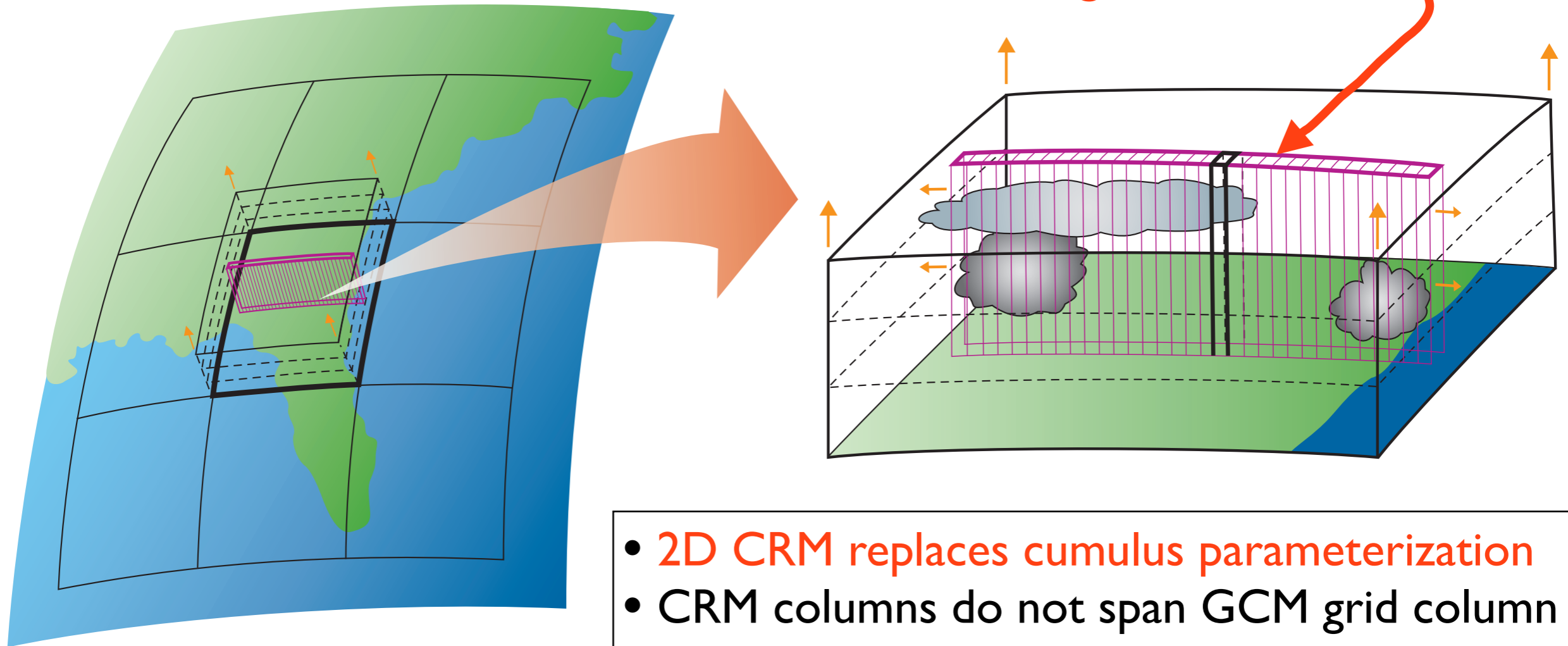
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“SP” Model Framework

32 4km x 4km grid columns



- 2D CRM replaces cumulus parameterization
- CRM columns do not span GCM grid column
- CRM runs continuously: system has memory

Schematic illustration of “super-parameterization”

The Simulations

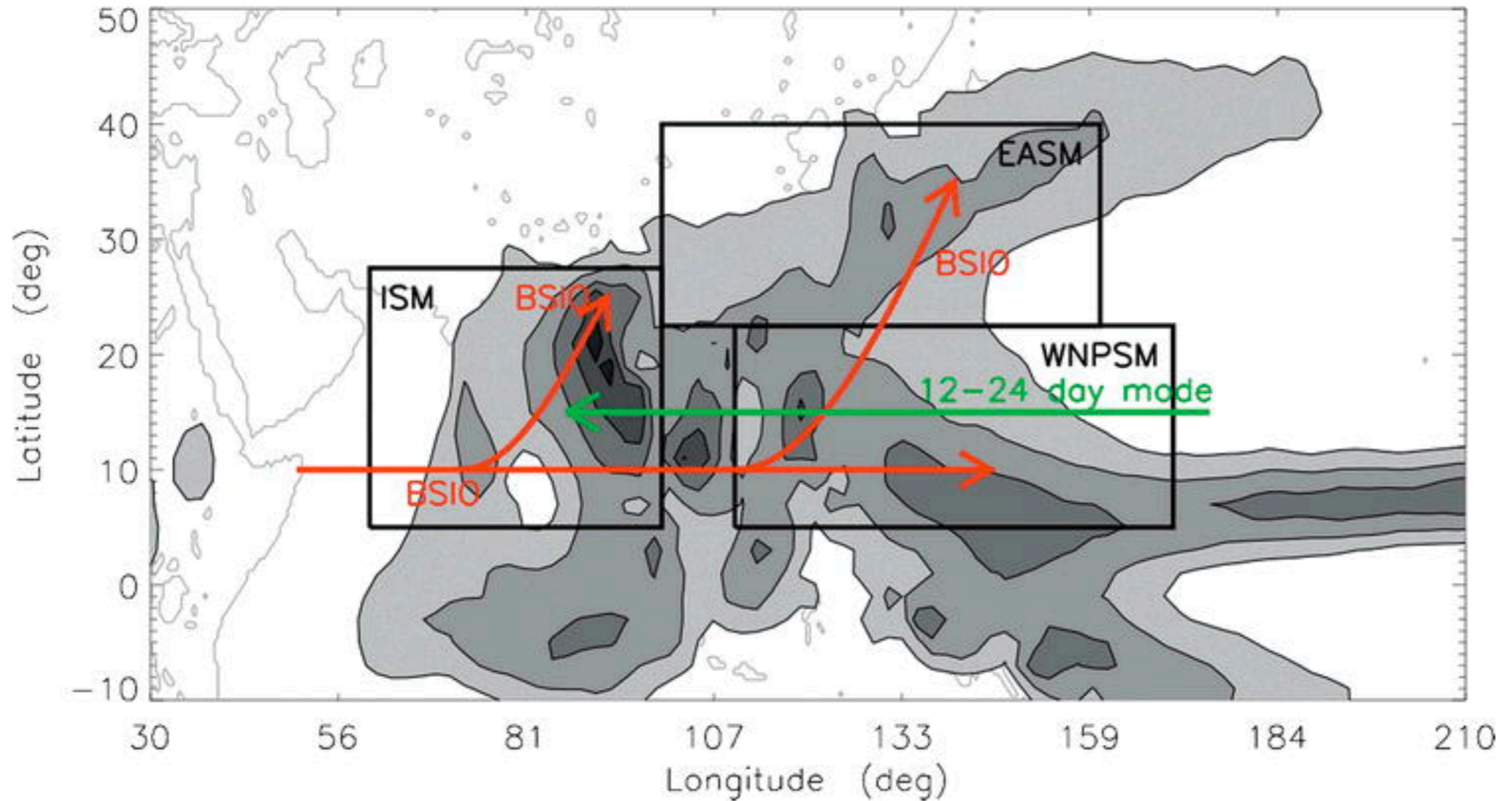
	Atmosphere only	Ocean coupling
Traditional cumulus parameterization	CAM (not shown)	CCSM (years 4-23)
Super-parameterization	SpCAM (14 year AMIP)	SpCCSM (years 4-23)

CAM = Community Atmospheric Model (v3.0)

- *CCSM = Community Climate System Model*
- *Coupled to POP ocean model gx3x5 for coupled runs*
- *T42 atmospheric resolution*

Asian Monsoon

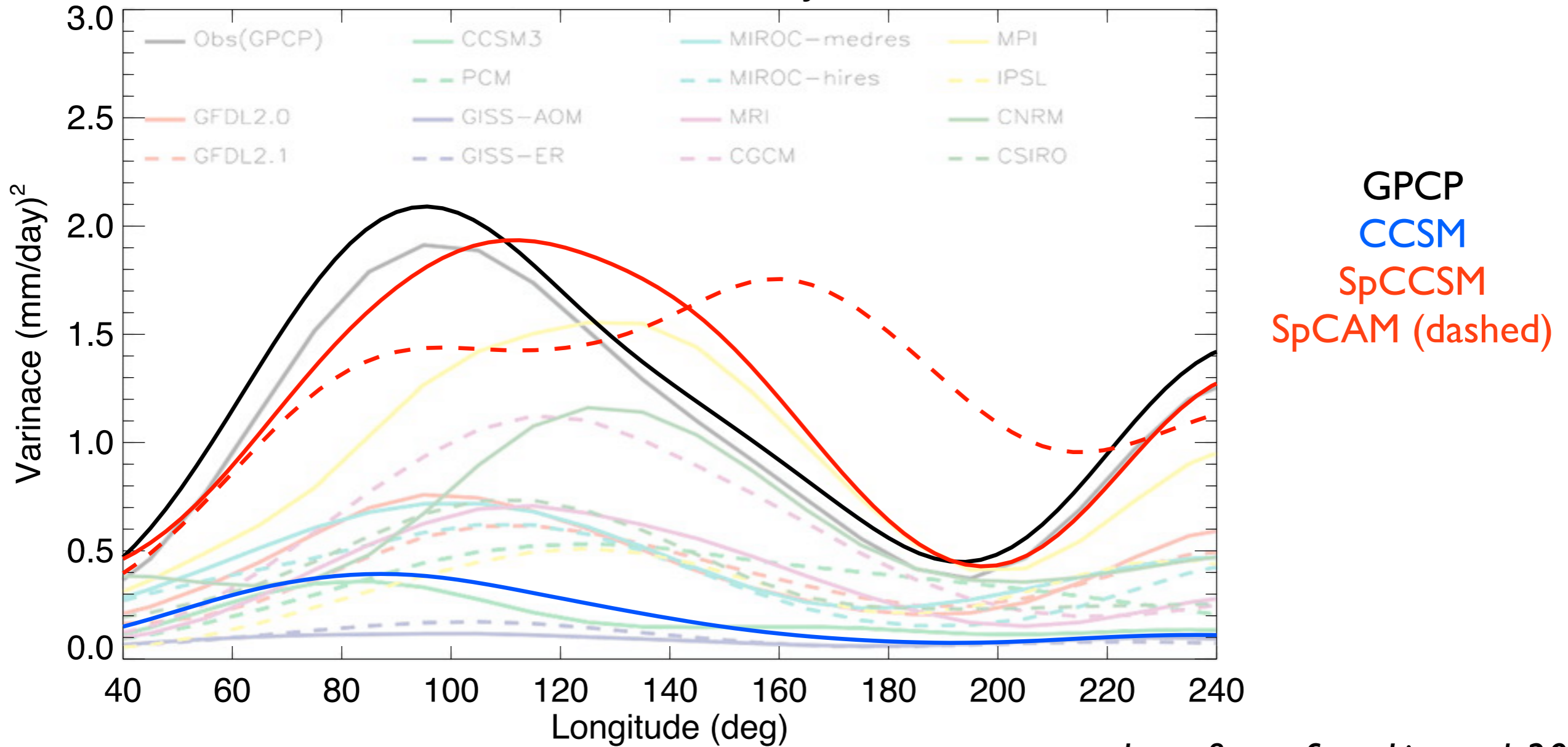
May-Oct mean precipitation



from Lin et al. 2008

Eastward-propagating precipitation

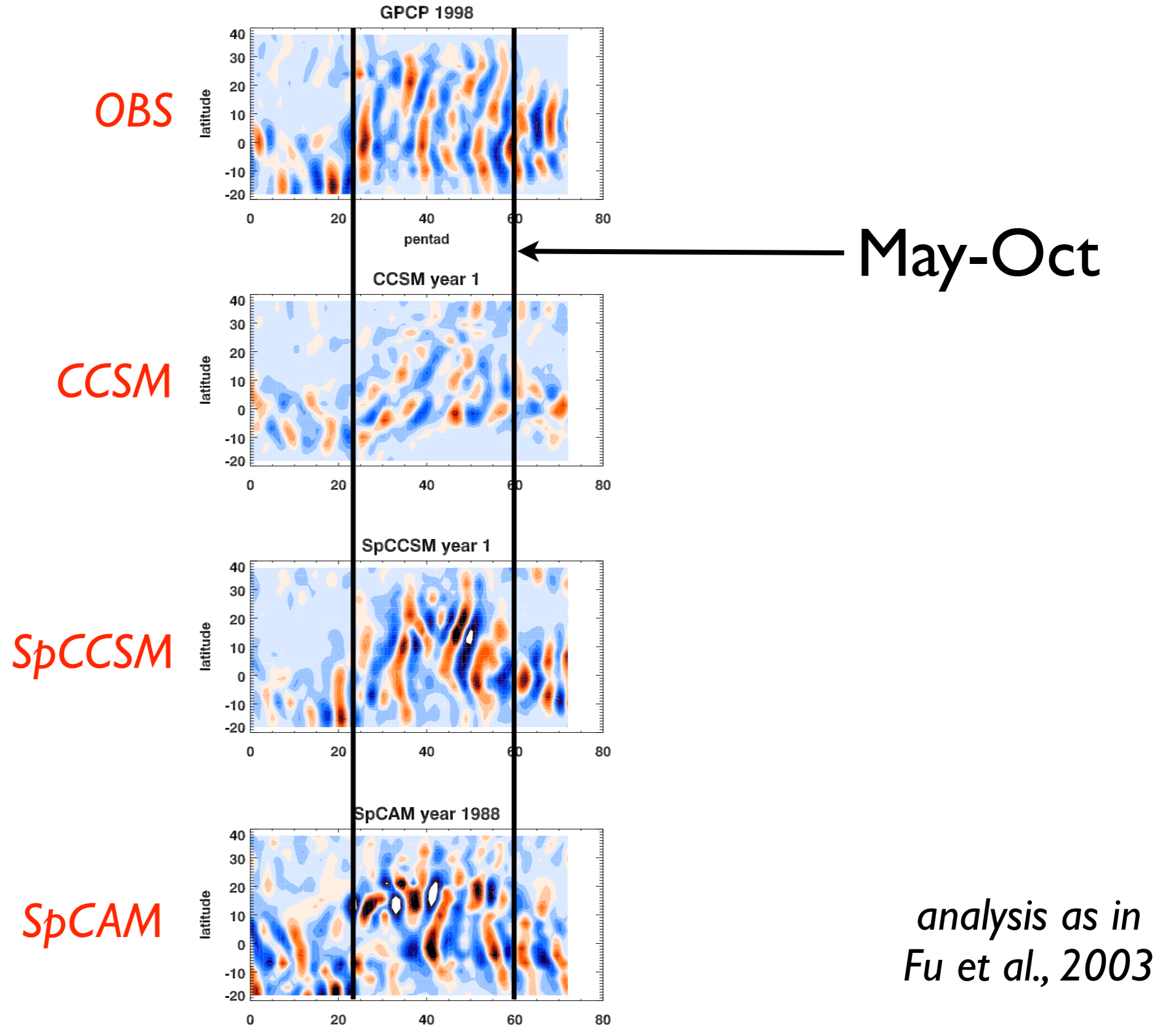
Variance BSIO, May-Oct



base figure from Lin et al. 2008

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

Northward-propagating precipitation



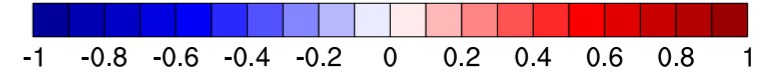
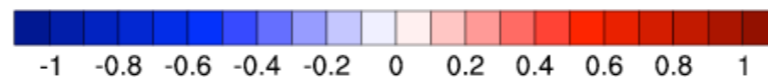
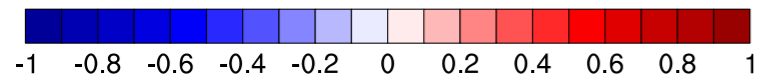
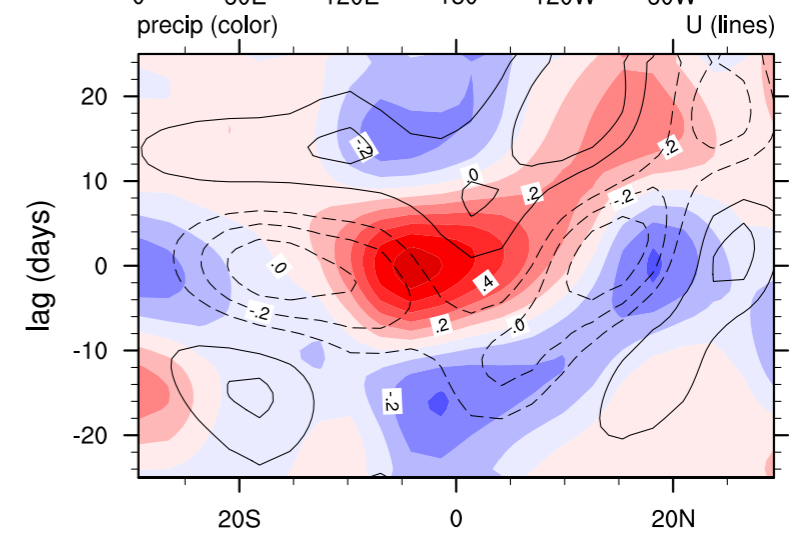
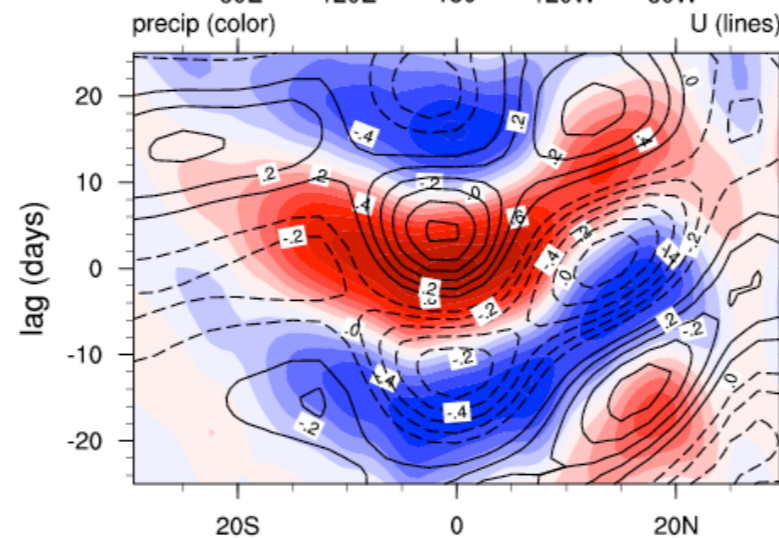
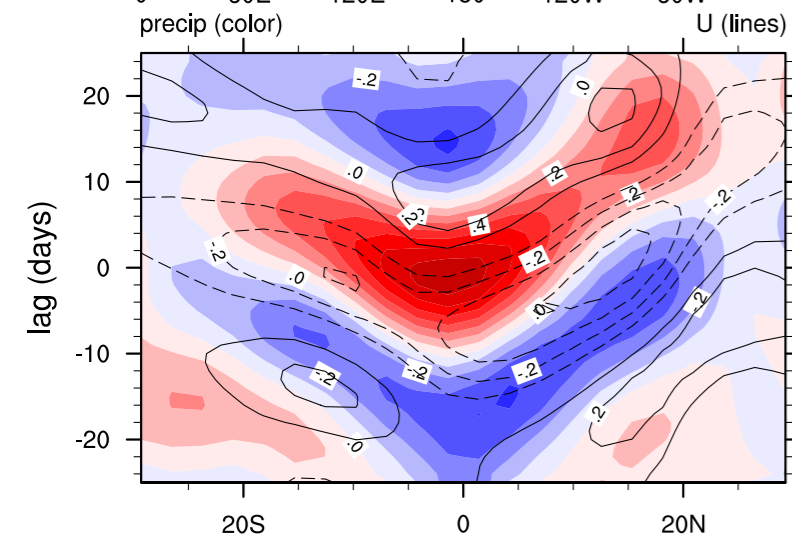
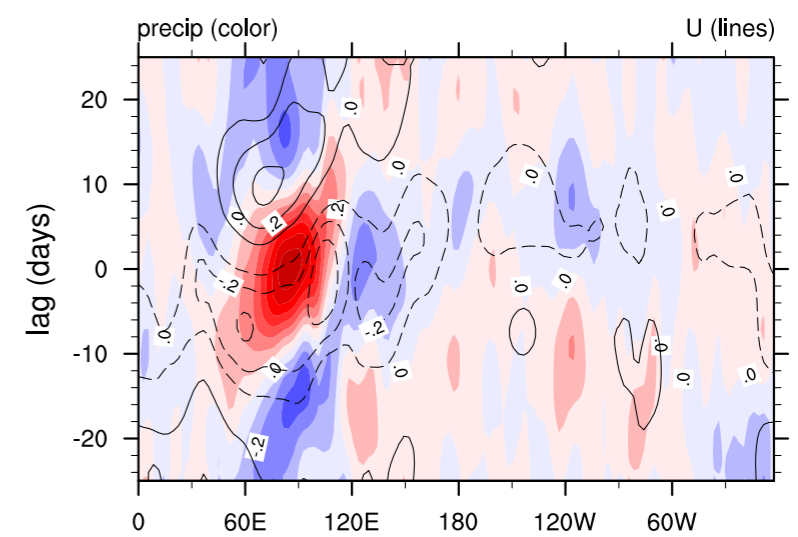
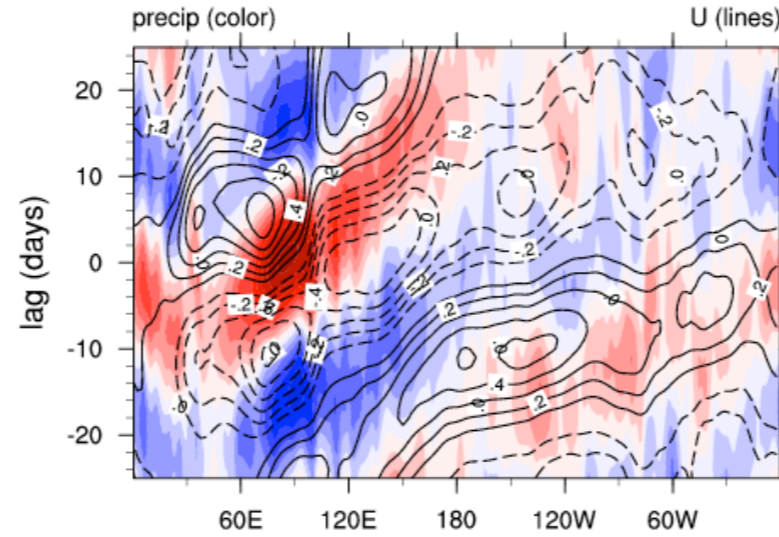
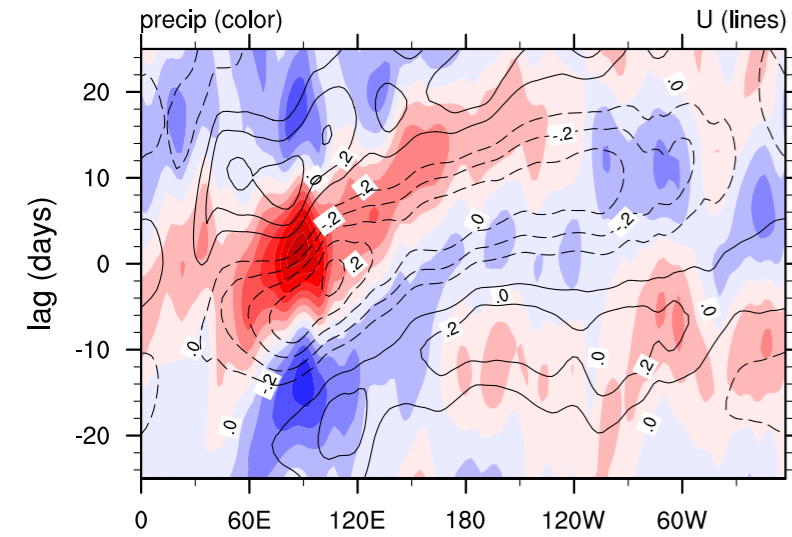
*analysis as in
Fu et al., 2003*

Variability: summer ISO

summer: 41001-230531

summer: 19961001-20051231

summer: 41001-230531



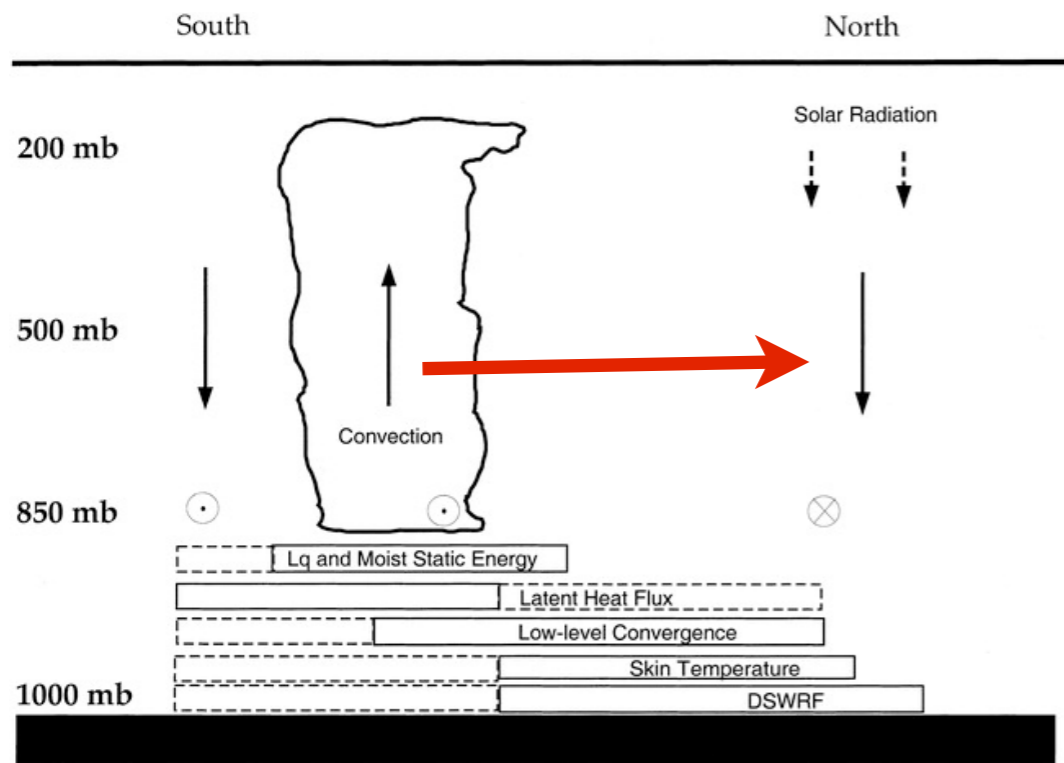
SpCCSM

OBS

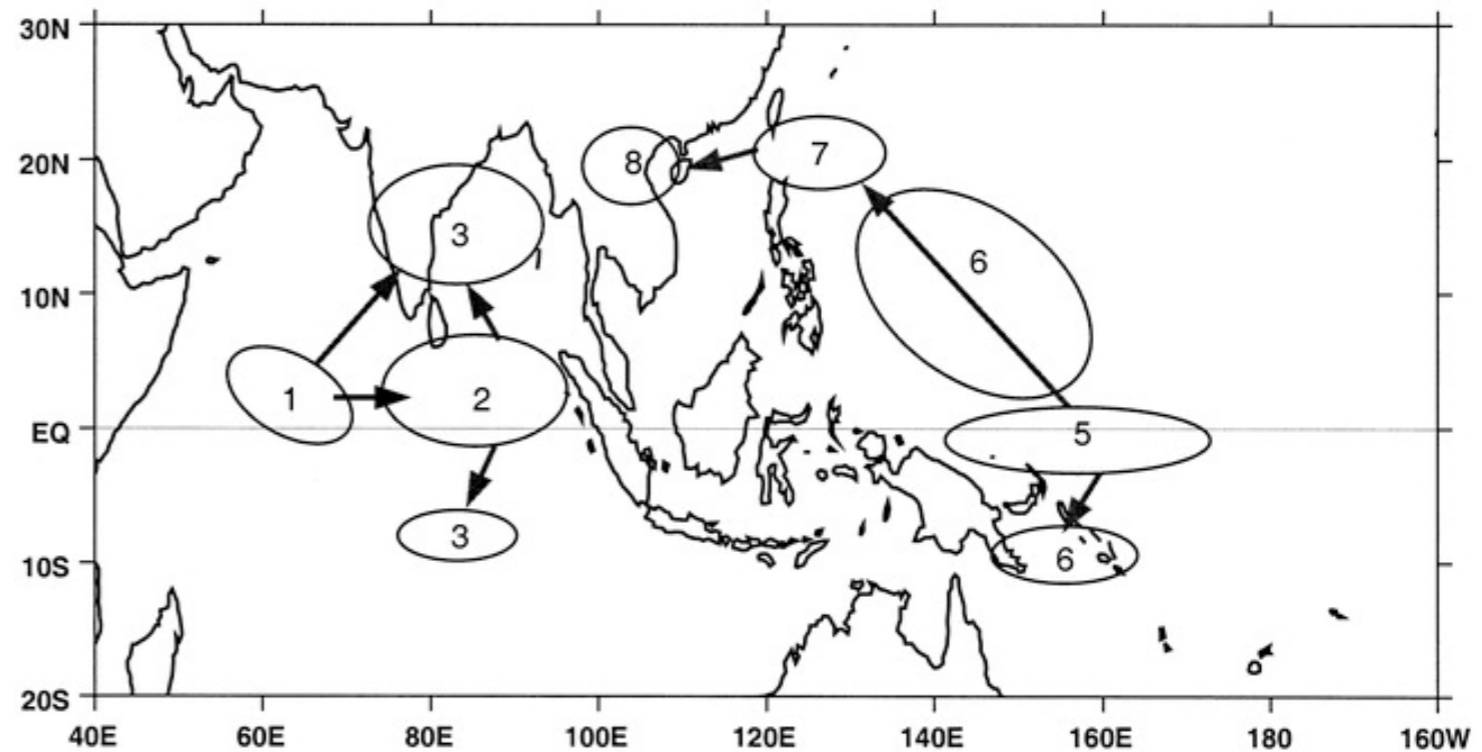
CCSM

Factors with potential relevance for northward propagation:

Air-Sea coupling/
surface fluxes

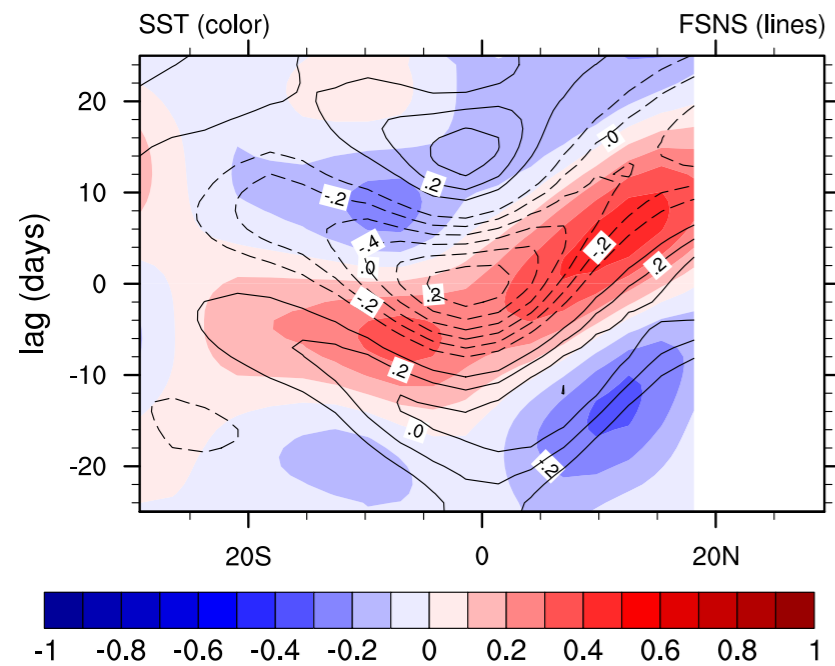


Northwestward-propagating
Rossby waves

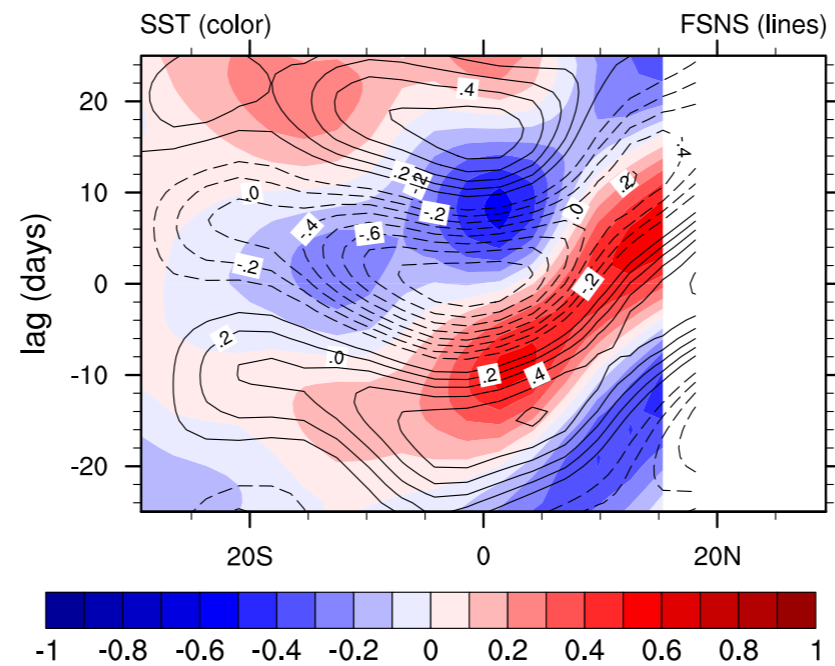


Figures from Kemball-Cook and Wang, 2001

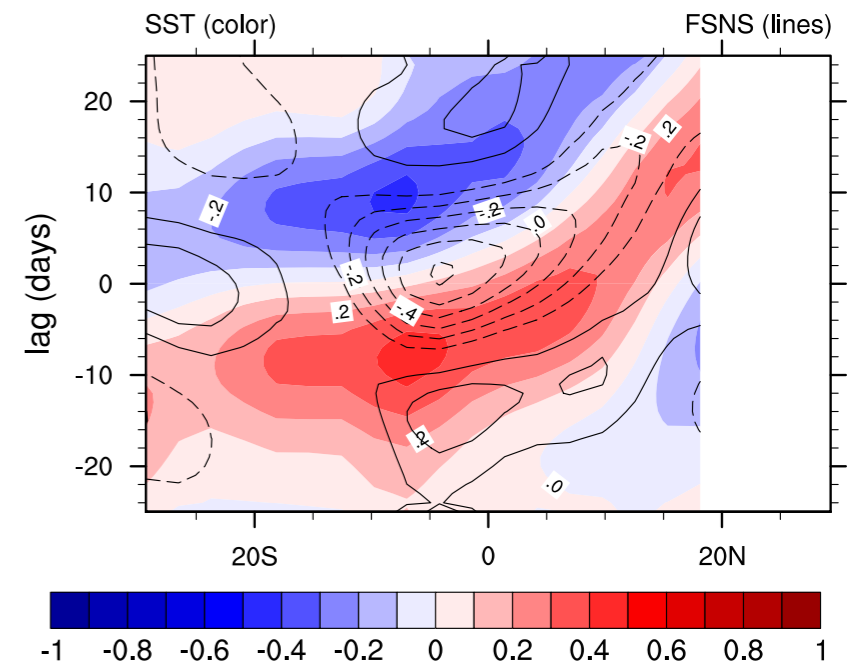
SST vs. Net surface SW flux



SpCCSM

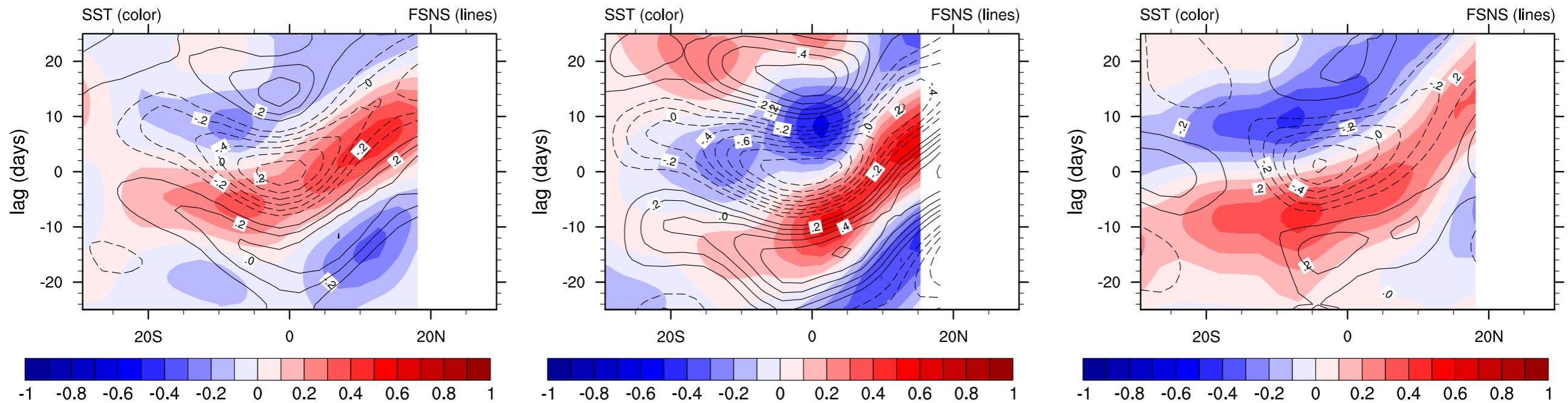


OBS



CCSM

SST vs. Net surface SW flux



SpCCSM

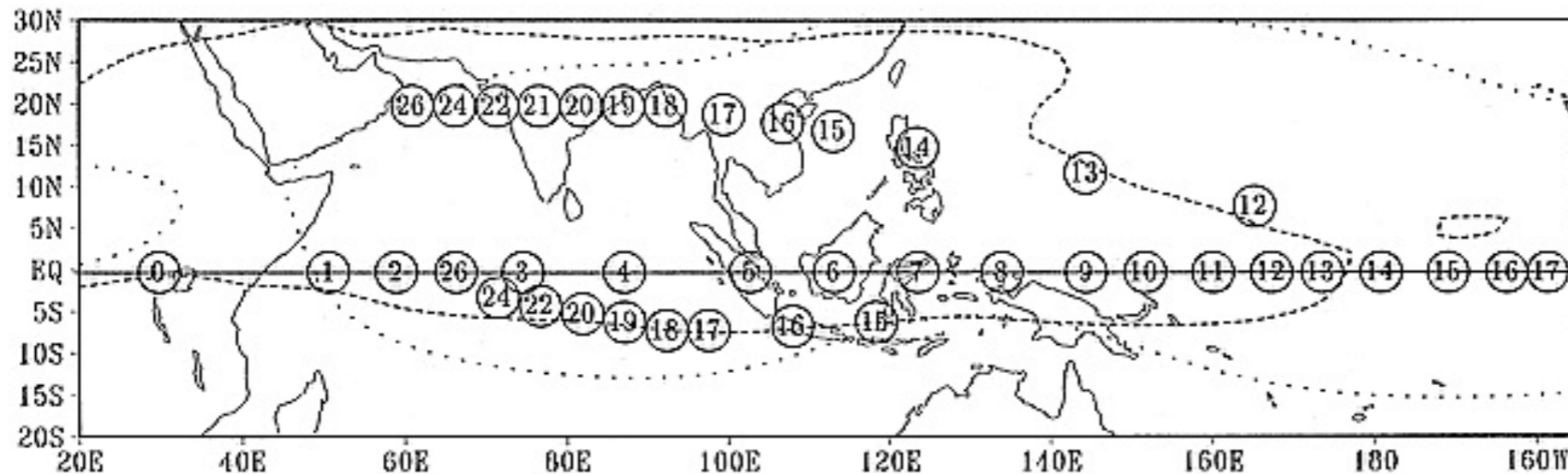
OBS

CCSM

- Both models capture the general behavior.
- Each model produces different details.
- Neither model is more successful than the other.

Northward propagation and equatorial Rossby waves:

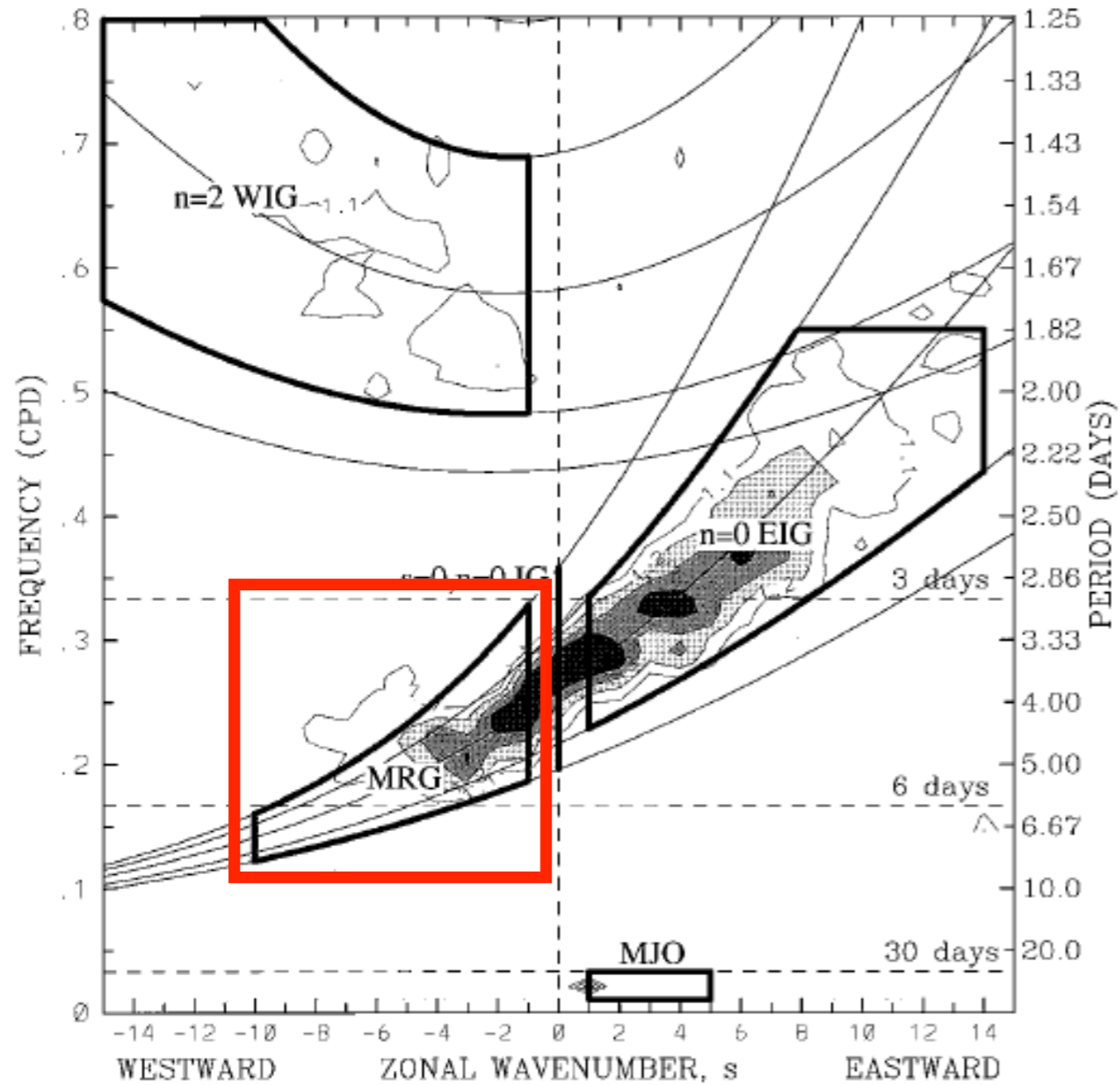
- Westward-propagating equatorial Rossby waves (Wang and Xie, 1997, Lawrence and Webster, 2002)



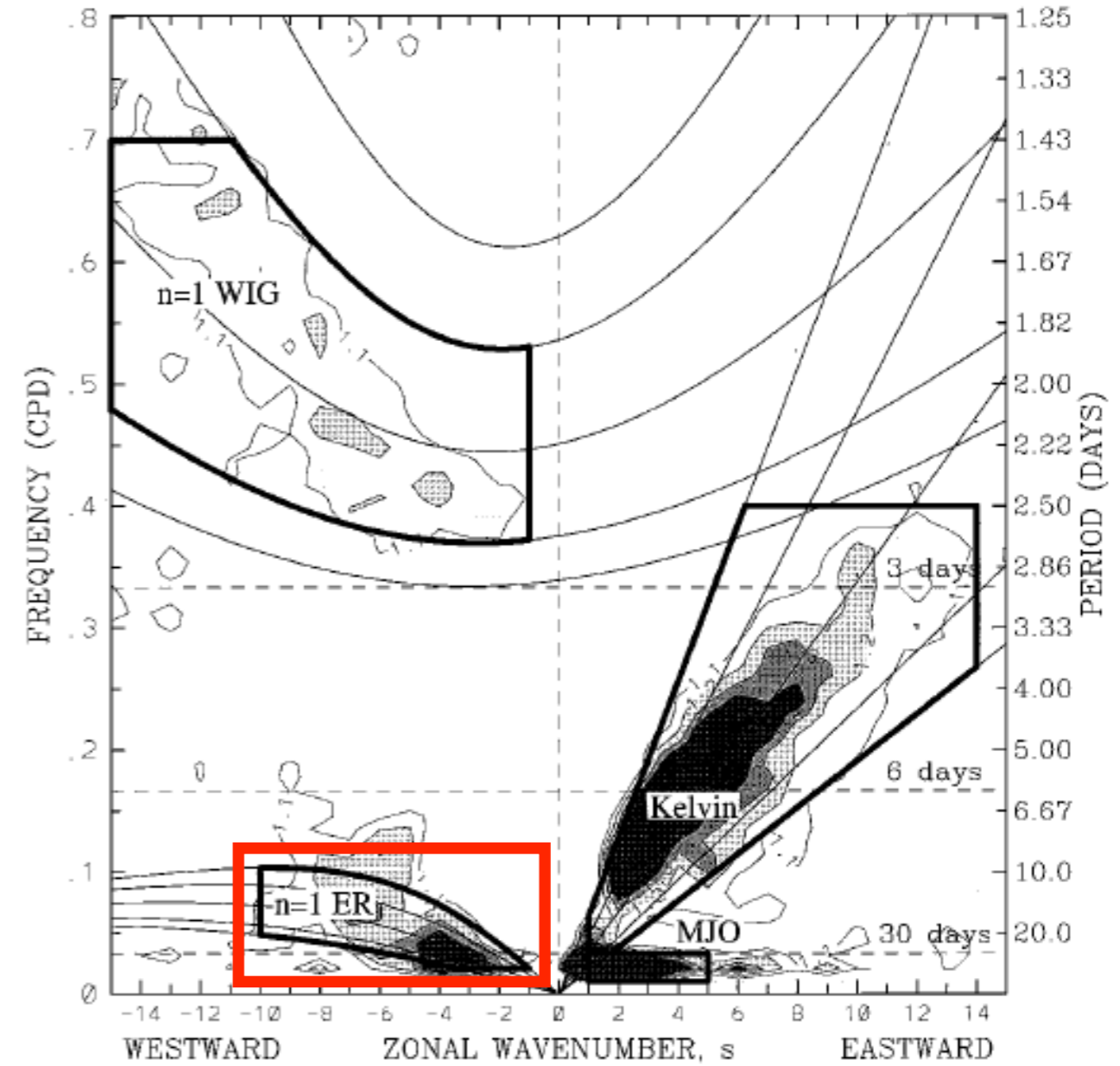
Wang & Xie, 1997

Filtering Equatorial Waves

a) Regions of filtering for OLR A (Antisymmetric)



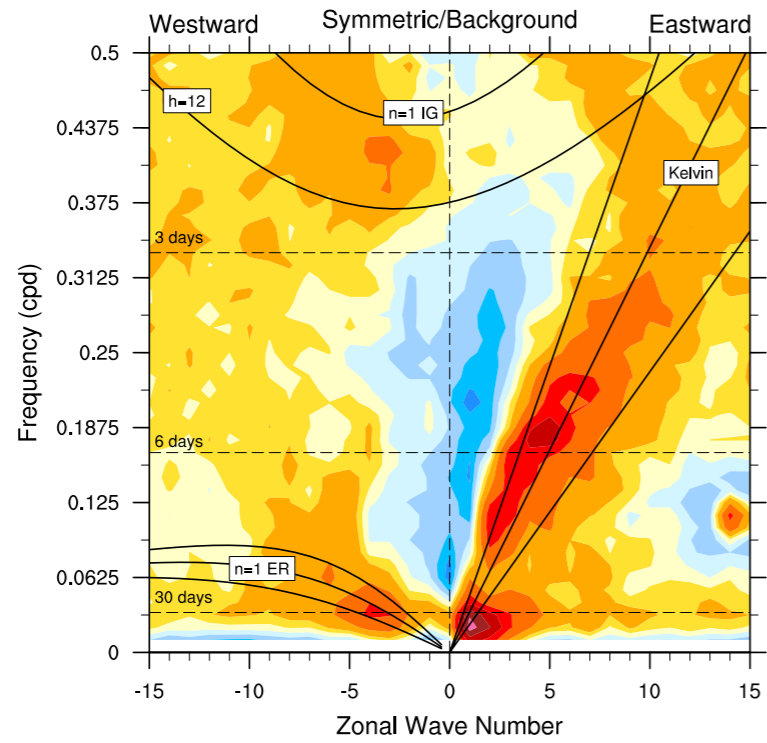
b) Regions of filtering for OLR S (Symmetric)



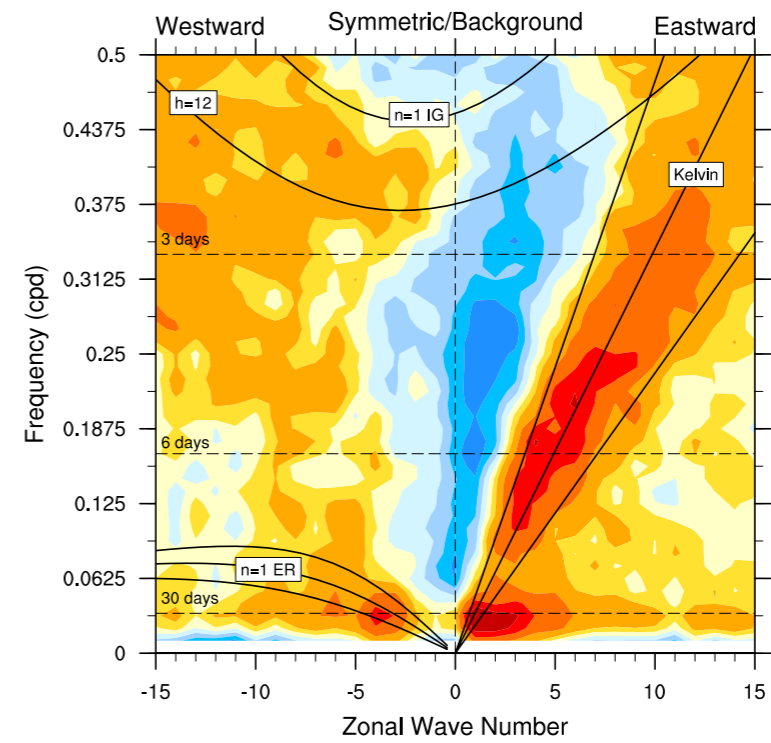
from Wheeler & Kiladis, 1999

Equatorial Waves (sym)

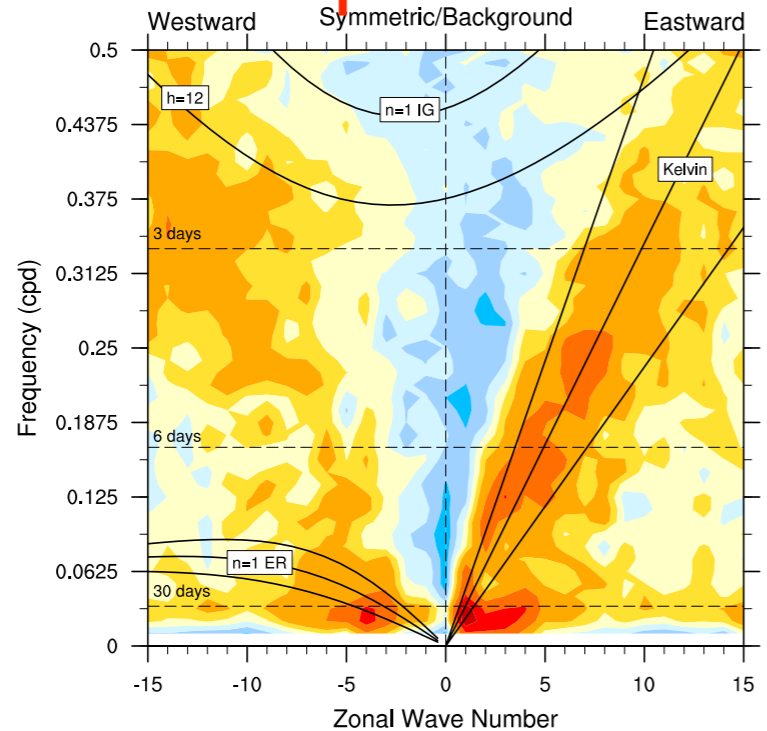
OBS



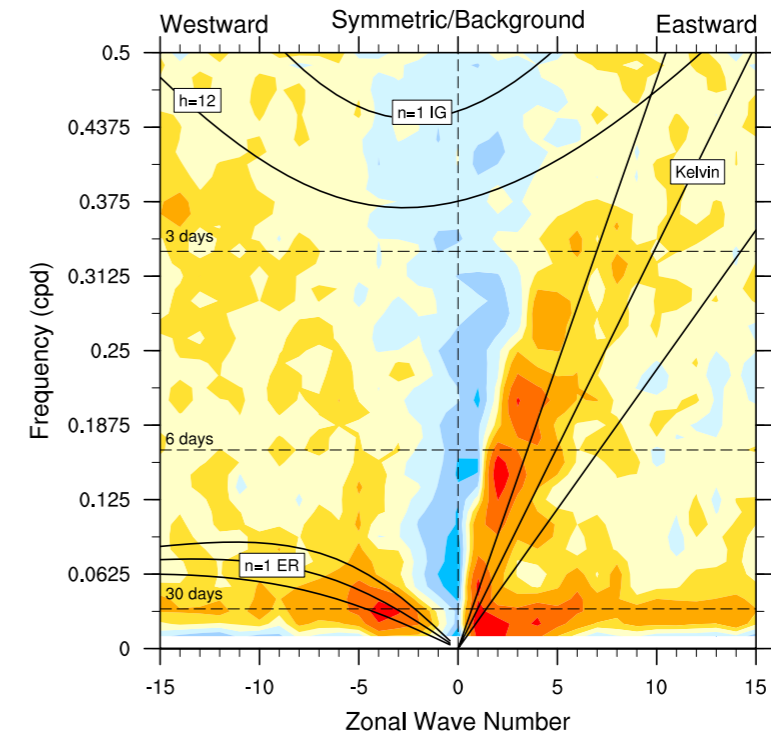
SpCCSM



SpCAM

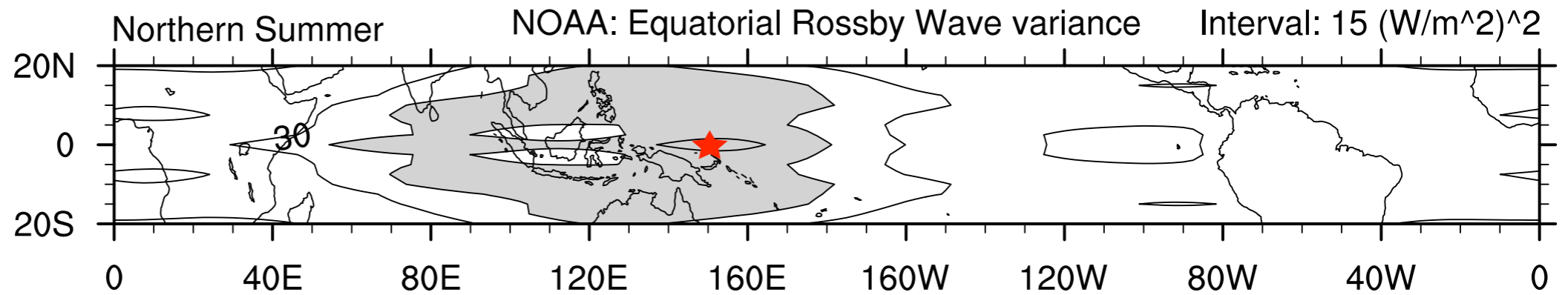


CCSM

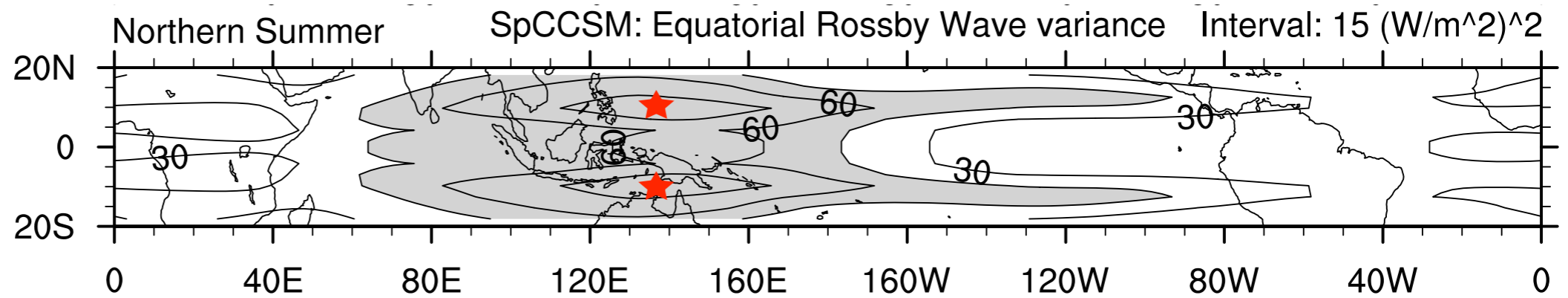


Equatorial Rossby Waves

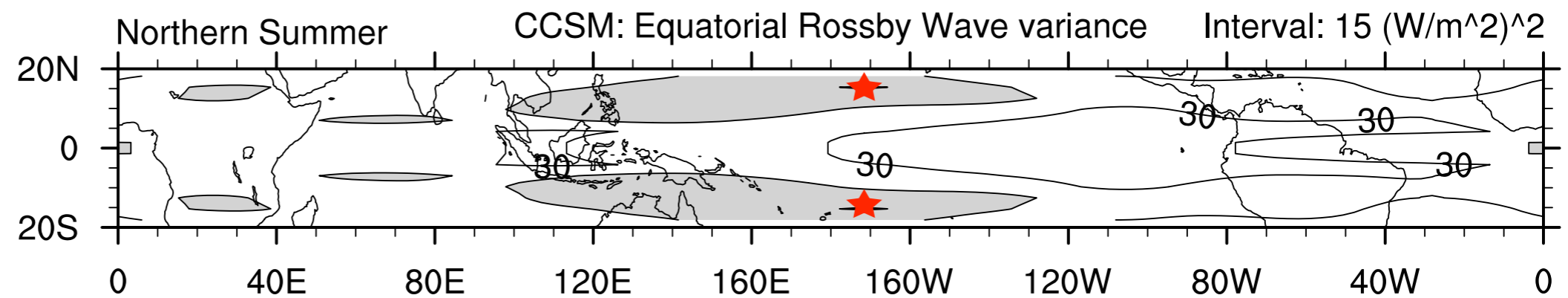
OBS



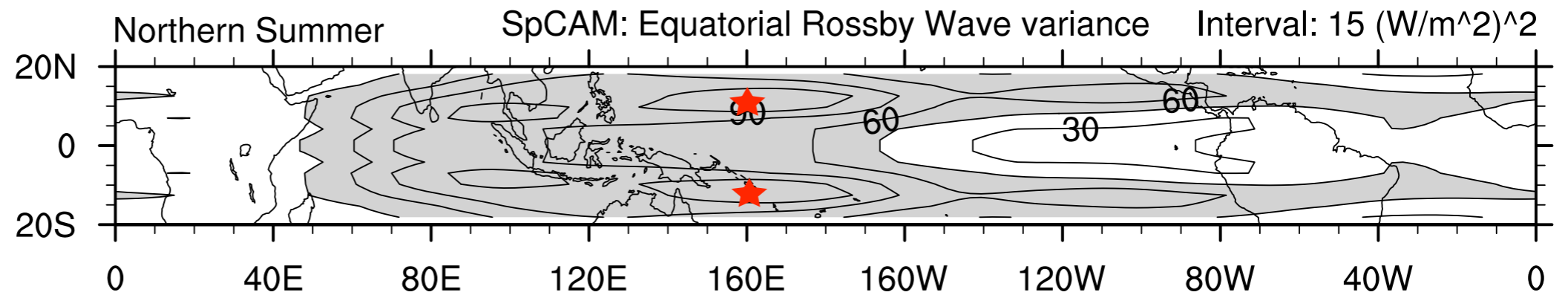
SpCCSM



CCSM

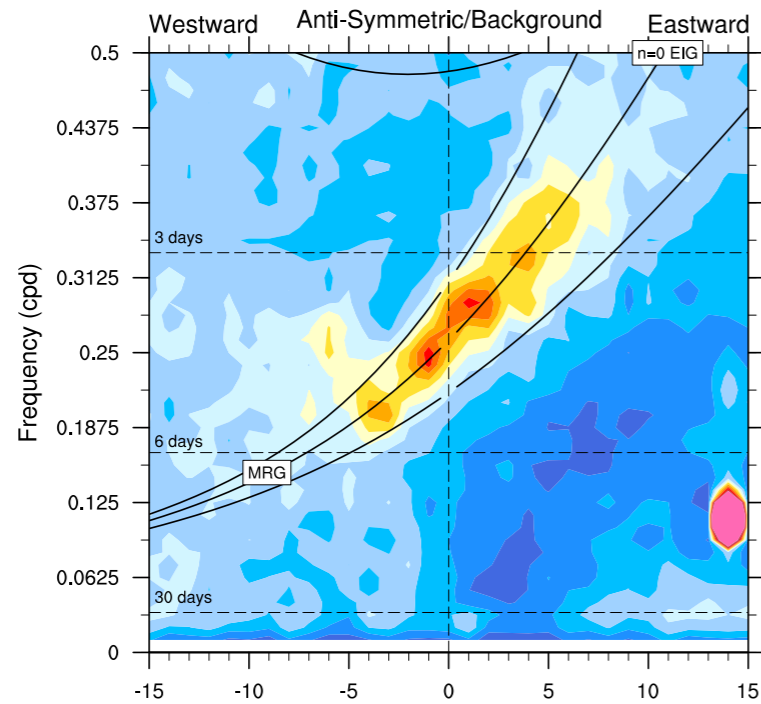


SpCAM

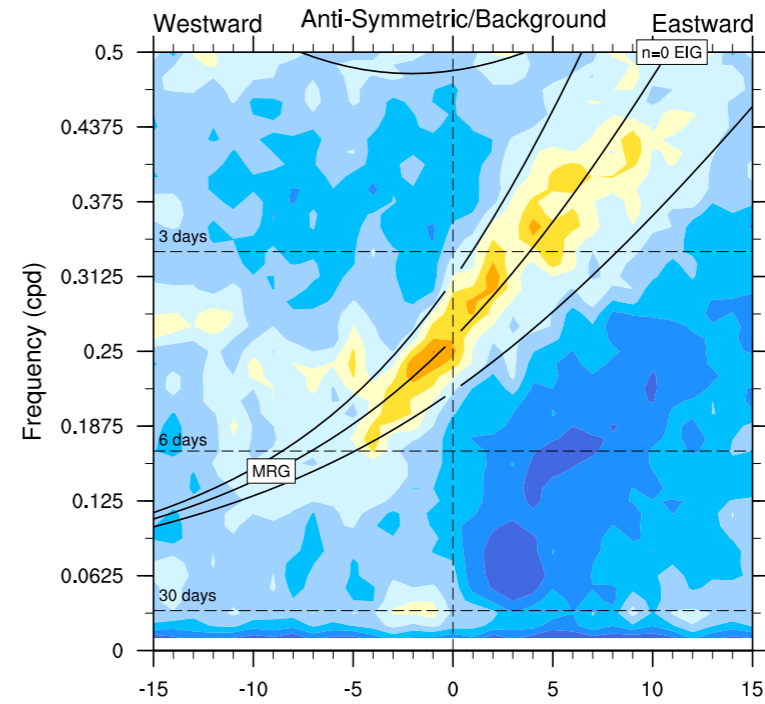


Equatorial Waves (asym)

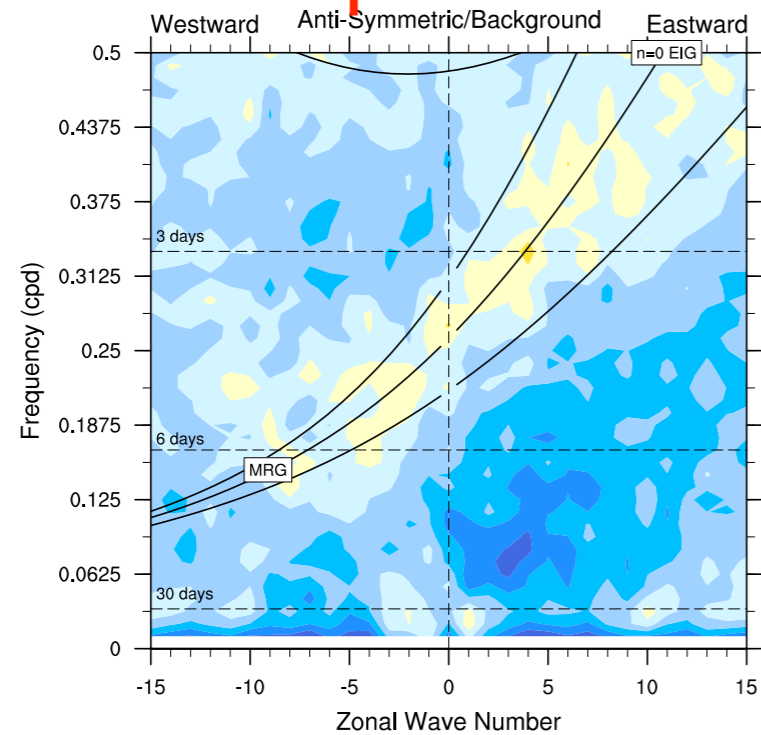
OBS



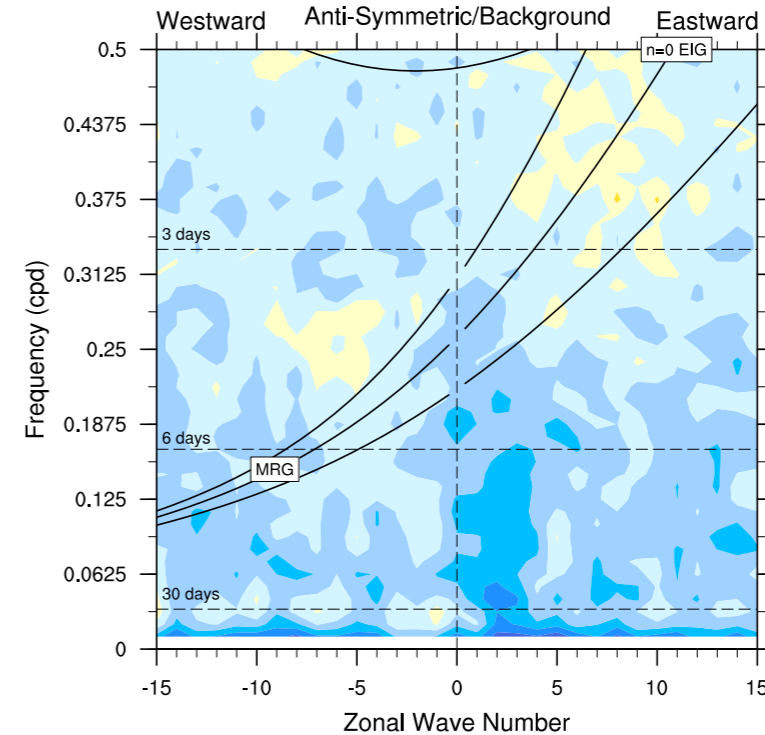
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SpCAM

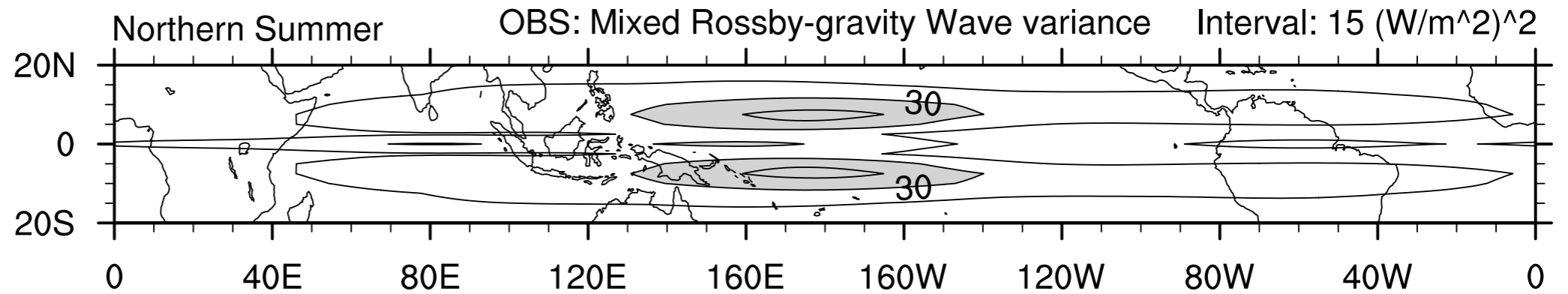


CCSM

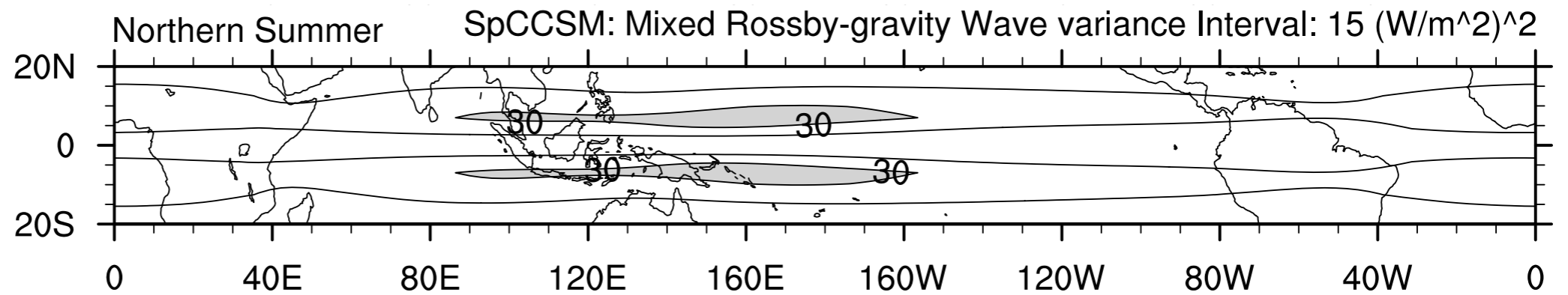


Mixed Rossby-Gravity Waves

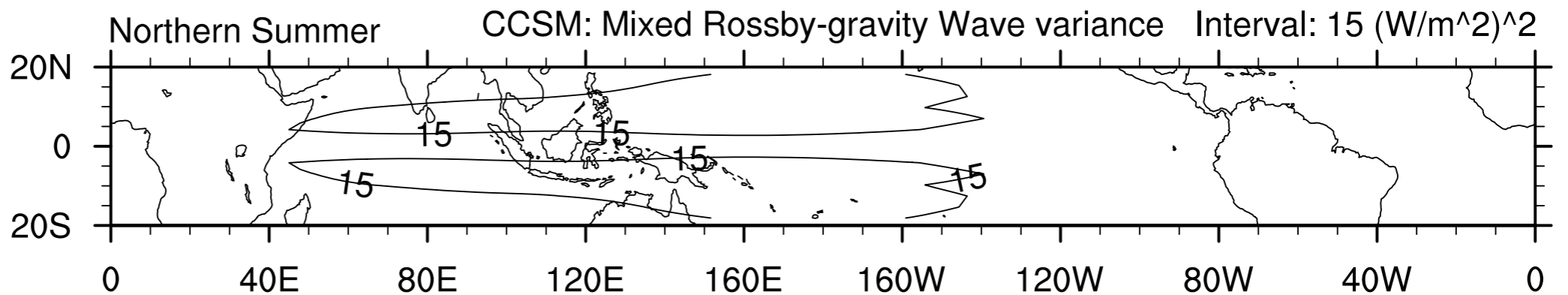
OBS



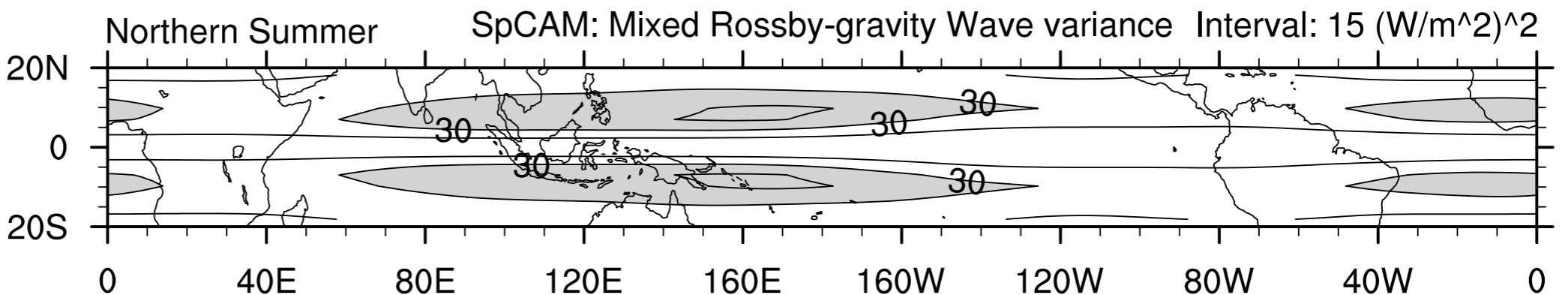
SpCCSM



CCSM



SpCAM

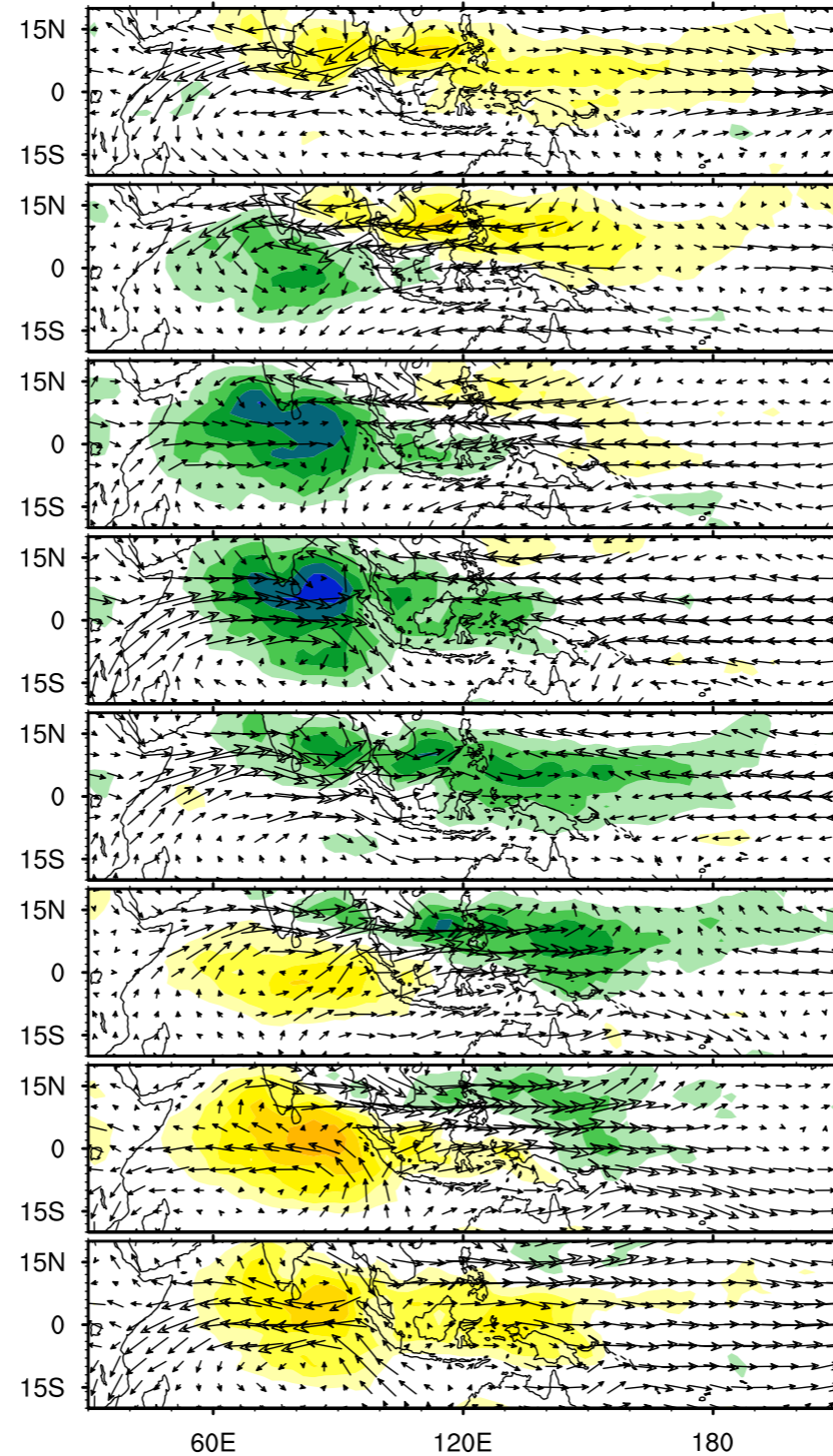


Factors influencing ER, MRG wave simulation:

- explicit convection AND coupling results in the most realistic distribution of $n=1$ ER and MRG variance.
- MRG variance is weaker than ER variance, and concentrated in central Pacific.
 - ➔ *what role might these waves play in the monsoon?*

How to composite the monsoon?

OBS

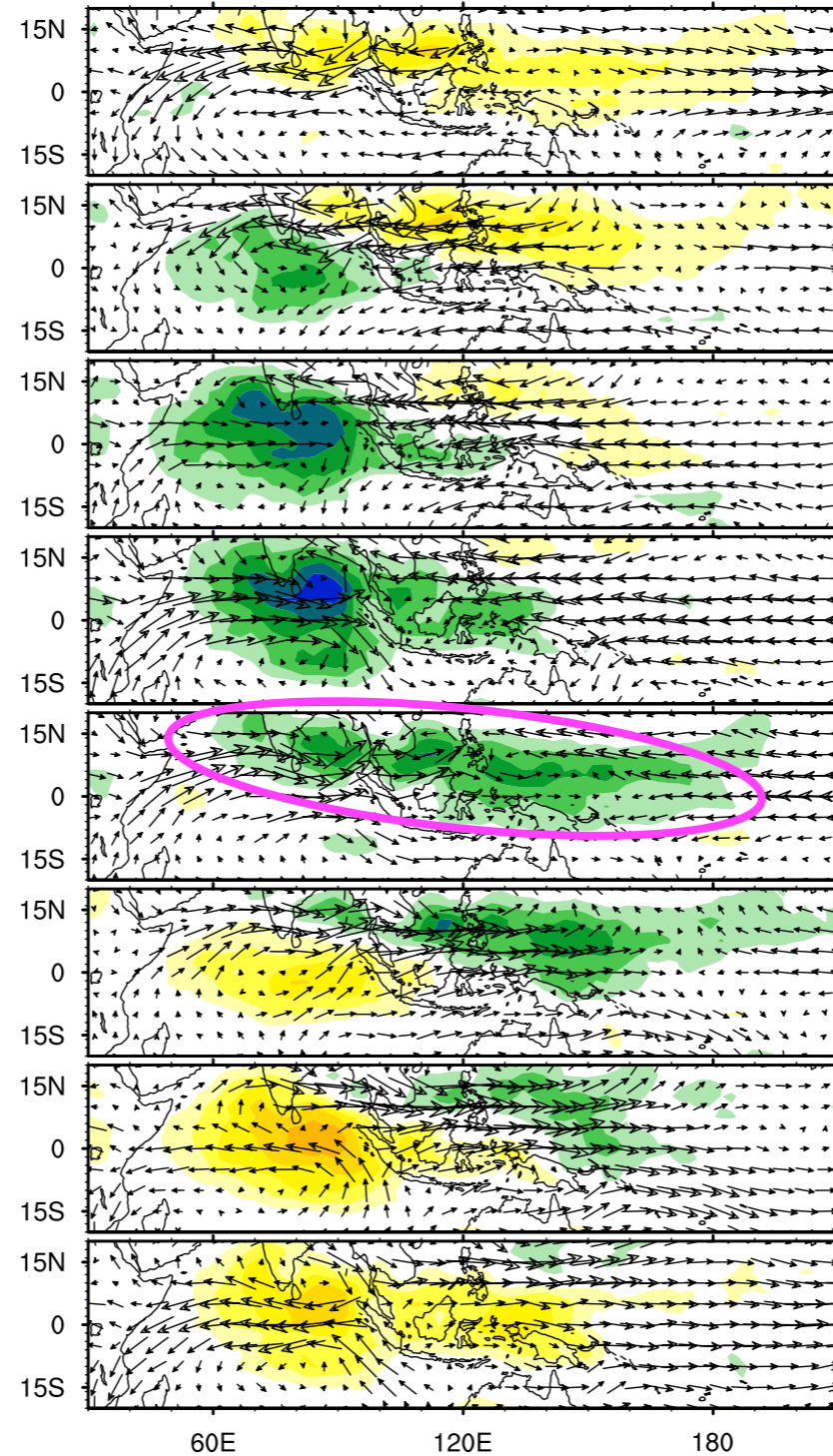


May-Oct

How to composite the monsoon?

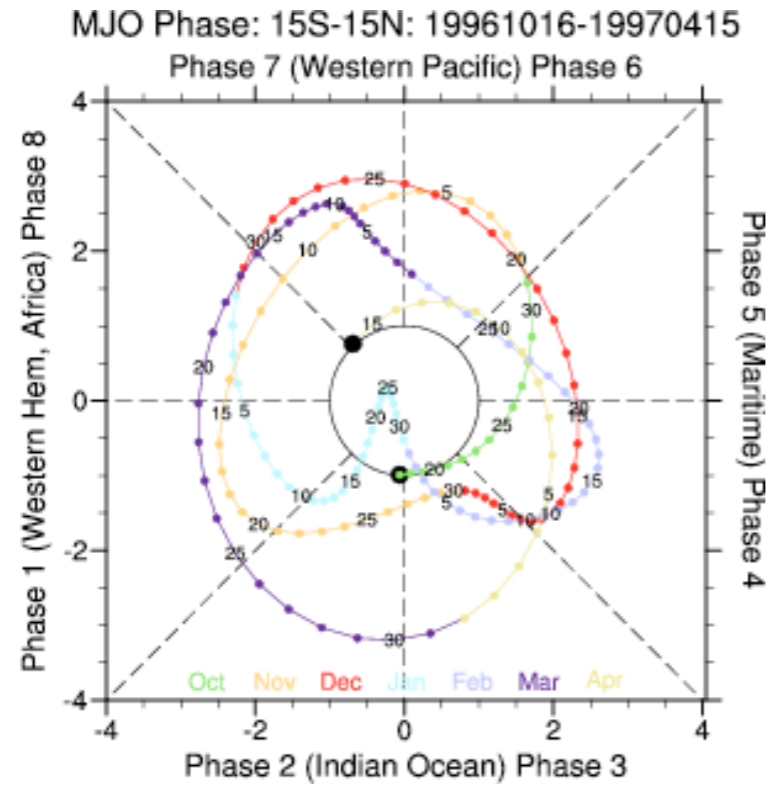
OBS

May-Oct

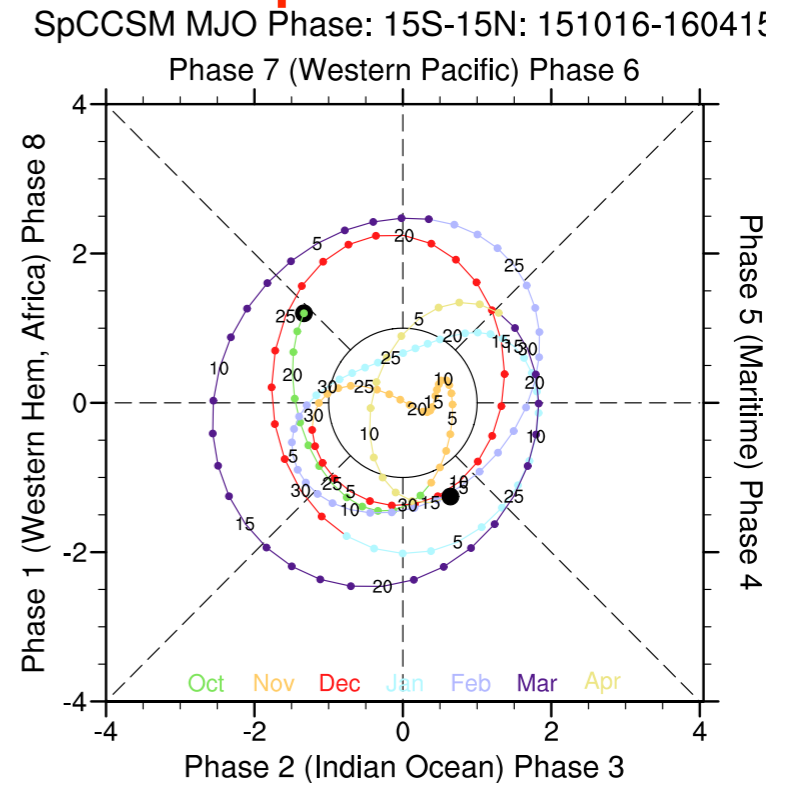


ISO Phase Space

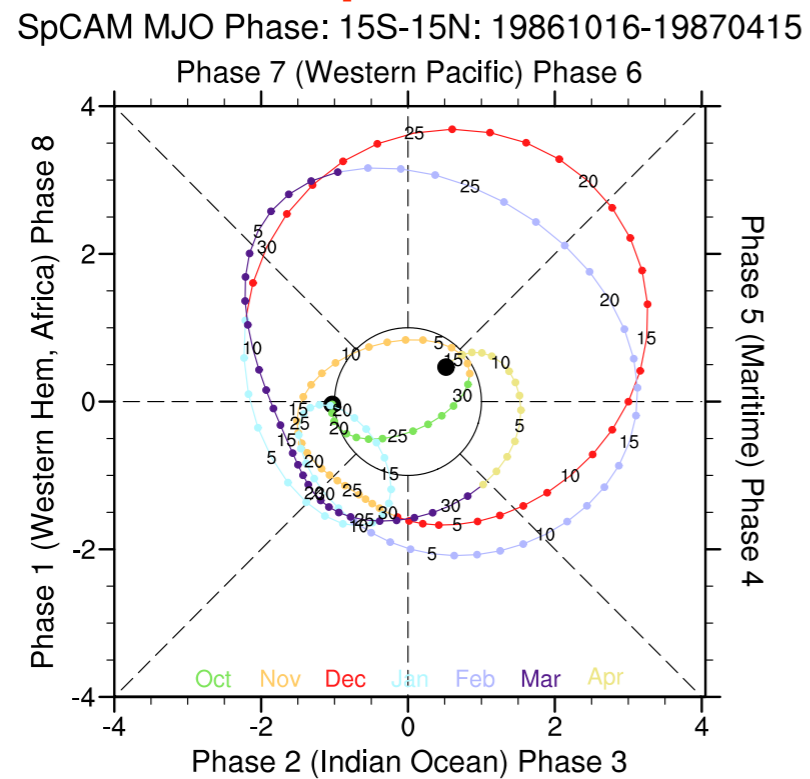
OBS



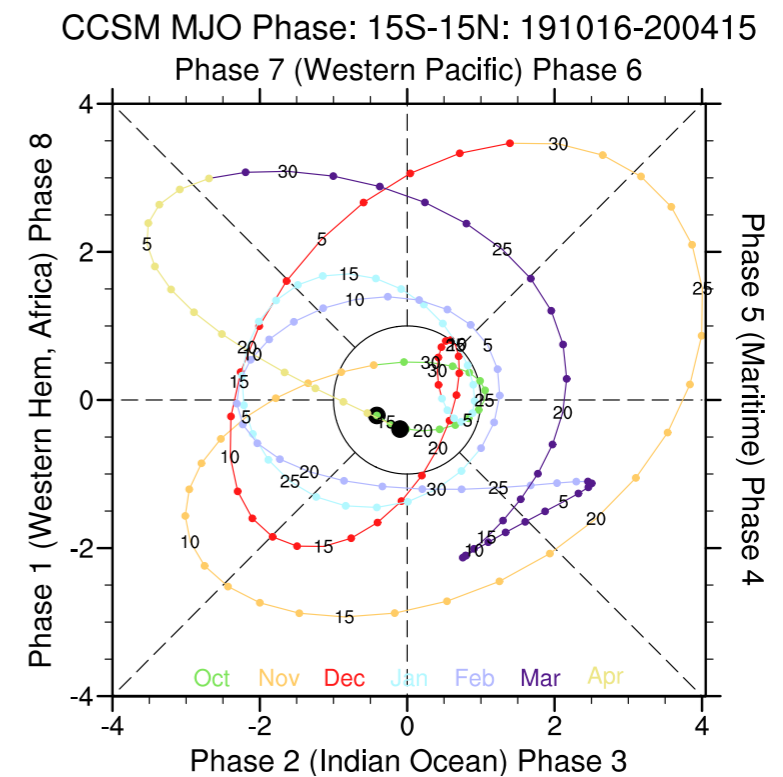
SpCCSM



SpCAM



CCSM



May-Oct Composite OLR

OBS

SpCAM

SpCCSM

CCSM

P1

P2

P3

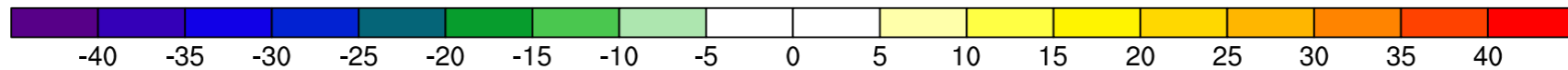
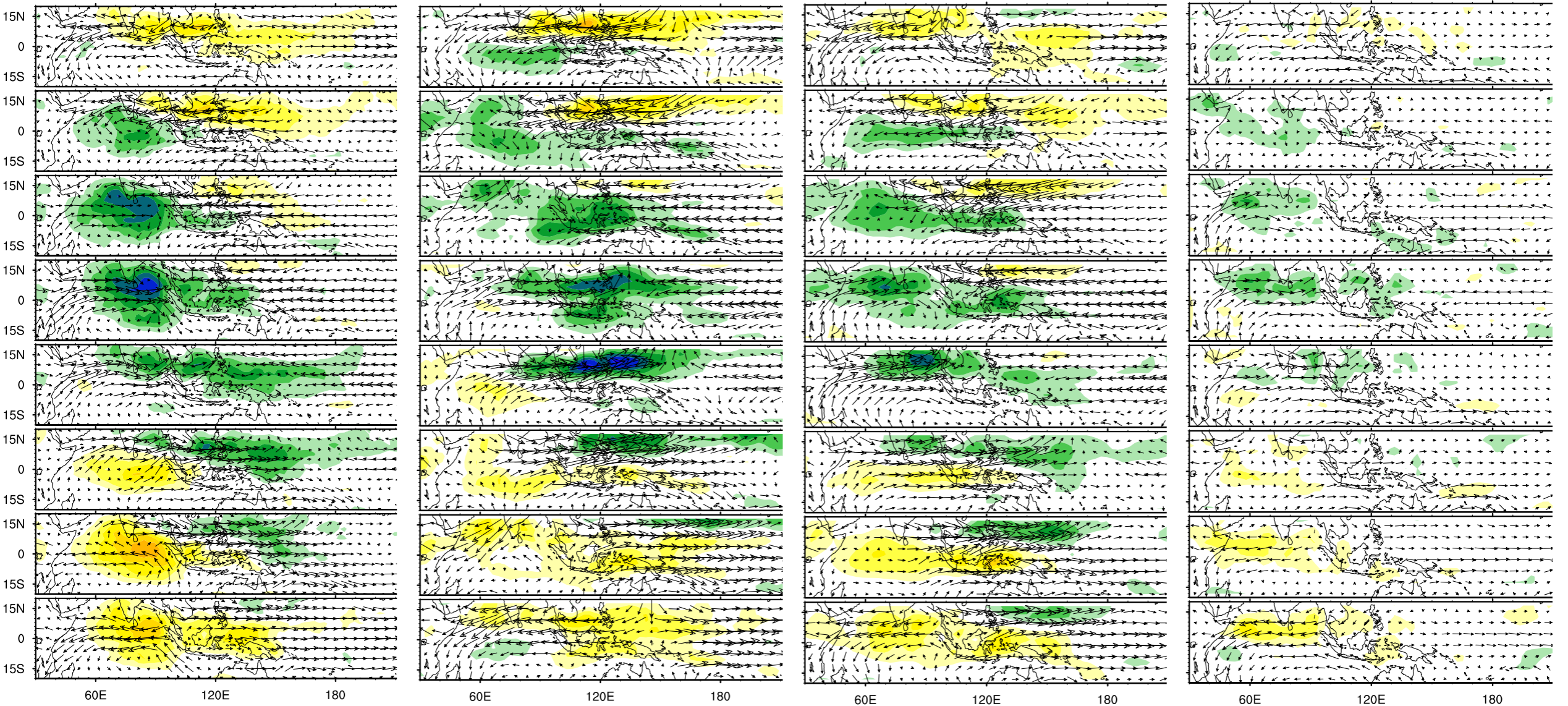
P4

P5

P6

P7

P8



May-Oct Composite OLR

OBS

SpCAM

SpCCSM

CCSM

P1

P2

P3

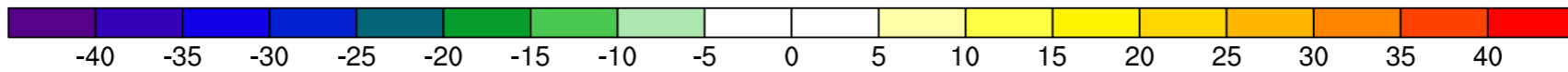
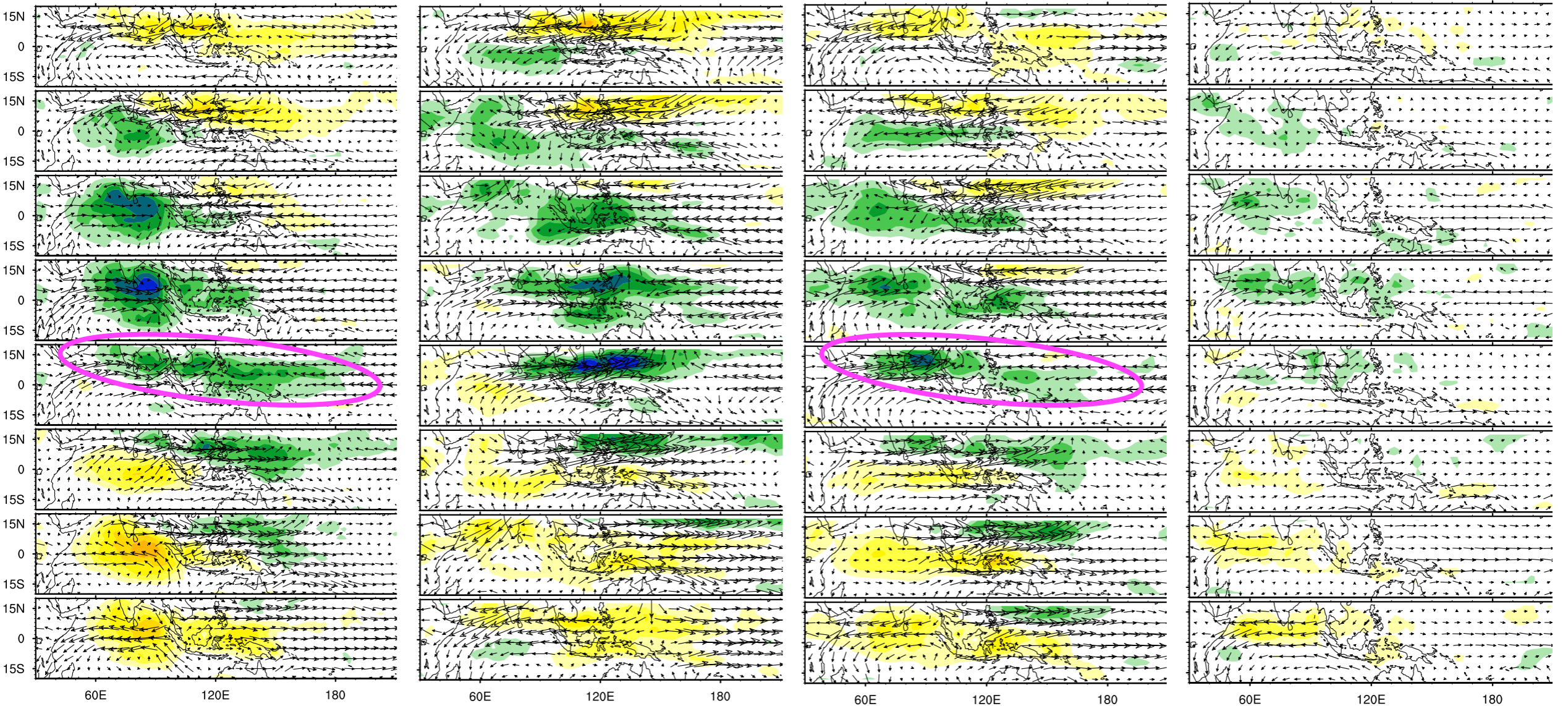
P4

P5

P6

P7

P8



How to composite $n=1$ ER and MRG wave activity?

- Compute wave type OLR ***variance***, rather than OLR mean, for each ISO phase.
- Better yet, plot departure of phase variance from season-mean variance.

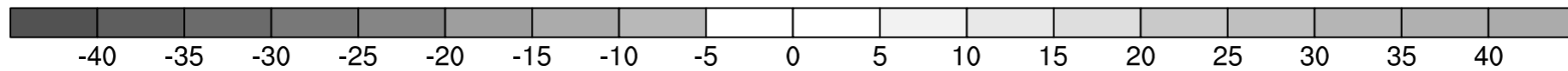
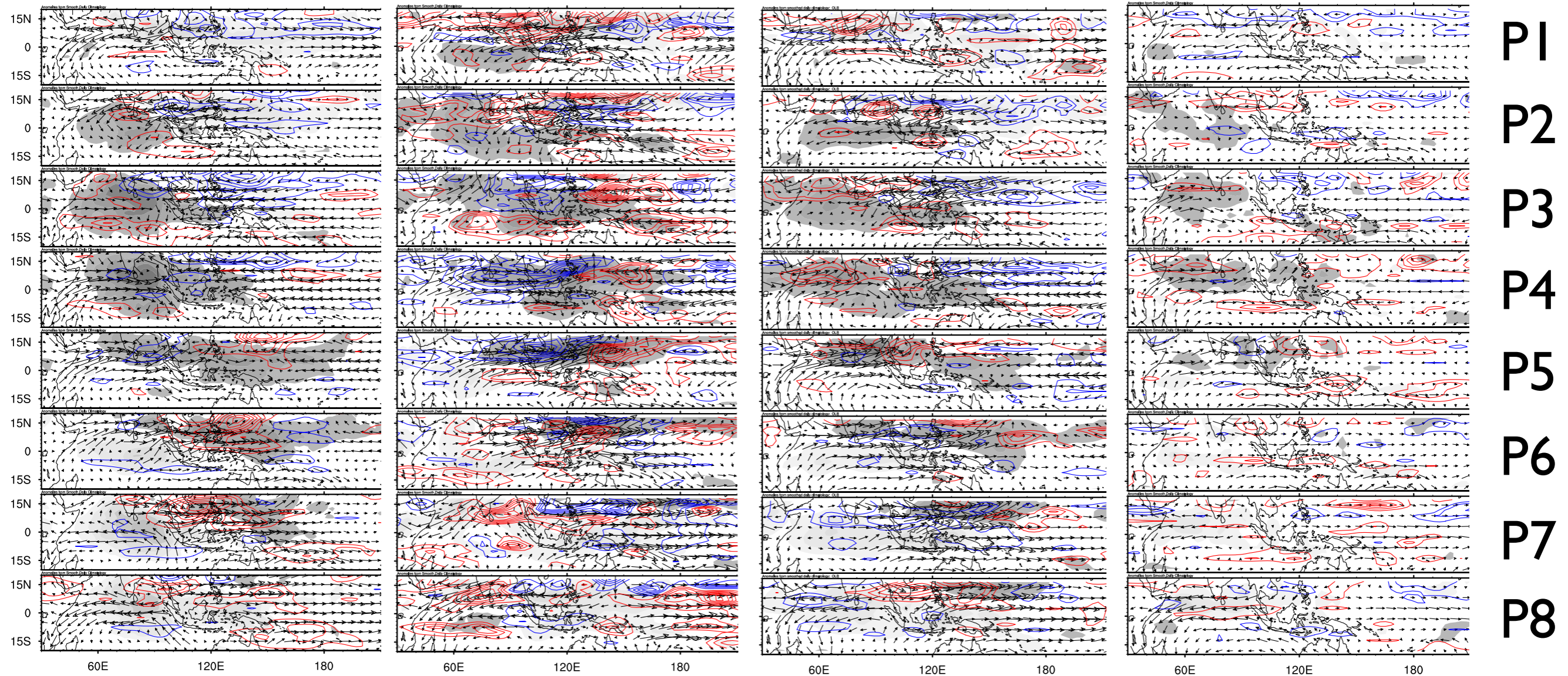
May-Oct Composite ERvar

OBS

SpCAM

SpCCSM

CCSM



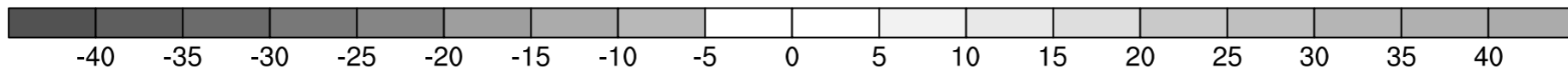
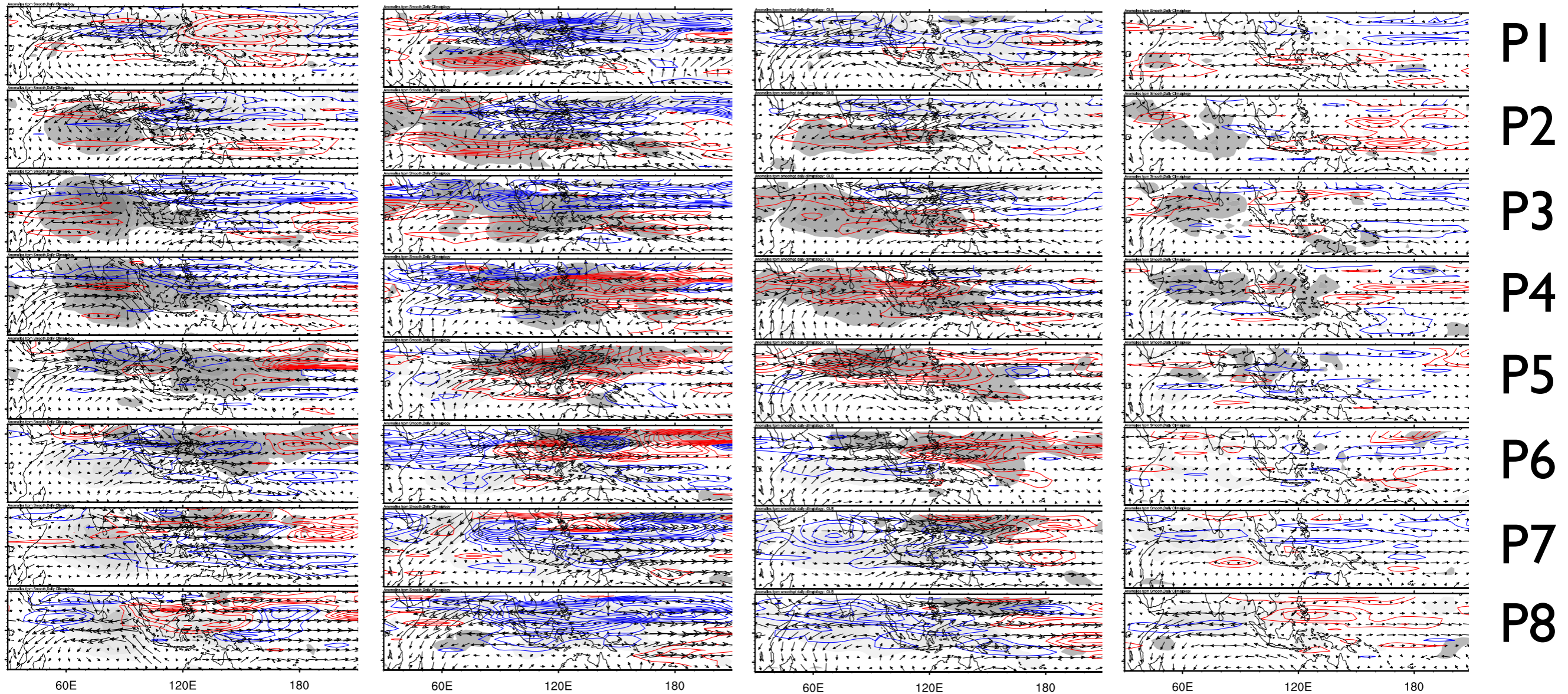
May-Oct Composite MRGvar

OBS

SpCAM

SpCCSM

CCSM



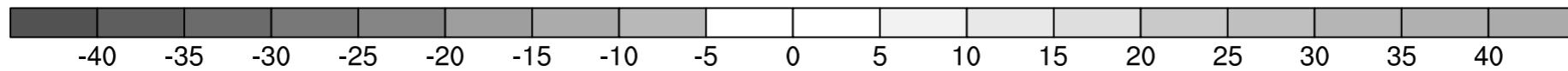
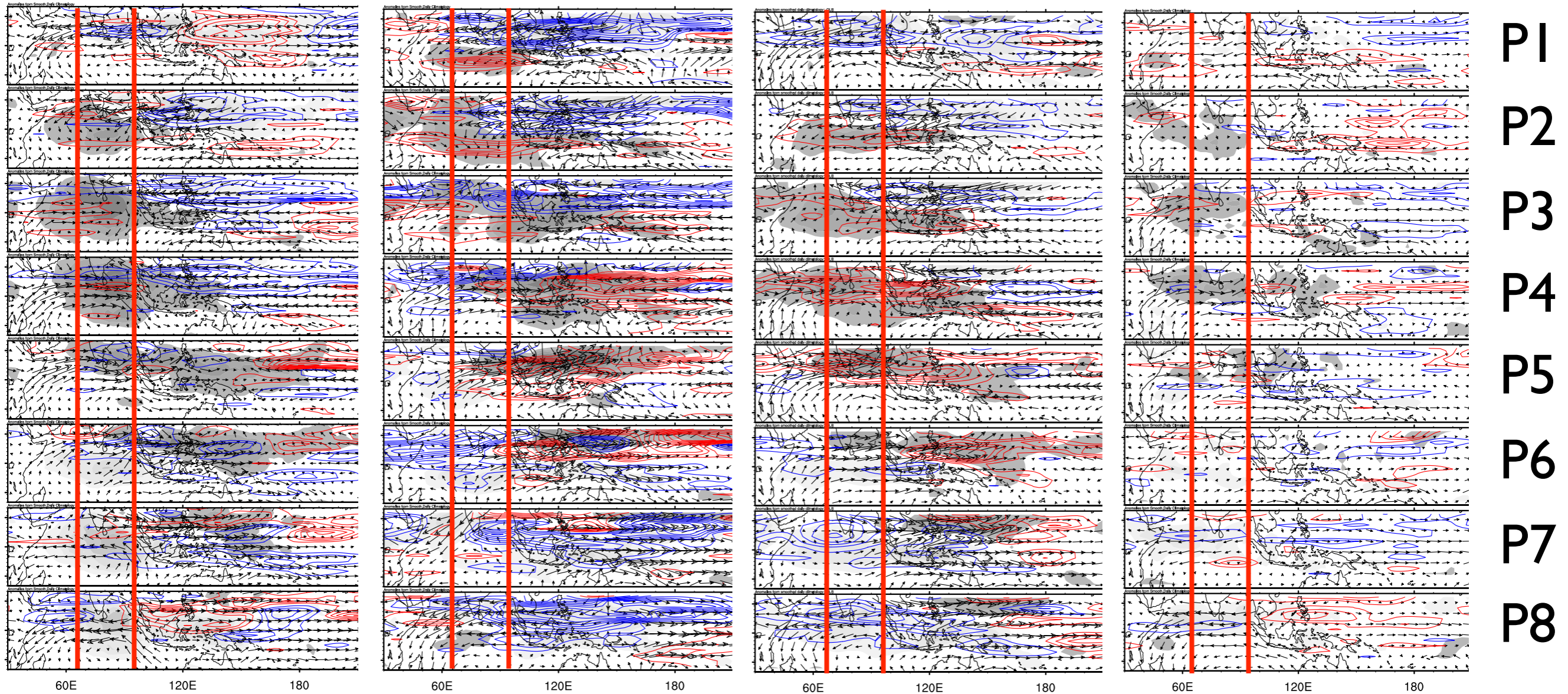
May-Oct Composite MRGvar

OBS

SpCAM

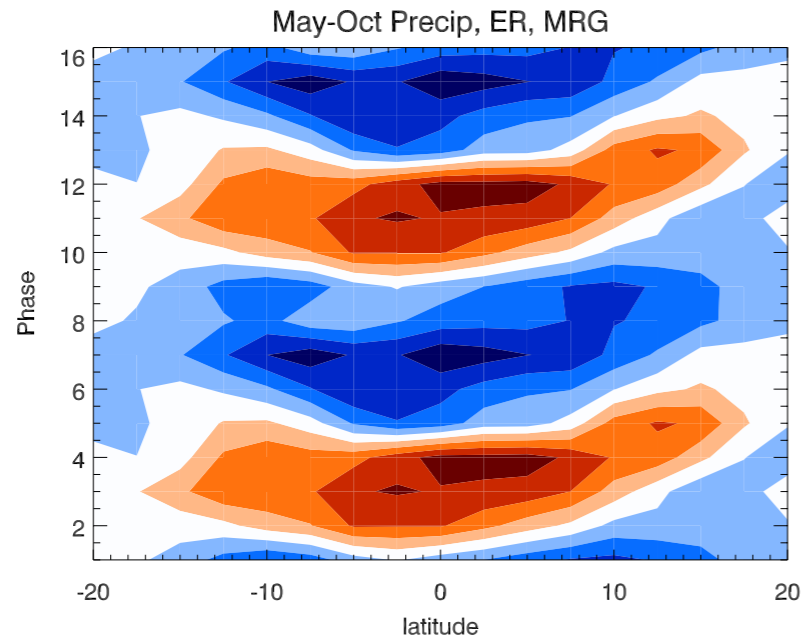
SpCCSM

CCSM

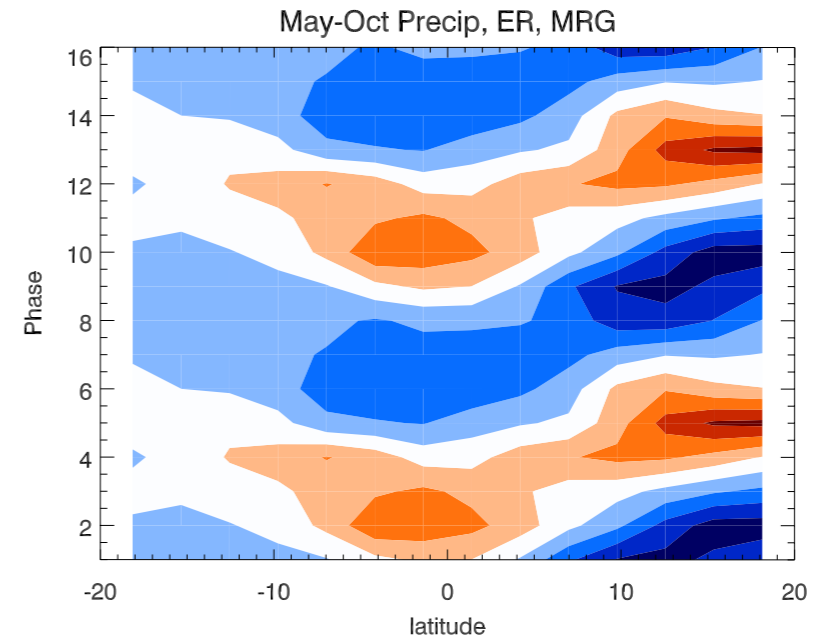


Indian Ocean meridional composite by MJO PCI+PC2 phase (2 cycles shown)

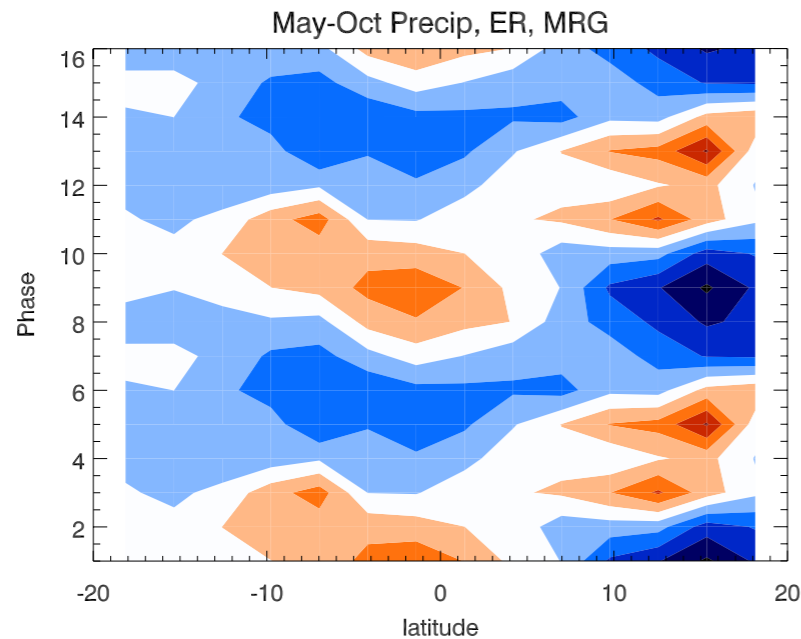
OBS



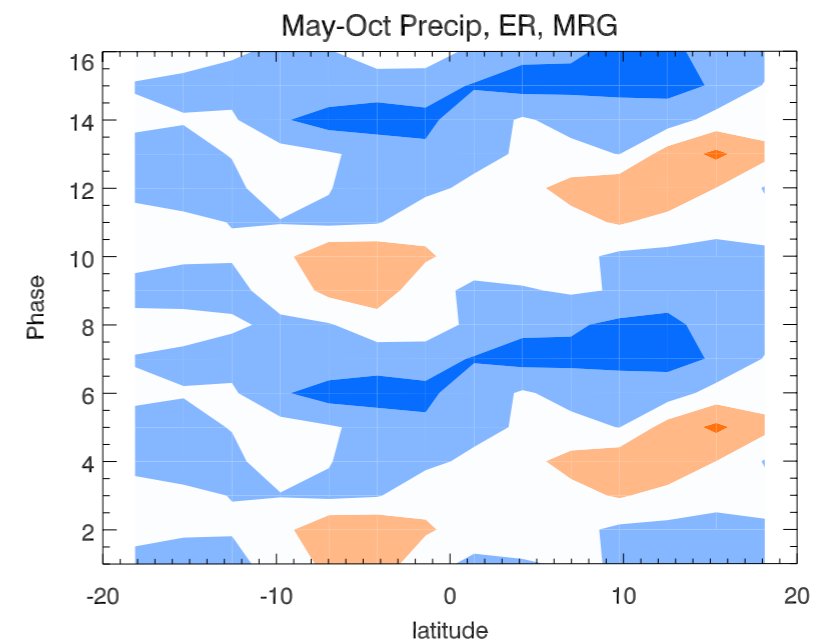
SpCCSM



SpCAM



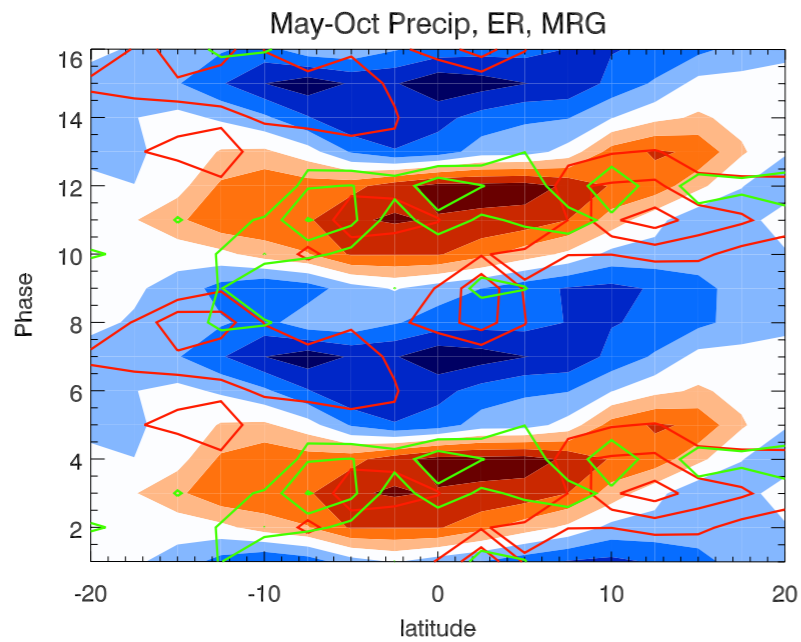
CCSM



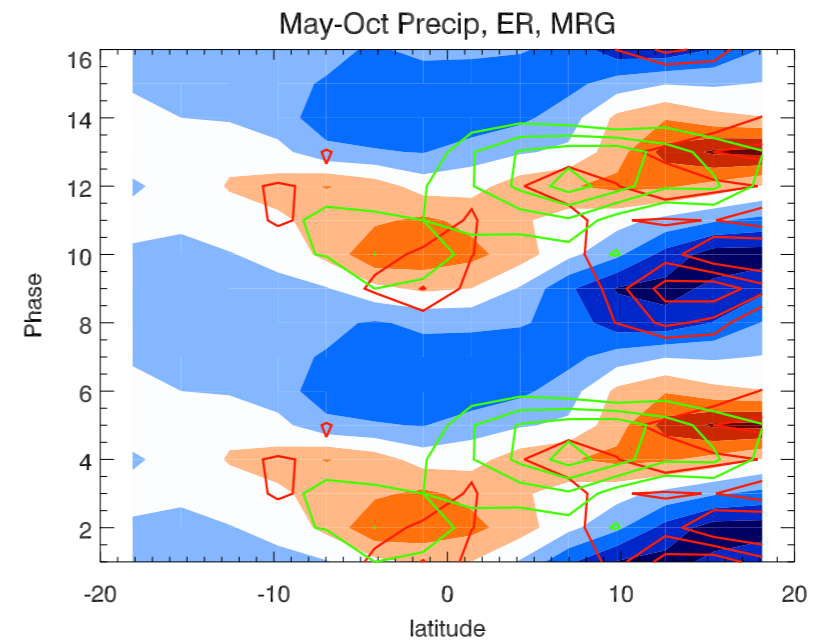
Precip' (red= positive anomaly)

Indian Ocean meridional composite by MJO PCI+PC2 phase (2 cycles shown)

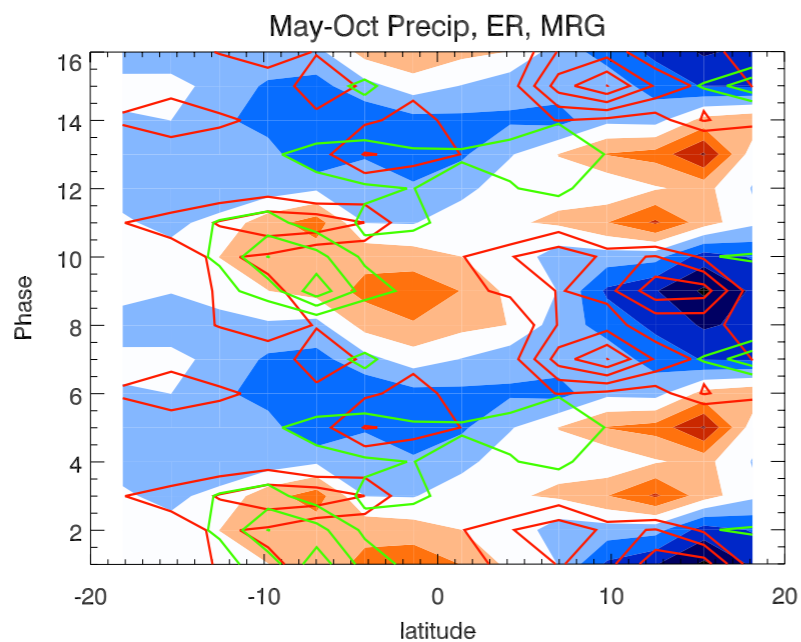
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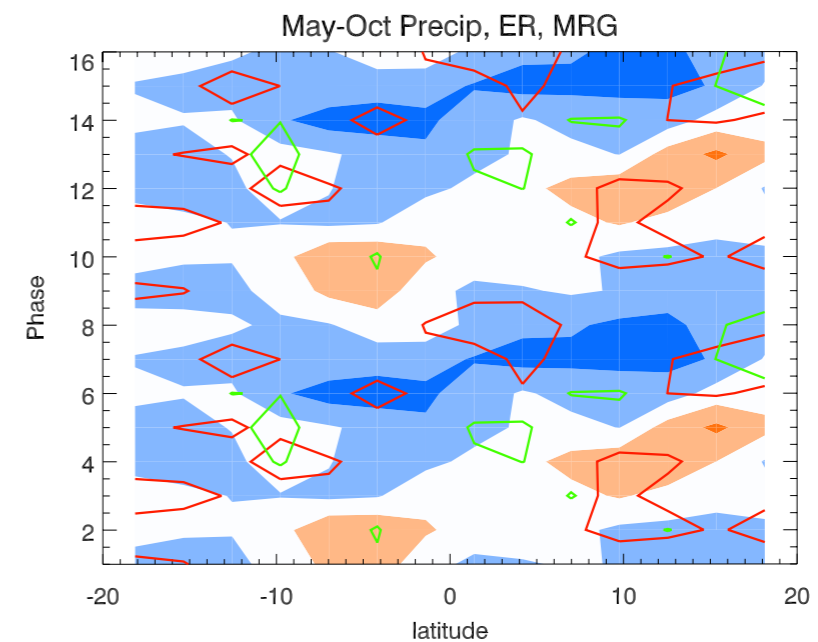
SpCCSM



SpCAM



CCSM



Precip' (shaded), +MRG', +ER'

Conclusions (Processes)

- $n=1$ ER wave may “pre-condition” the atmosphere for northward-propagating convection.
- $n=1$ ER wave is primarily improved by “Sp” but is further improved with coupling.
- MRG waves are associated with low-latitude (0~12N) northward propagation.
- MRG waves are best represented with “Sp” *AND* coupling.

CLIVAR EOF compositing

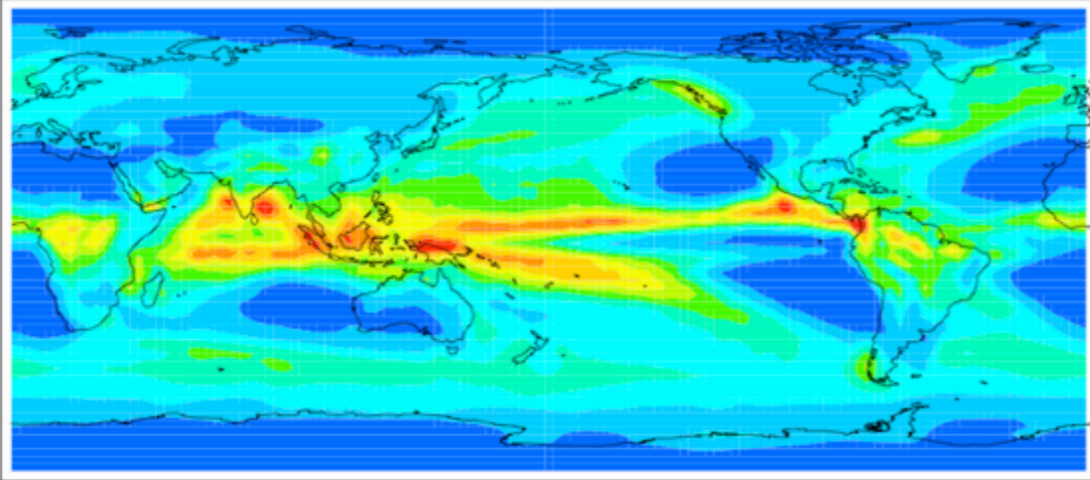
- captures some elements of northward- and westward-propagating elements of monsoon.
- can be used to study phenomena that span a variety of space and time scales.
- appears to miss some northward events, especially in models.
- notes on northward EOF composite.

End

Annual Rainfall

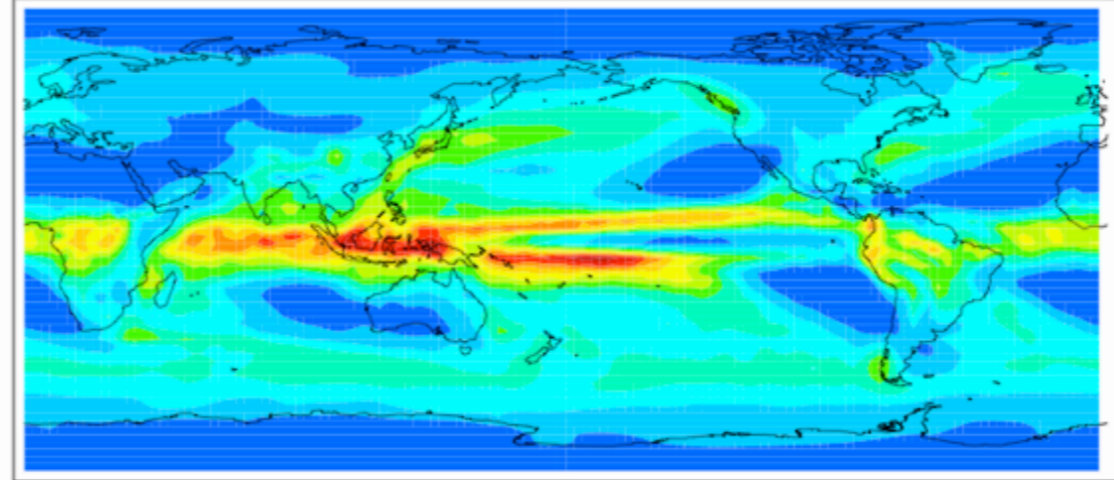
CAM

CAM PRECT ANN mean=2.83



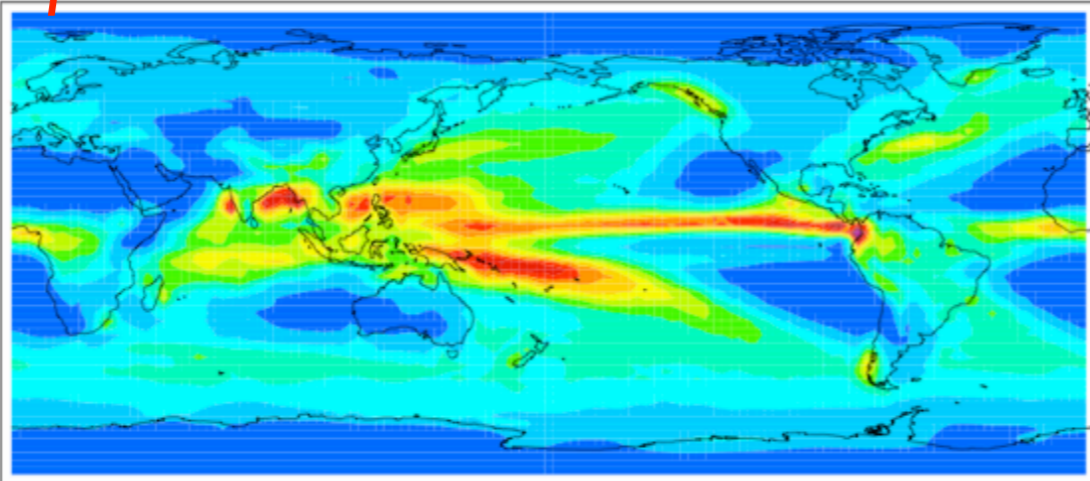
CCSM

CCSM PRECT ANN mean=2.74



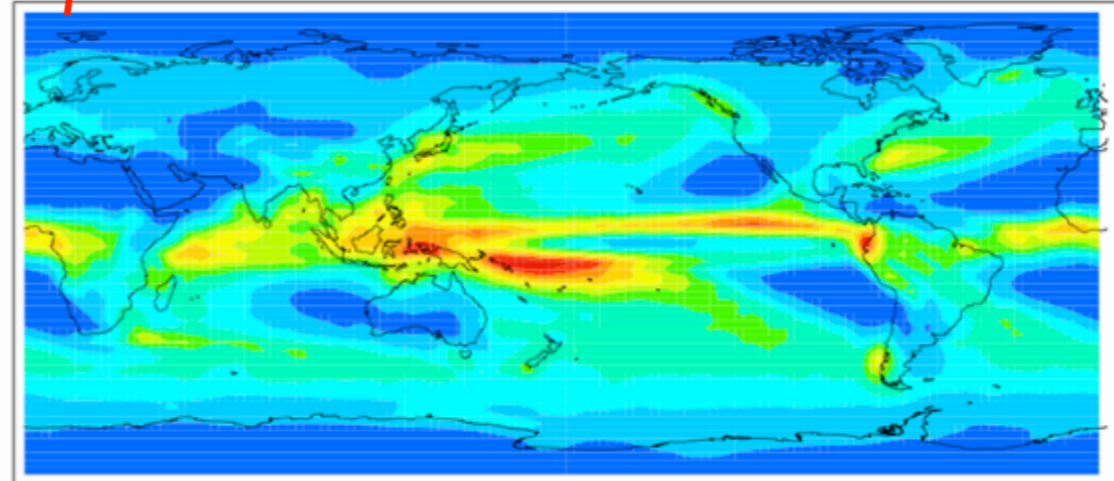
SpCAM

MMF PRECT ANN mean=2.80



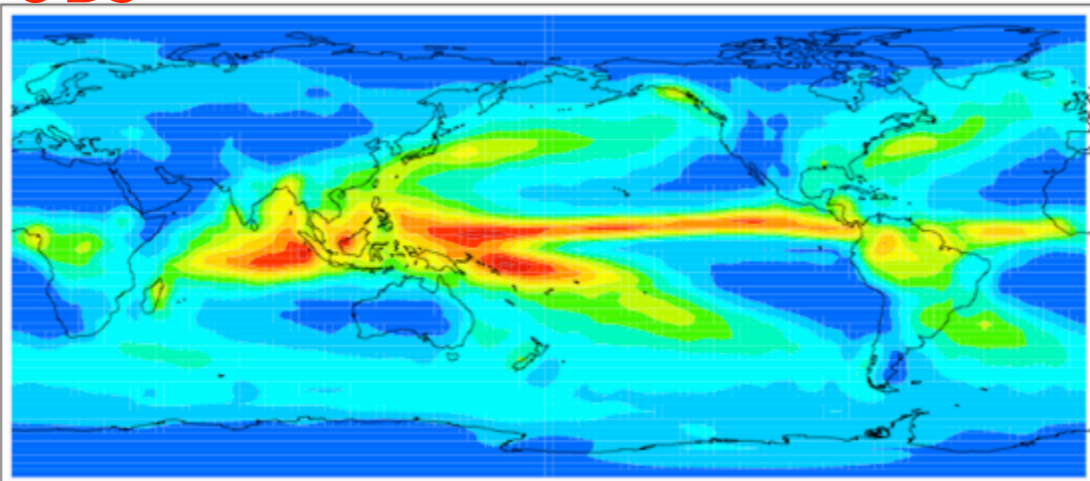
SpCCSM

CMMF PRECT ANN mean=2.79



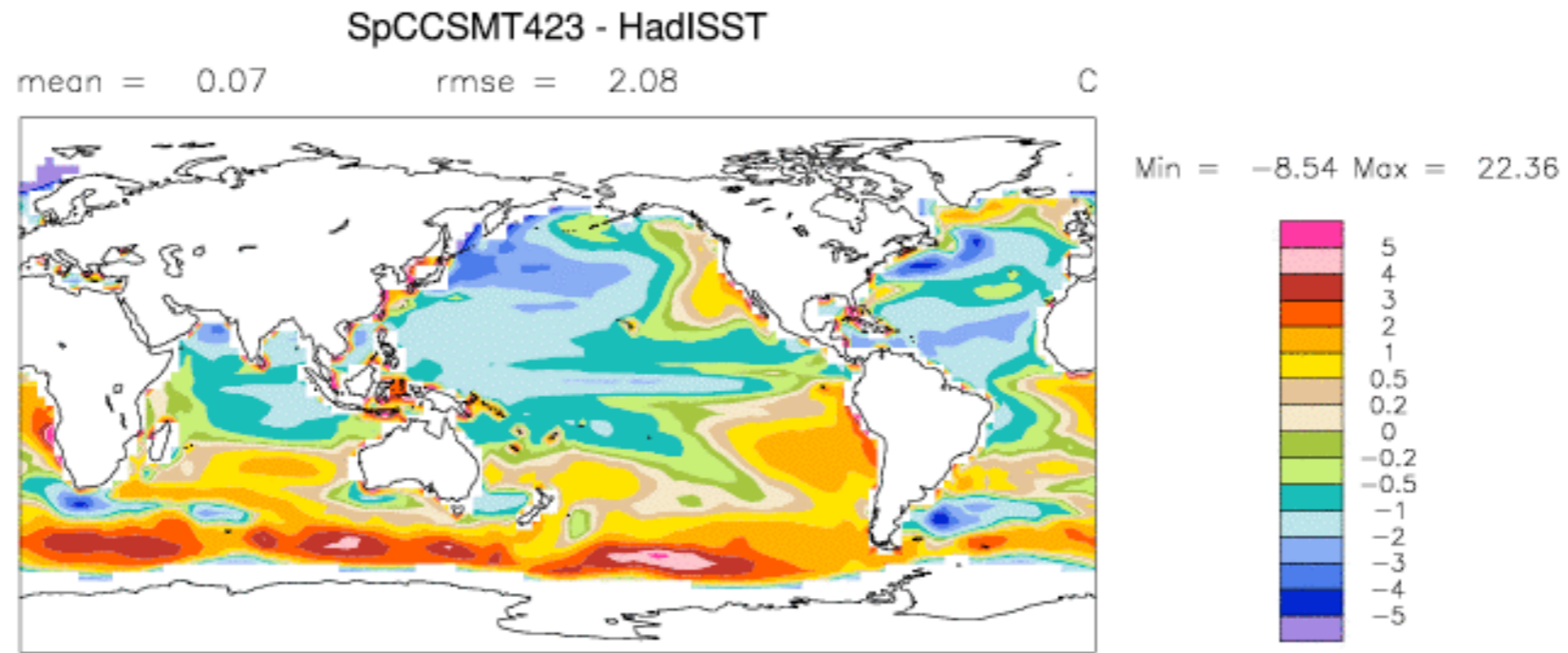
OBS

CMAF PRECT ANN mean=2.69

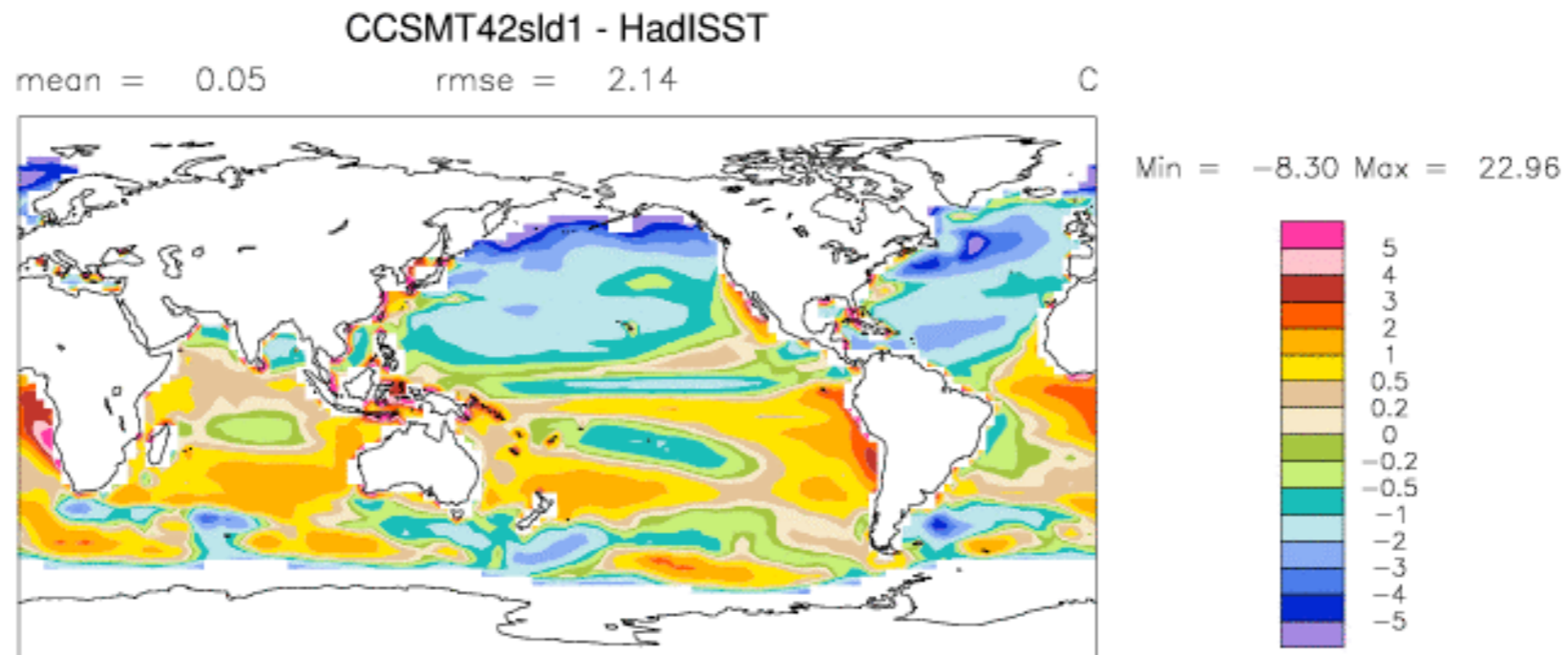


SST

SpCCSM

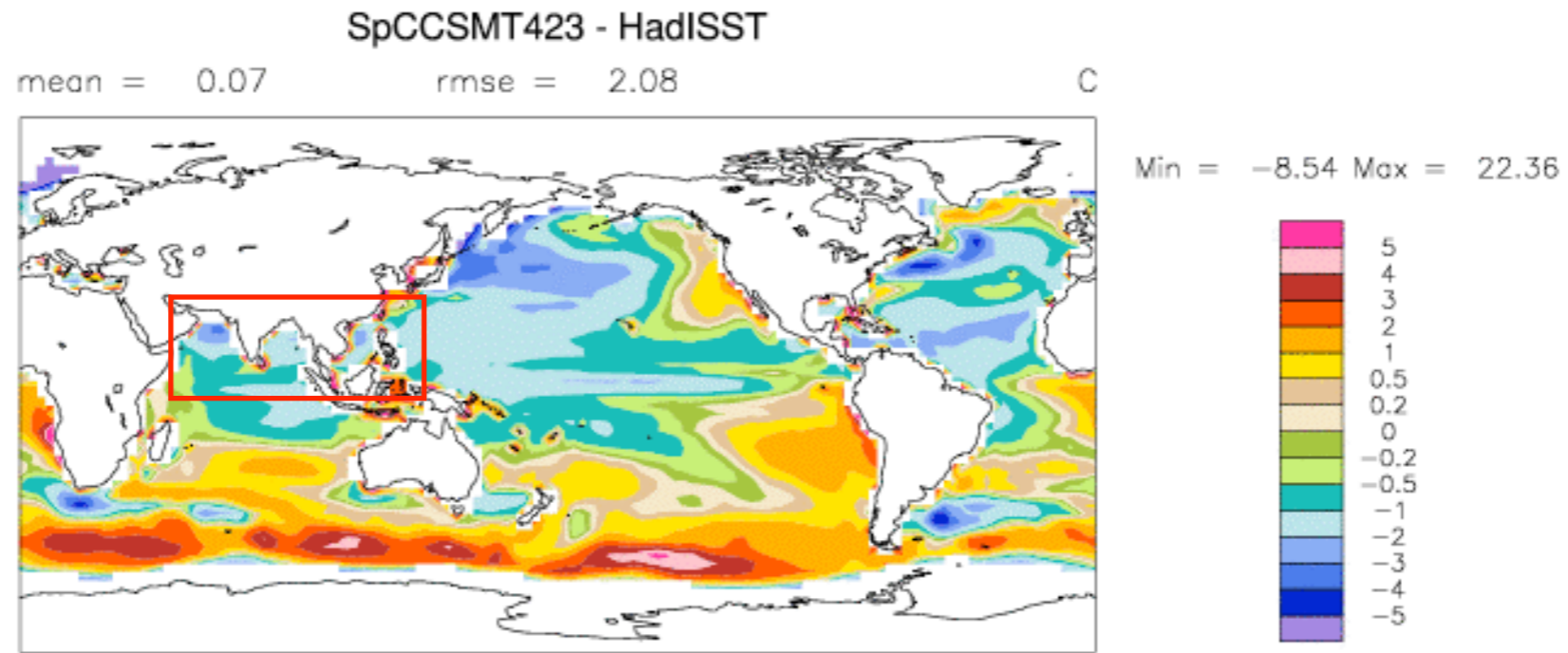


CCSM



SST

SpCCSM



CCSM

