Boreal Summer Monsoon Intraseasonal Oscillation

MISO

Metrics for Boreal Summer and Asian Monsoon Intraseasonal Oscillation (MISO)

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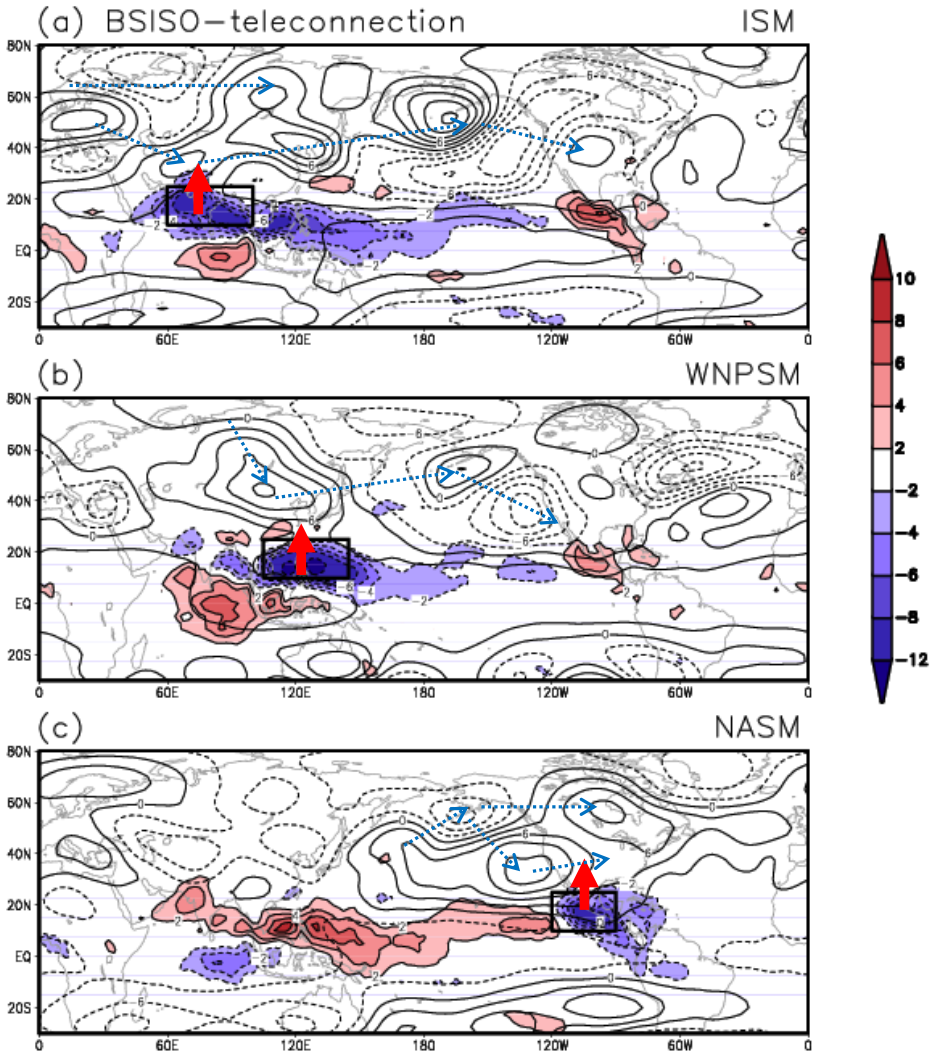
Content

Boreal Summer Monsoon ISO Teleconnection

Boreal Summer Teleconnection

- ✓ **Silk road pattern** (Enomoto et al. 2003)
- ✓ **Western North Pacific-North America pattern** (Wang et al. 2001)
- ✓ **Tokyo-Chicago express** (Lau et al. 2004)
- ✓ **Circum global teleconnection (CGT)** (Ding and Wang 2005)

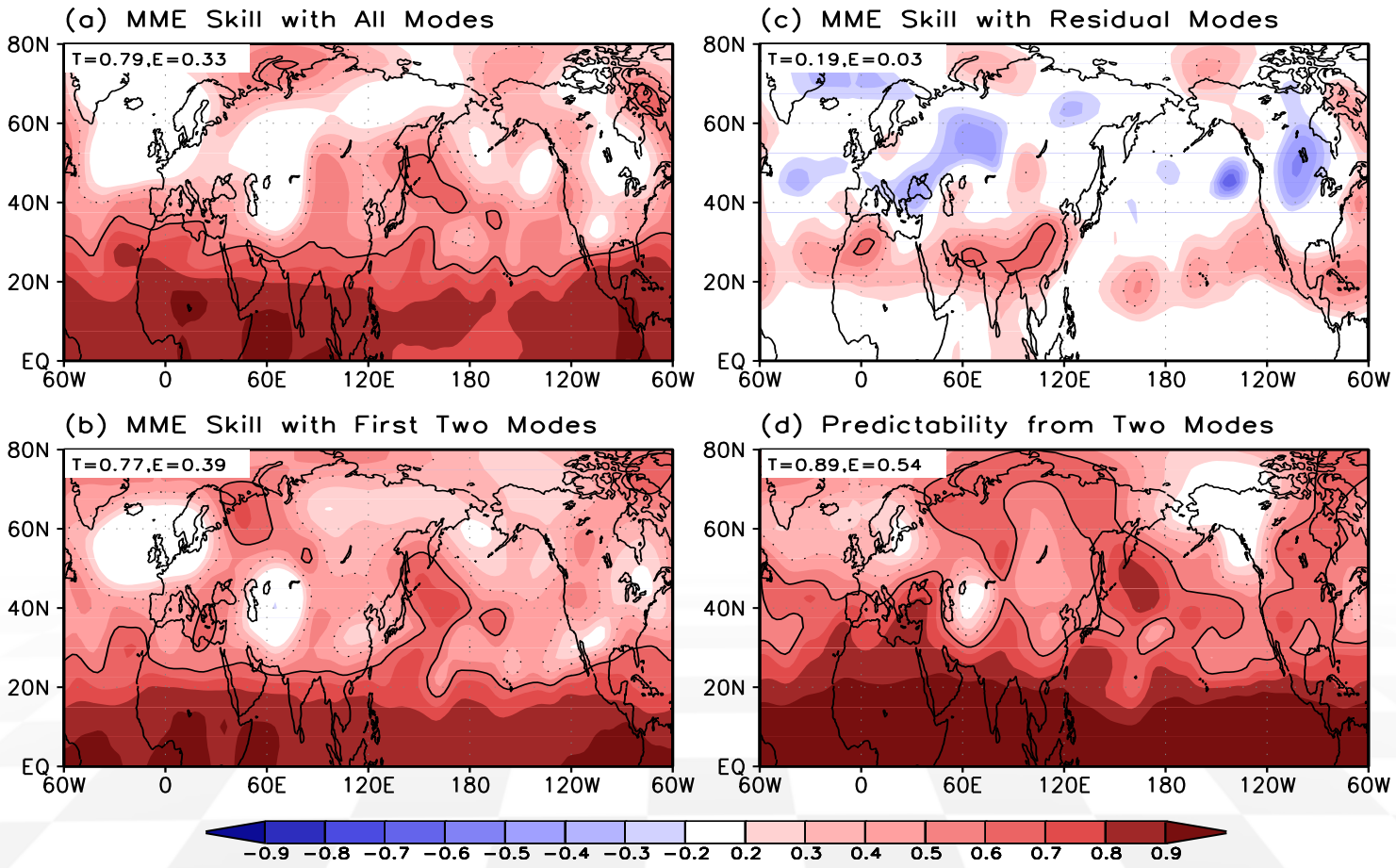


Regressed GPH200 (Contour) and OLR (shading) according to ISM, WNPSM, and NASM index

Blue and red arrows indicate the propagation of the wave activity flux.

Predictability Source of
Boreal Summer Extratropical Atmospheric Variability

JJA 200-hPa Geopotential Height



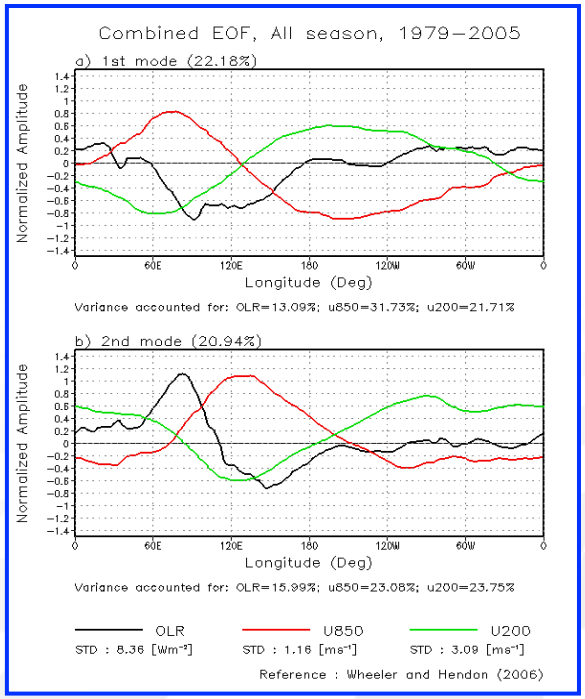
Lee et al. (2011, Clim Dyn)

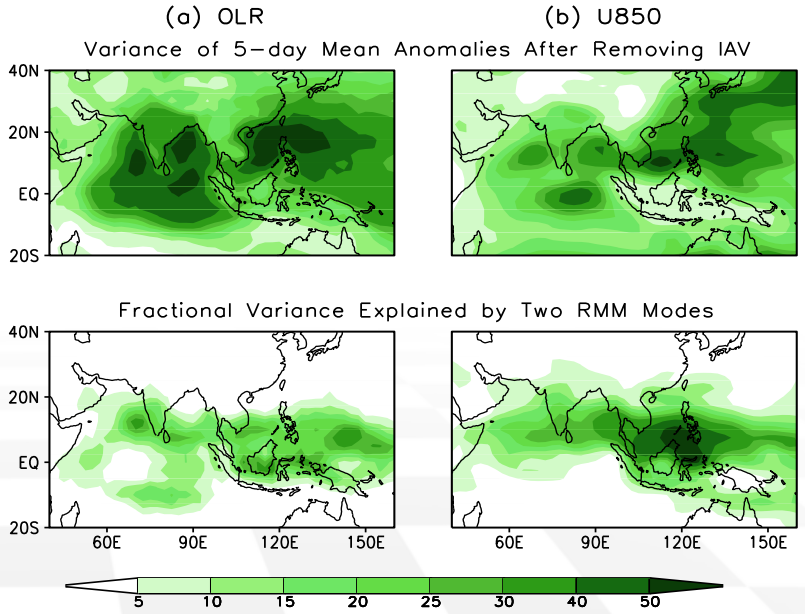
Motivation:

Limitation of the RMM index for representing BS MISO

As a measure of the strength of the MJO, **Wheeler and Hendon (2004) Realtime Multivariate MJO (RMM) index** used the **first two leading multivariate EOF modes of the equatorial mean (between 15S and 15N) OLR, and zonal winds at 850 and 200 hPa**. This index captures equatorial eastward propagating mode, the MJO, very well and has been applied all year around to depict MJO activity. However, **it is not clear whether RMM remains a best measure of the boreal summer monsoon intraseasonal oscillation (MISO)** that is **one of the most prominent short-term climate variability in the global climate system and more complex in nature than the MJO**

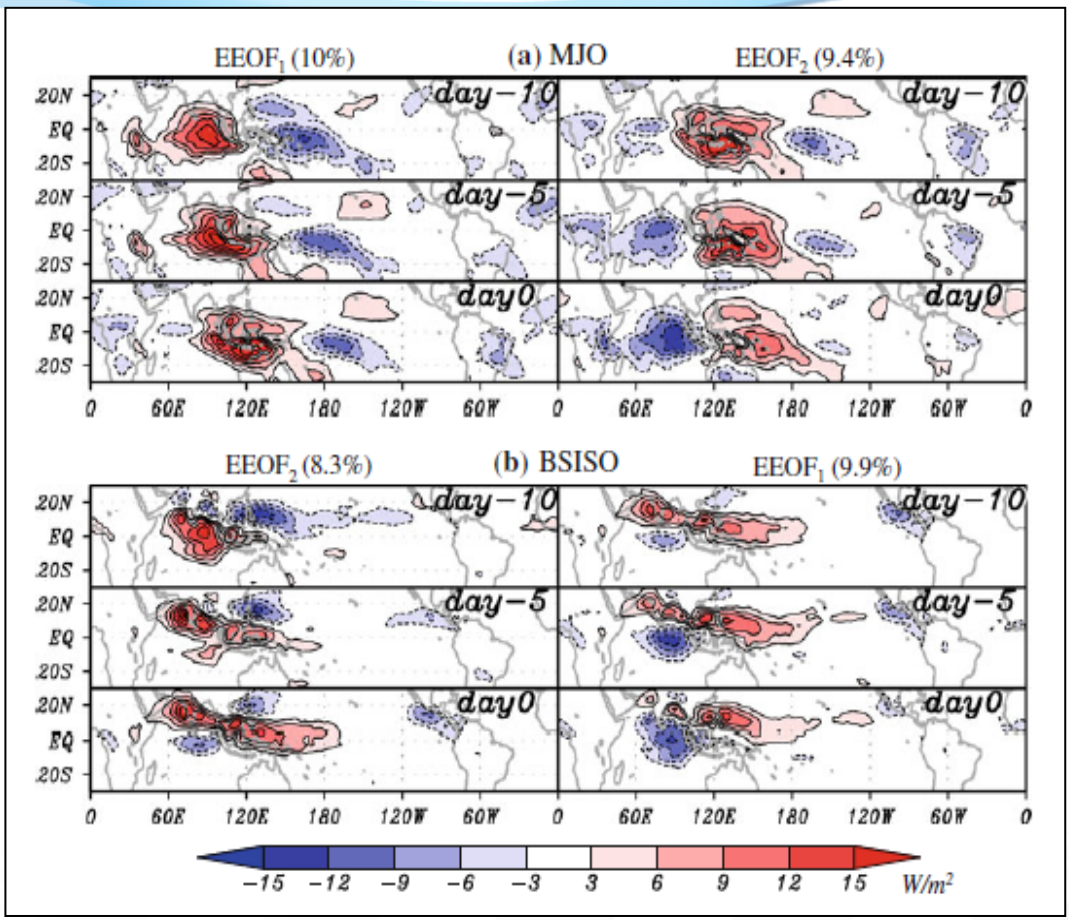
Wheeler an Hendon (2004)





RMM index has limitation to explain ISO variability over off-equatorial monsoon domain in boreal summer.

Bimodal Representation of the Tropical ISO

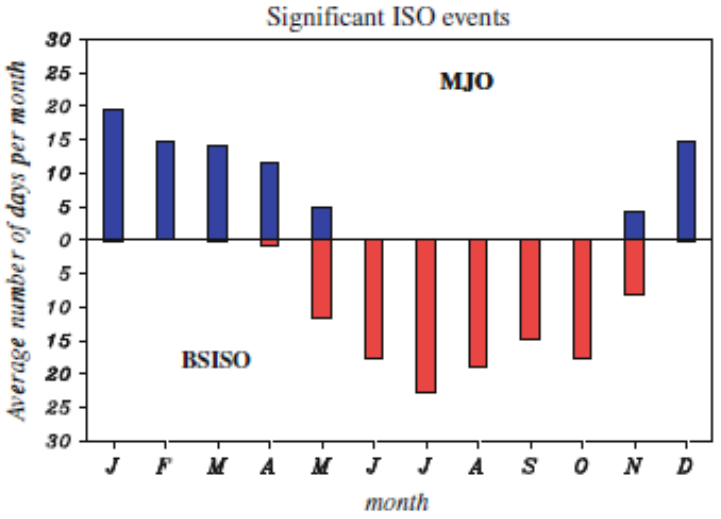


Spatial-temporal pattern of OLR anomaly associated with the intraseasonal oscillation during (a) boreal winter (DJF, referred to as MJO mode) and (b) boreal summer (JJA, referred to as BSISO mode) by means of the extended EOF (EEOF) analysis.

Kikuch et al. (2011, Clim Dyn)

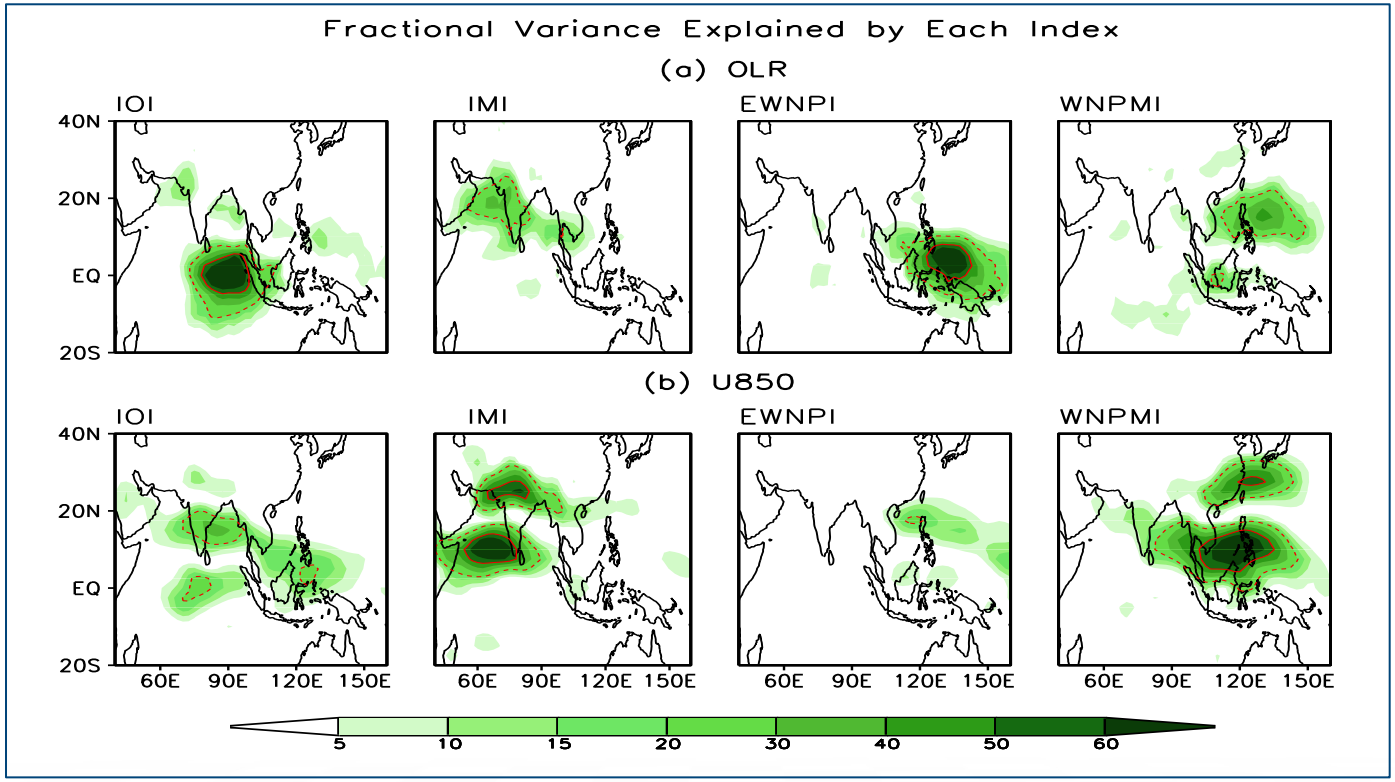
Rainfall anomalies propagate in a eastward fashion and mainly affect the Tropical eastern hemisphere

Rainfall anomalies propagate in a northeast fashion and mainly affect the Tropical eastern hemisphere



Motivation:

Limitation of the regional indices for representing BS MISO



Regional Monsoon ISO Indices

- IOI (Indian Ocean Index): OLR(80-100E, 5S-5N)
- IMI (Indian Monsoon Index, Wang et al. 2001): U850 (40-80E, 5-15N) – U850 (60-90E, 20-30N)
- EWNPI (Equatorial WNP Index): OLR(125-140E, Eq-7.5N)
- WNPMI (Western North Pacific Monsoon Index, Wang and Fan 1999):
  U850 (90-130E, 5-15N) - U850 (110-140E, 22.5-32.5N)

Can one design a better index to describe boreal summer MISO?

Process to define the MISO index

Data Process

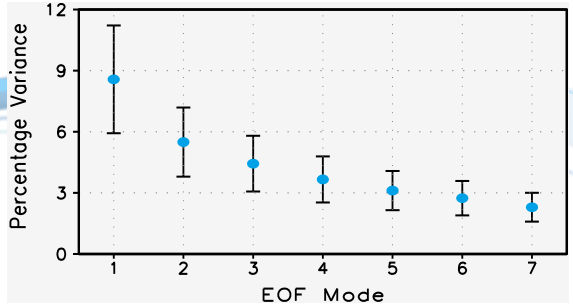
- **Variables :** daily **OLR and U850**
- **Data Period**: **MJJAS 1981-2010**
- Removal of the first 3 harmonics in climatological annual cycle
- Removal of the effect of ENSO signal through subtracting last 120 day mean
- Normalization of each of two fields by area averaged temporal standard deviation (The ASM standard deviation is 27.58 W m^{-2} for OLR and 3.62 m s^{-1} for U850)
- **MISO index:** The first four leading multivariate EOF modes of daily OLR and U850 over the ASM region (10^oS-40^oN, 40^o-150^oE)

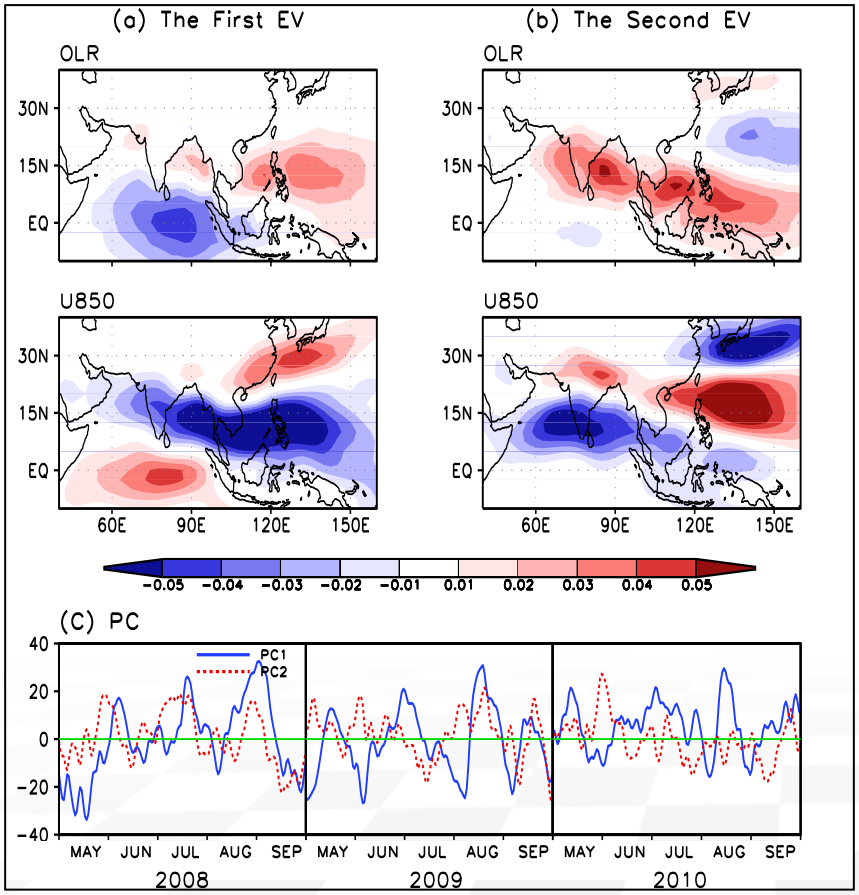
✓ Filtering is not applied to define MISO index for monitor and forecast purpose

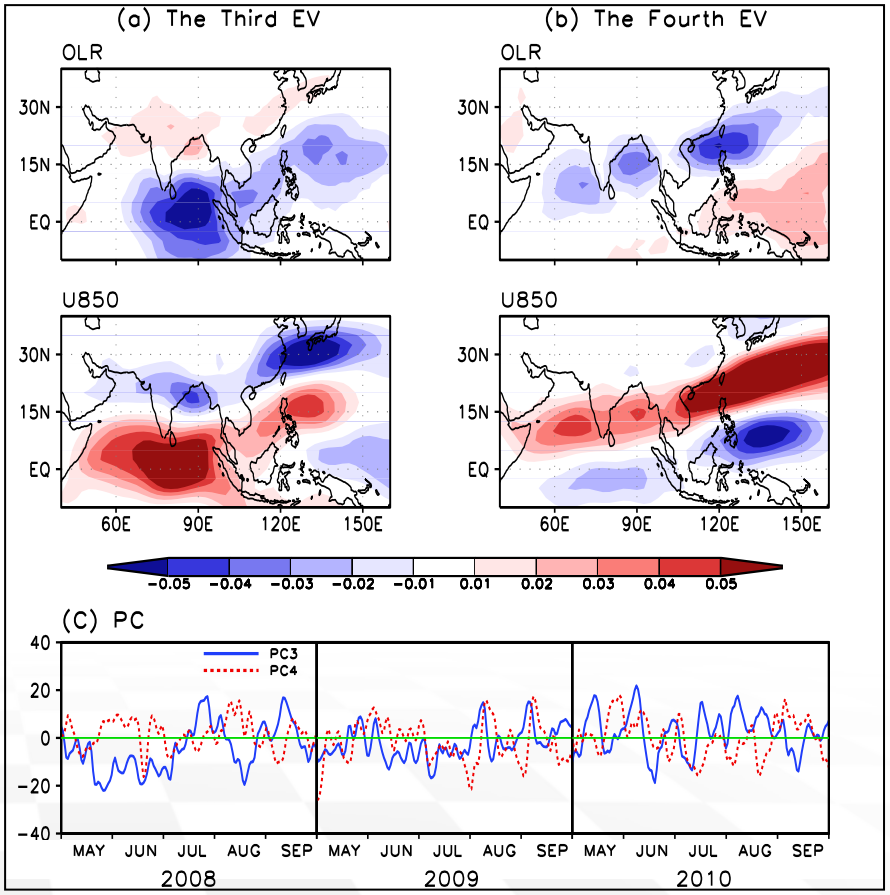
Criterion for Determining the MISO Index

1. **Fractional variance explained by the reconstructed field from the MISO index**
2. **Ability to capture the northward propagating MISO**

MV EOF Modes for BS MISO







Major Northward Propagating MISO mode

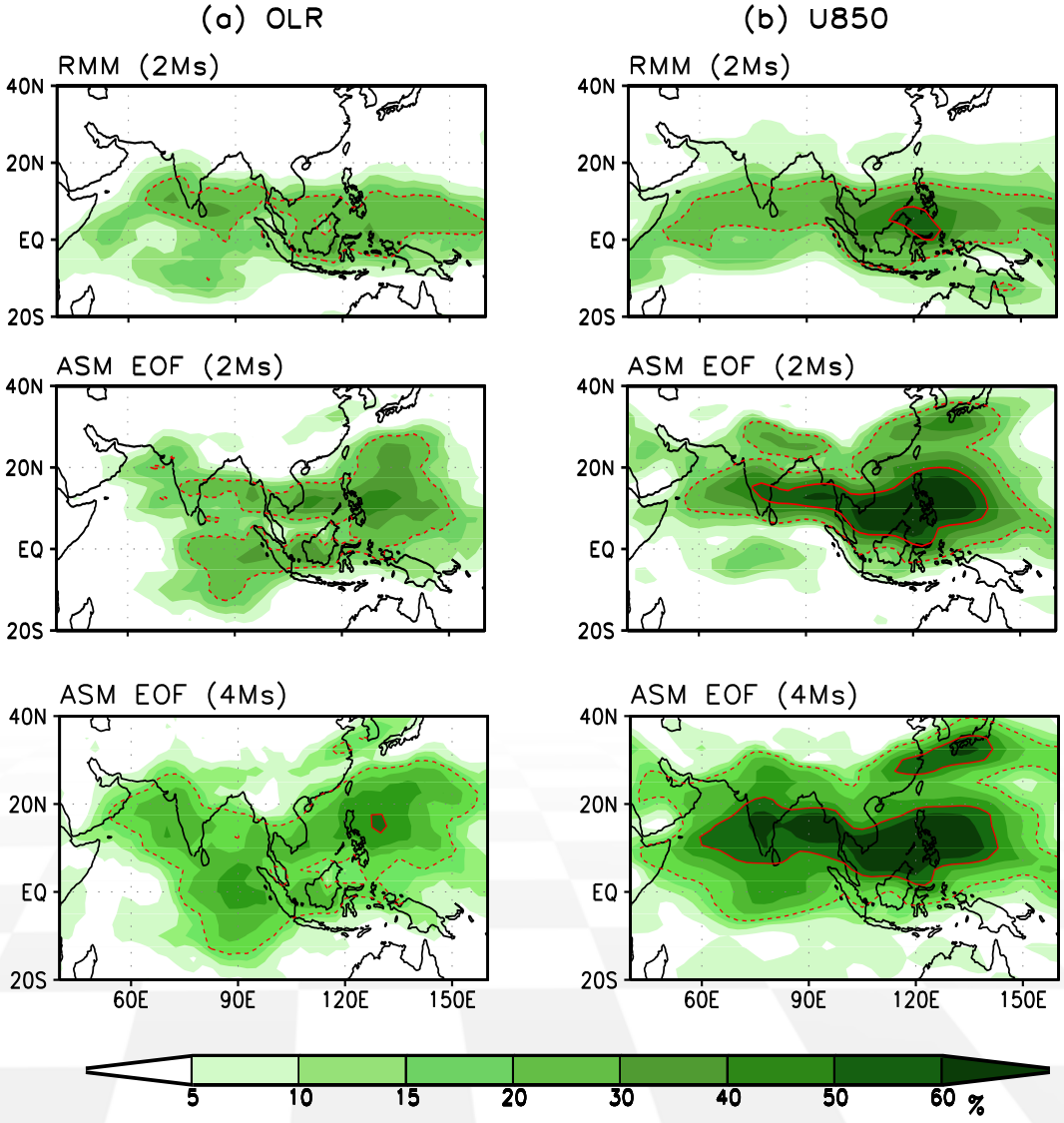
Grand Onset mode (LinHo and Wang 2002)

Fractional Variance
: Comparison between RMM and MISO

RMM Index (2 Modes)

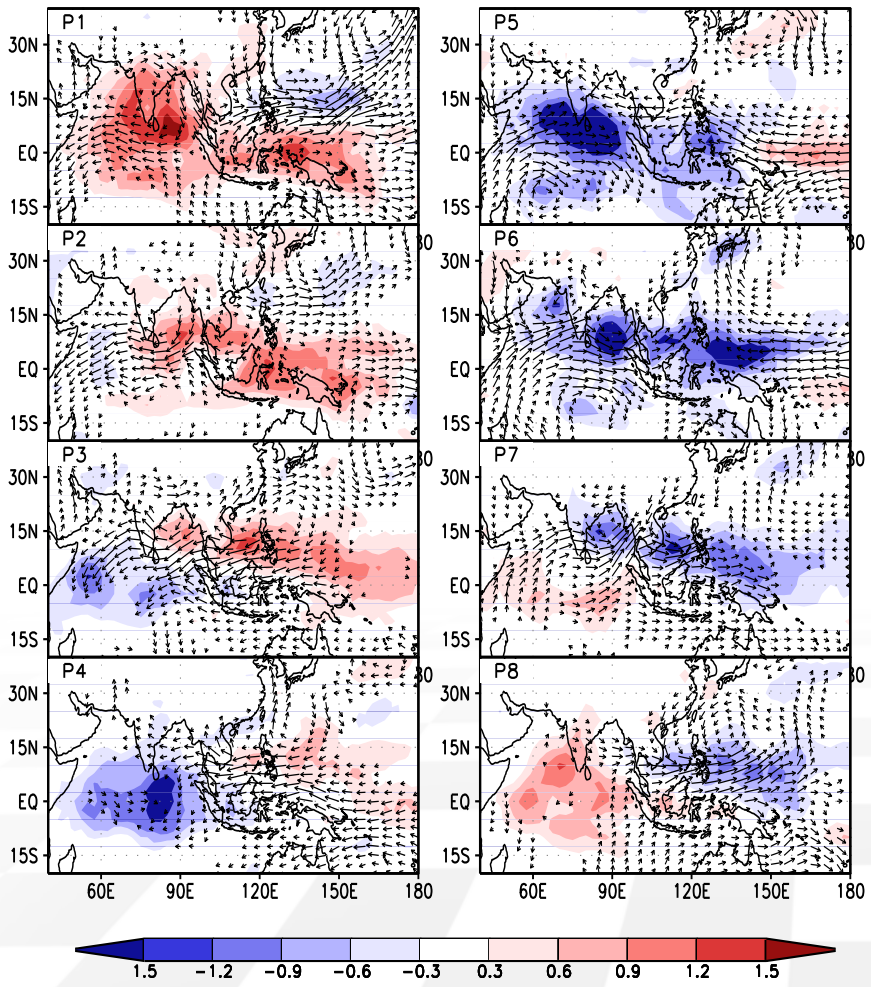
MISO Index (2 Modes)

MISO Index (4 Modes)

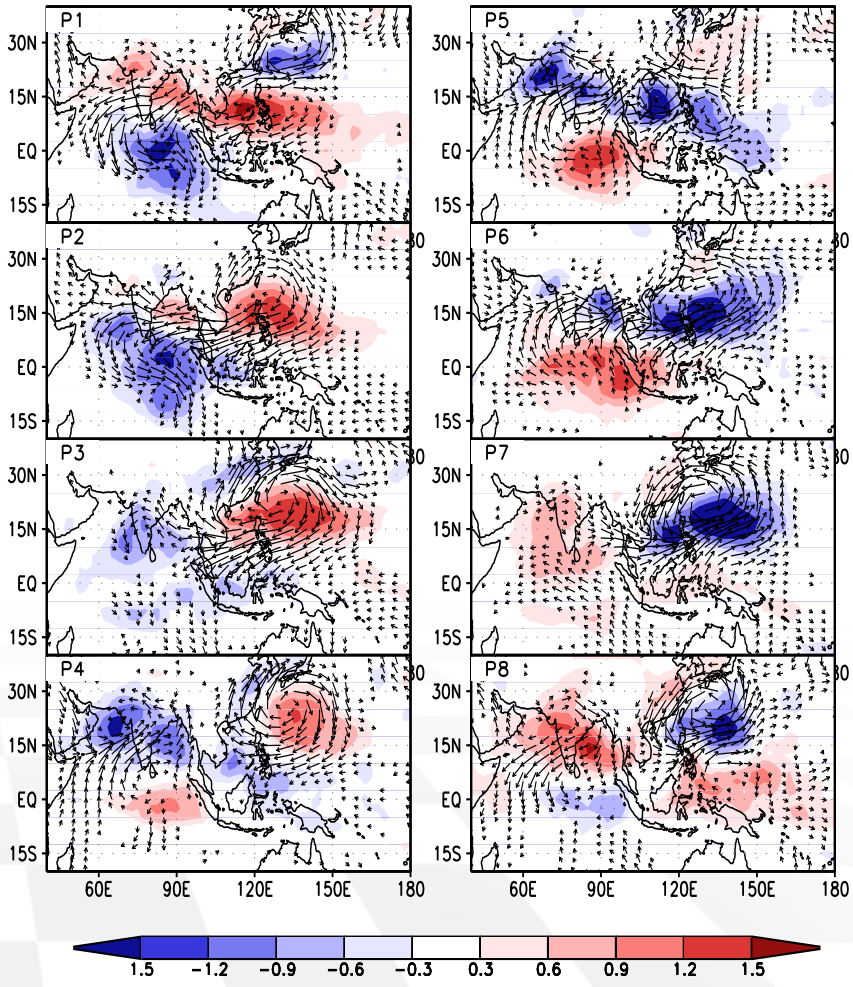


Life Cycle Composite
: Comparison between RMM and MISO

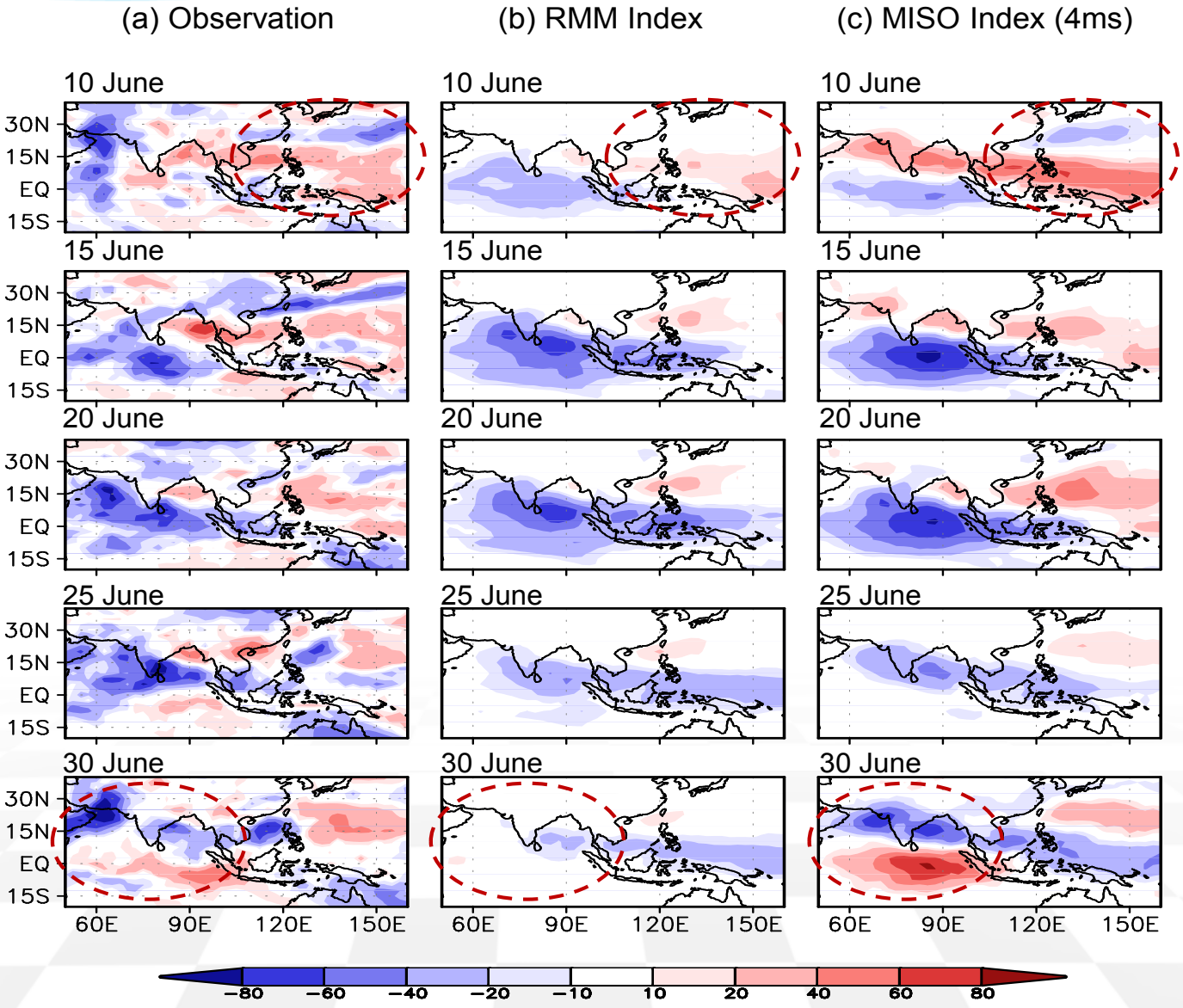
RMM Index



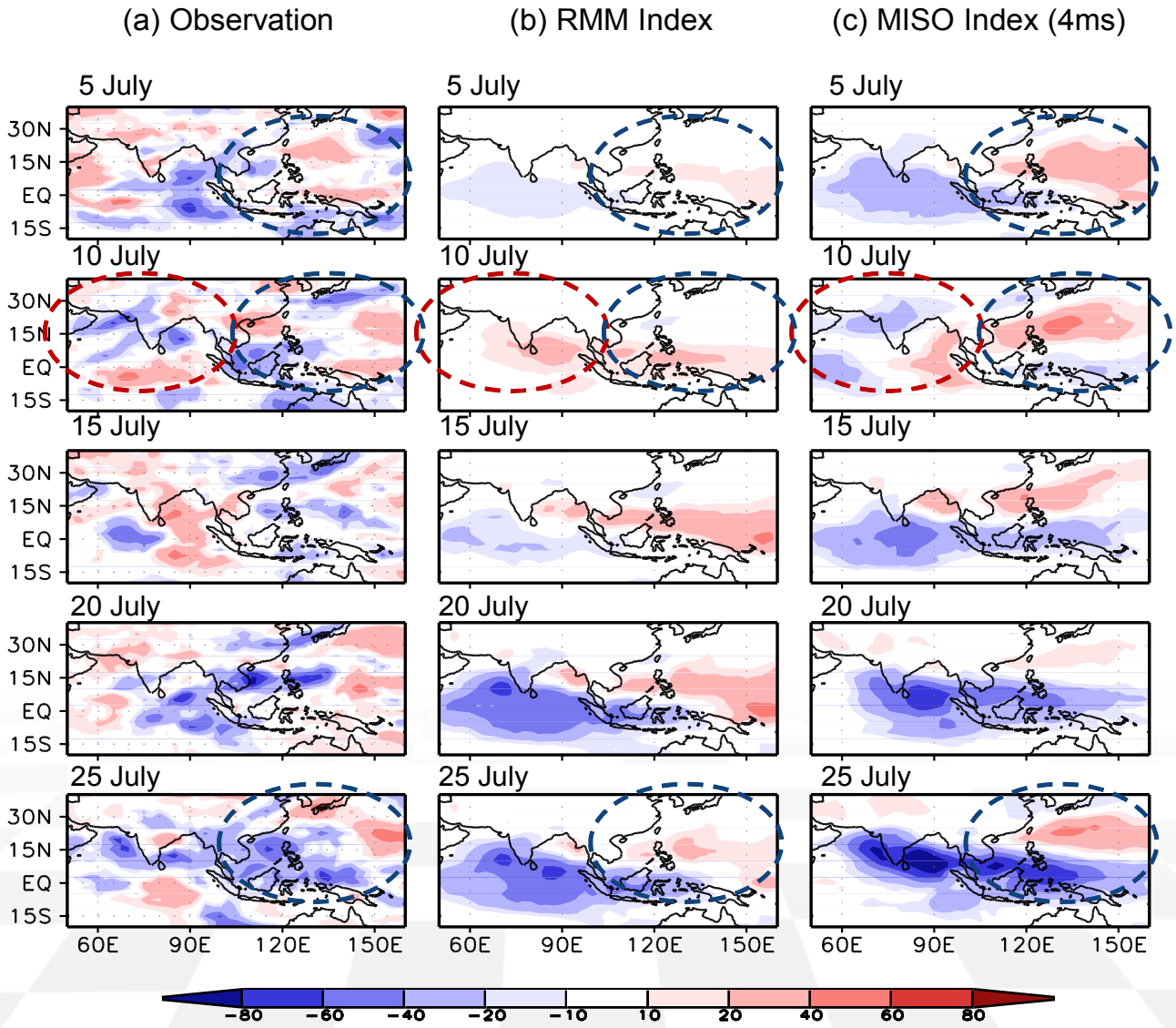
MISO Index



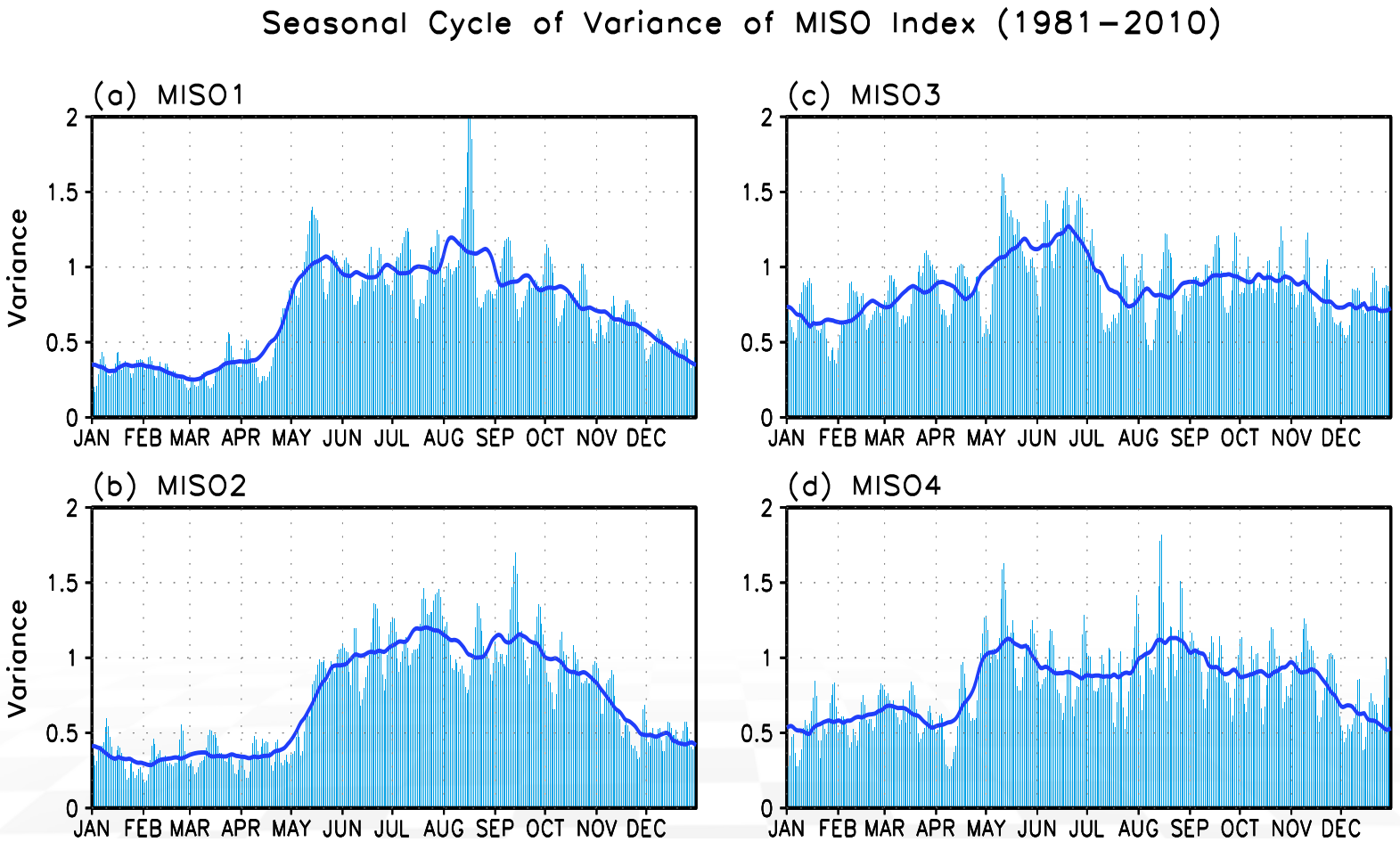
Reconstructed Pentad OLR Anomaly in 2007
: Comparison between RMM and MISO



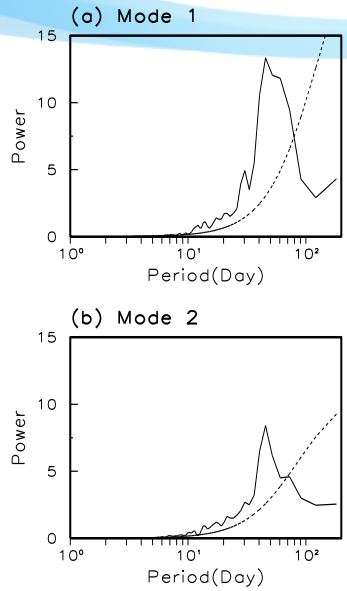
Reconstructed Pentad OLR Anomaly in 2010
: Comparison between RMM and MISO

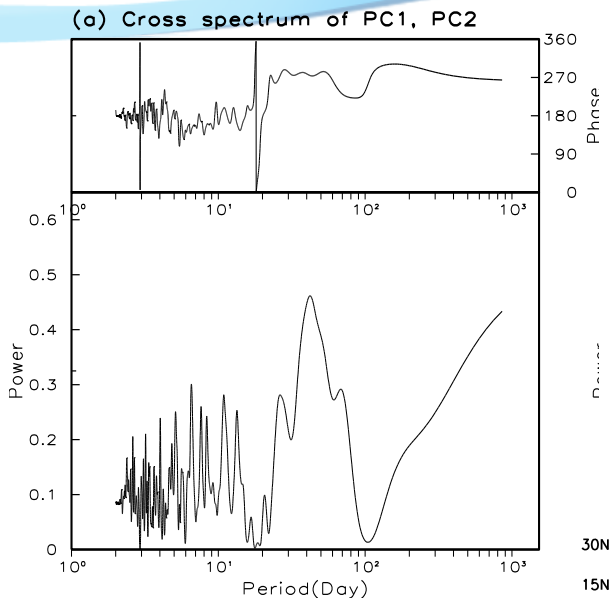


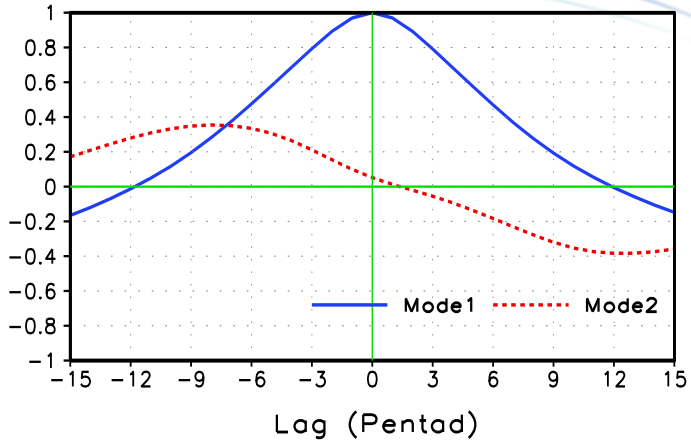
Characteristics of the MISO Index

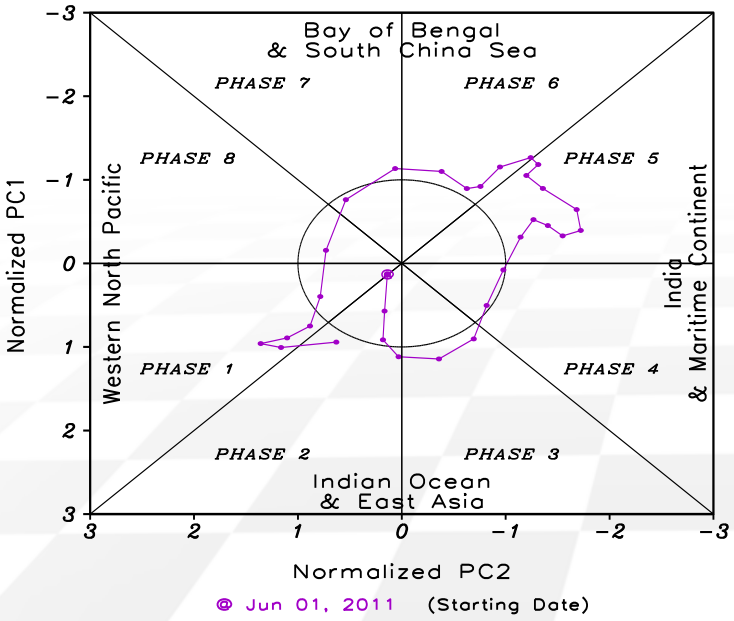


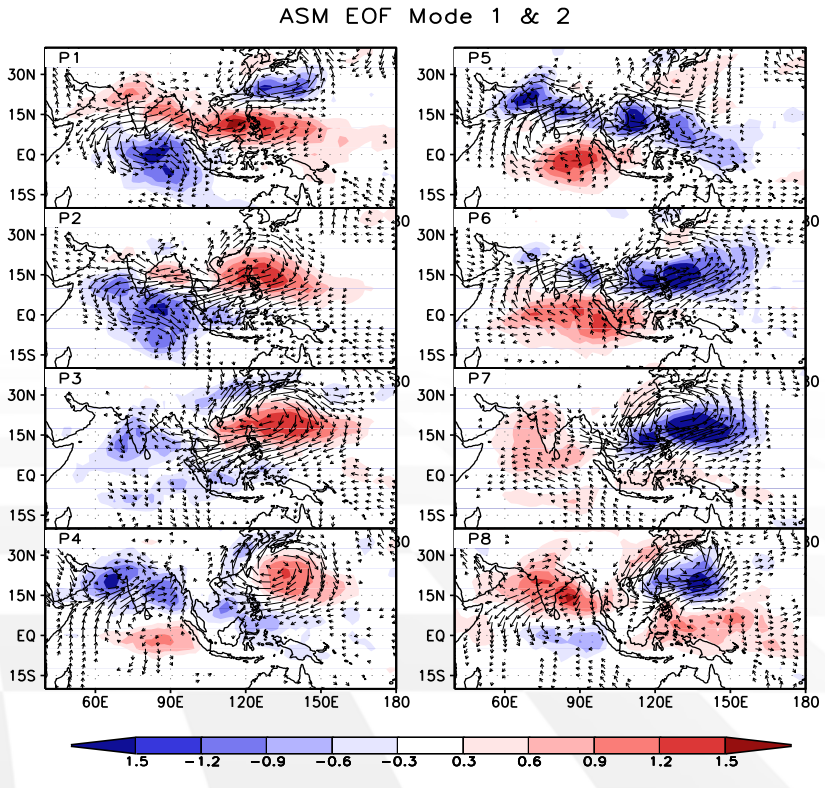
MISO EOF 1 & 2


(a) Mode 1
Power
Period(Day)
(b) Mode 2
Power
Period(Day)

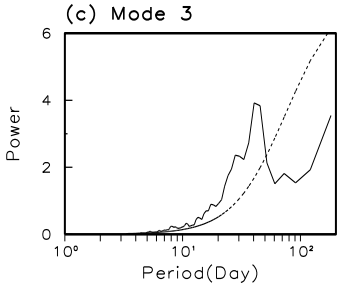

(a) Cross spectrum of PC1, PC2
Phase
Power
Period(Day)

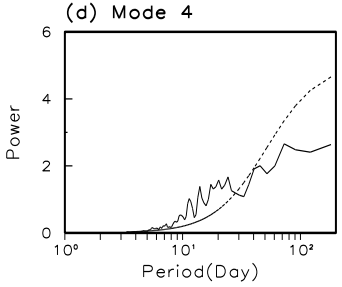

Mode1
Mode2
Lag (Pentad)

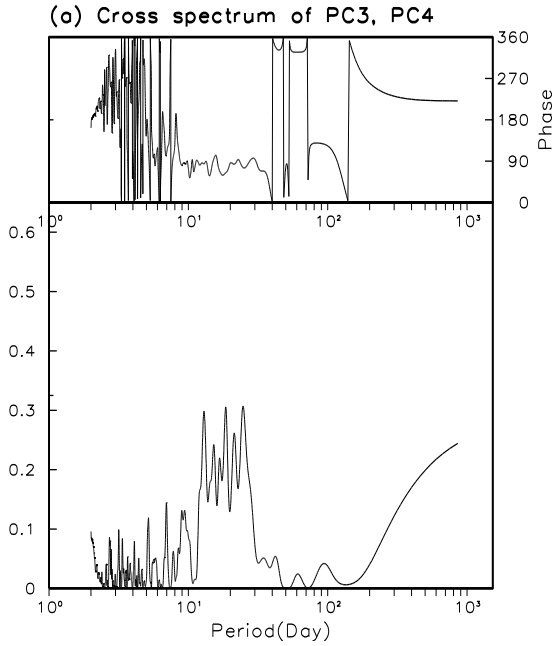

Bay of Bengal
& South China Sea
PHASE 7
PHASE 6
PHASE 8
PHASE 5
Western North Pacific
India
& Maritime Continent
PHASE 1
PHASE 4
PHASE 2
PHASE 3
Indian Ocean
& East Asia
Normalized PC1
Normalized PC2
@ Jun 01, 2011 (Starting Date)

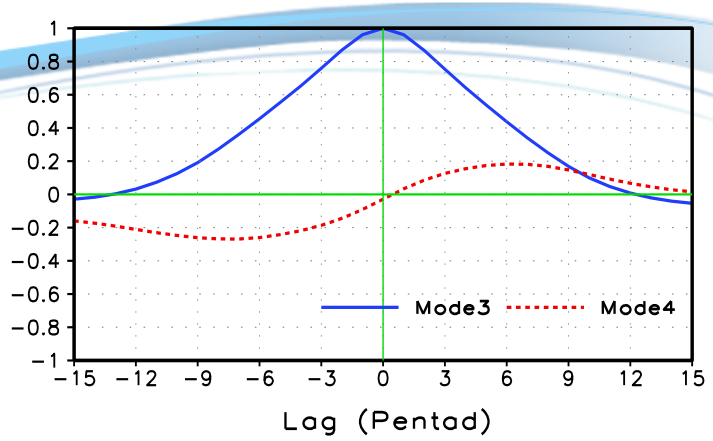

ASM EOF Mode 1 & 2
P1
P2
P3
P4
P5
P6
P7
P8
30N
15N
EQ
15S
60E
90E
120E
150E
180
1.5
-1.2
-0.9
-0.6
-0.3
0.3
0.6
0.9
1.2
1.5

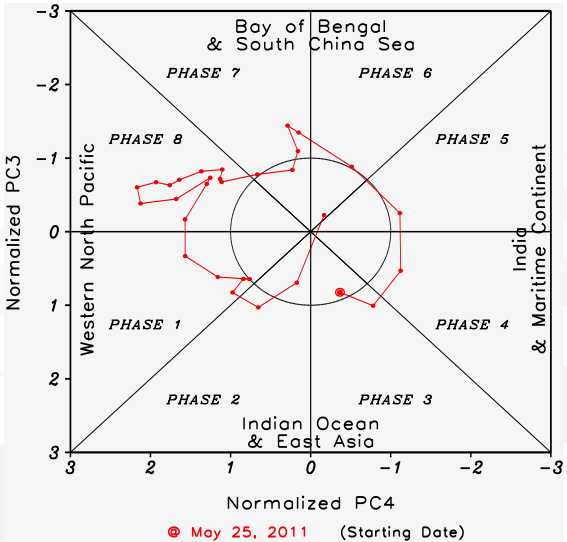
MISO EOF 3 & 4

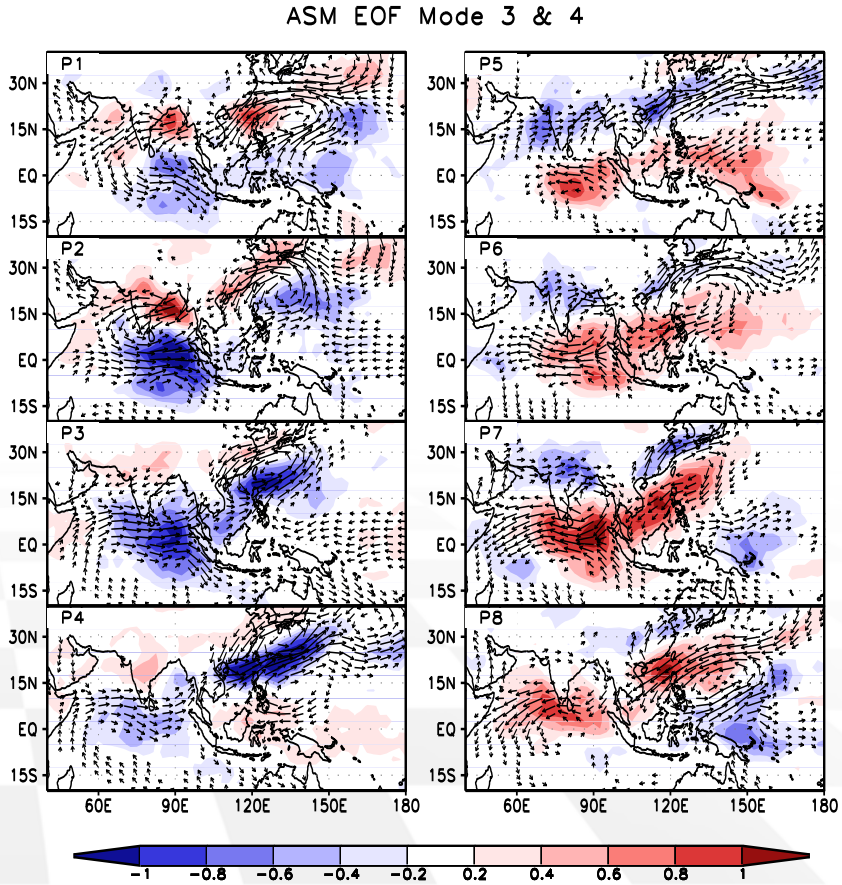

(c) Mode 3
Power
Period(Day)


(d) Mode 4
Power
Period(Day)

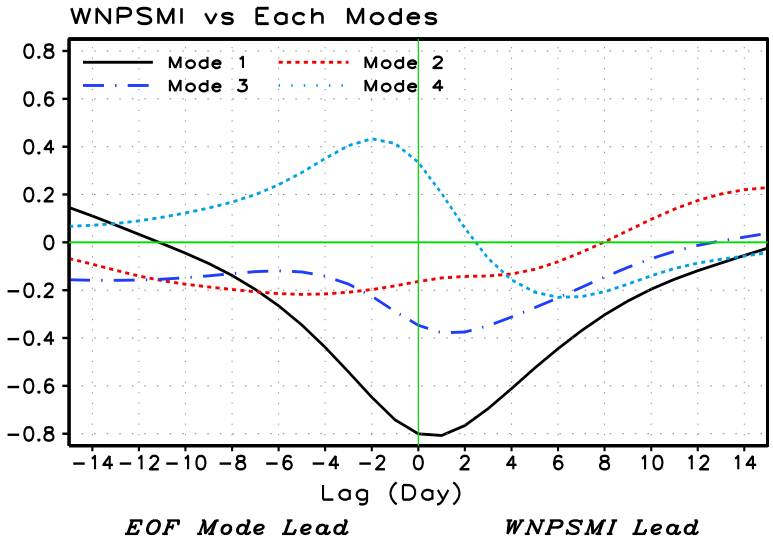

(a) Cross spectrum of PC3, PC4
Phase
Period(Day)

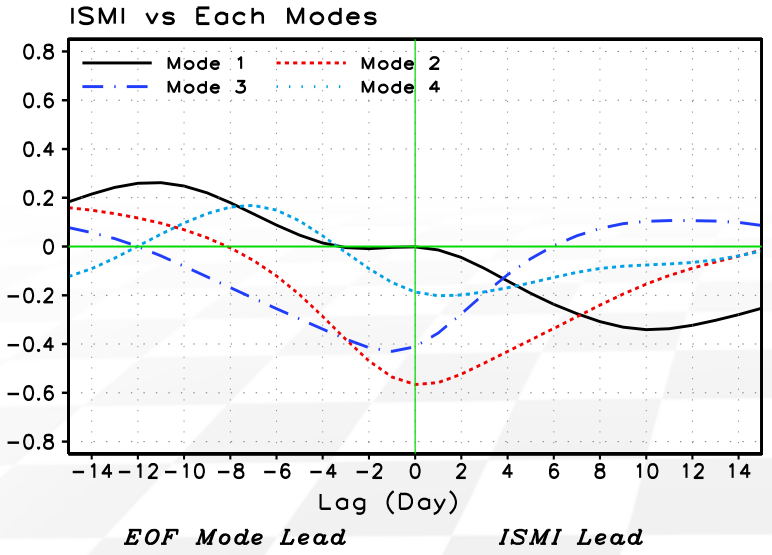

Mode3
Mode4
Lag (Pentad)

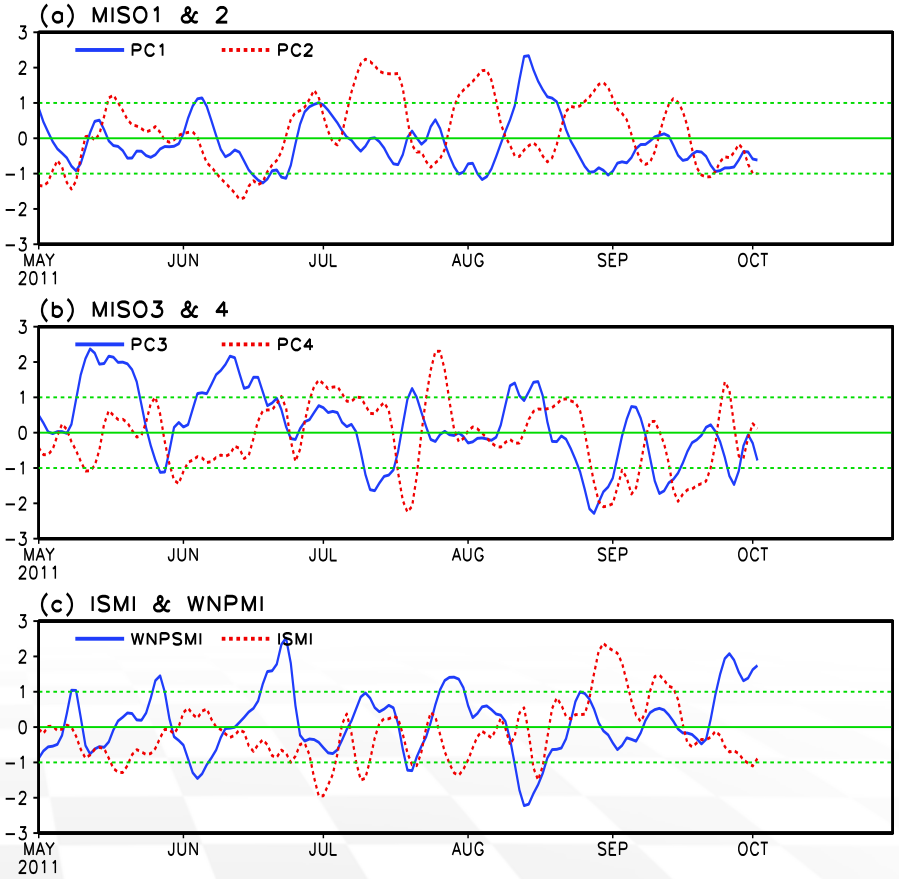

Bay of Bengal
& South China Sea
PHASE 7
PHASE 6
PHASE 8
PHASE 5
PHASE 1
PHASE 4
PHASE 2
PHASE 3
Indian Ocean
& East Asia
Western North Pacific
India
& Maritime Continent
Normalized PC3
Normalized PC4
@ May 25, 2011 (Starting Date)


ASM EOF Mode 3 & 4
P1
P2
P3
P4
P5
P6
P7
P8
30N
15N
EQ
15S
60E
90E
120E
150E
180
−1
−0.8
−0.6
−0.4
−0.2
0.2
0.4
0.6
0.8
1

Relationship with Regional Monsoon Indices

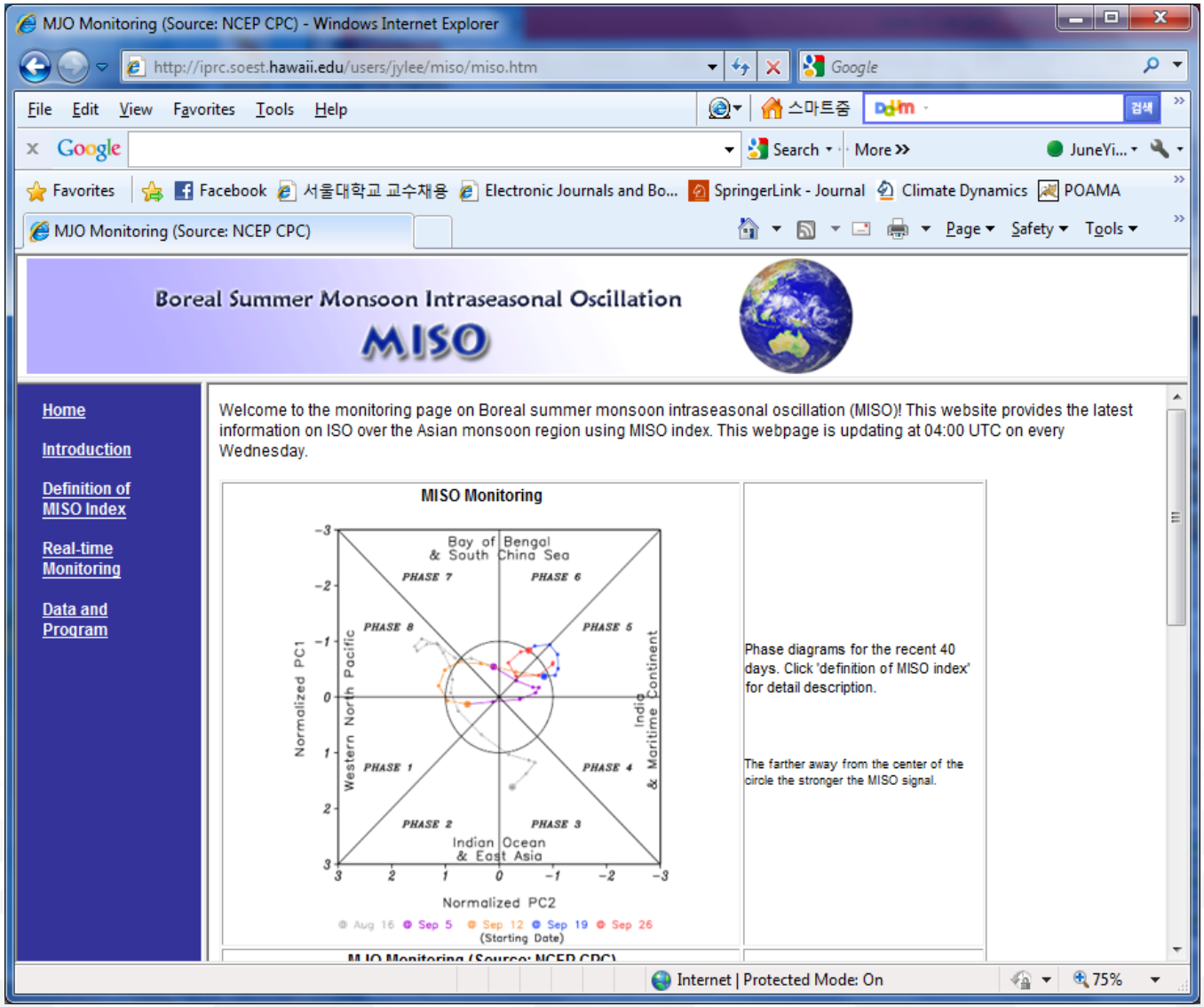






Development of MISO Monitoring Website

http://iprc.soest.hawaii.edu/users/jylee/miso/miso.htm



Summary

We suggest **a new MISO index that is defined by the first four multivariate EOF modes of daily OLR and U850 anomaly** over the ASM region (10°S-40°N, 40°-160°E).

The RMM index captures the OLR variability primarily in the equatorial region whereas **the MISO index captures large portion of the variability in the off-equatorial region**, yielding more realistic variance pattern.

The MISO index describes better ISO variability center and represents better northward as well as eastward propagating pattern in the ASM domain than the RMM index

The northward-propagating MISO component can be monitored using the phase diagram between the first and second PC similar as the eastward-propagating MJO. Taking into account distinct regional characteristics of MISO with smaller horizontal scale than MJO, the reconstructed field from the first four modes may provide more useful information.

Thank You!

Boreal Summer Monsoon Intraseasonal Oscillation

MISO

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ISVHE

CLIVAR/ISVHE

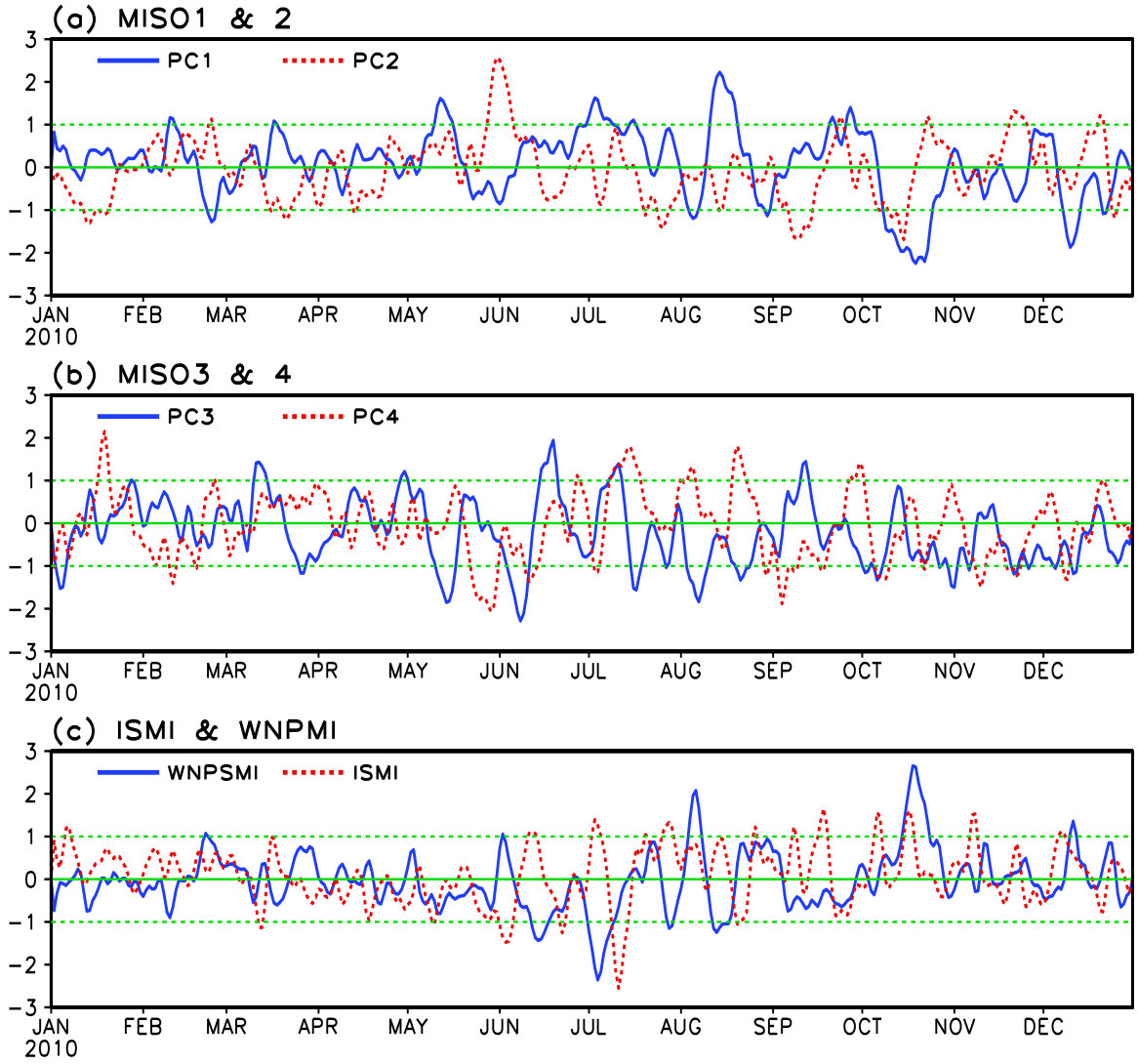
Intraseasonal Variability Hindcast Experiment

The **ISVHE** is a coordinated multi-institutional ISV hindcast experiment supported by **APCC, NOAA CTB, CLIVAR/AAMP & MJO WG, NOAA CTB, and AMY.**

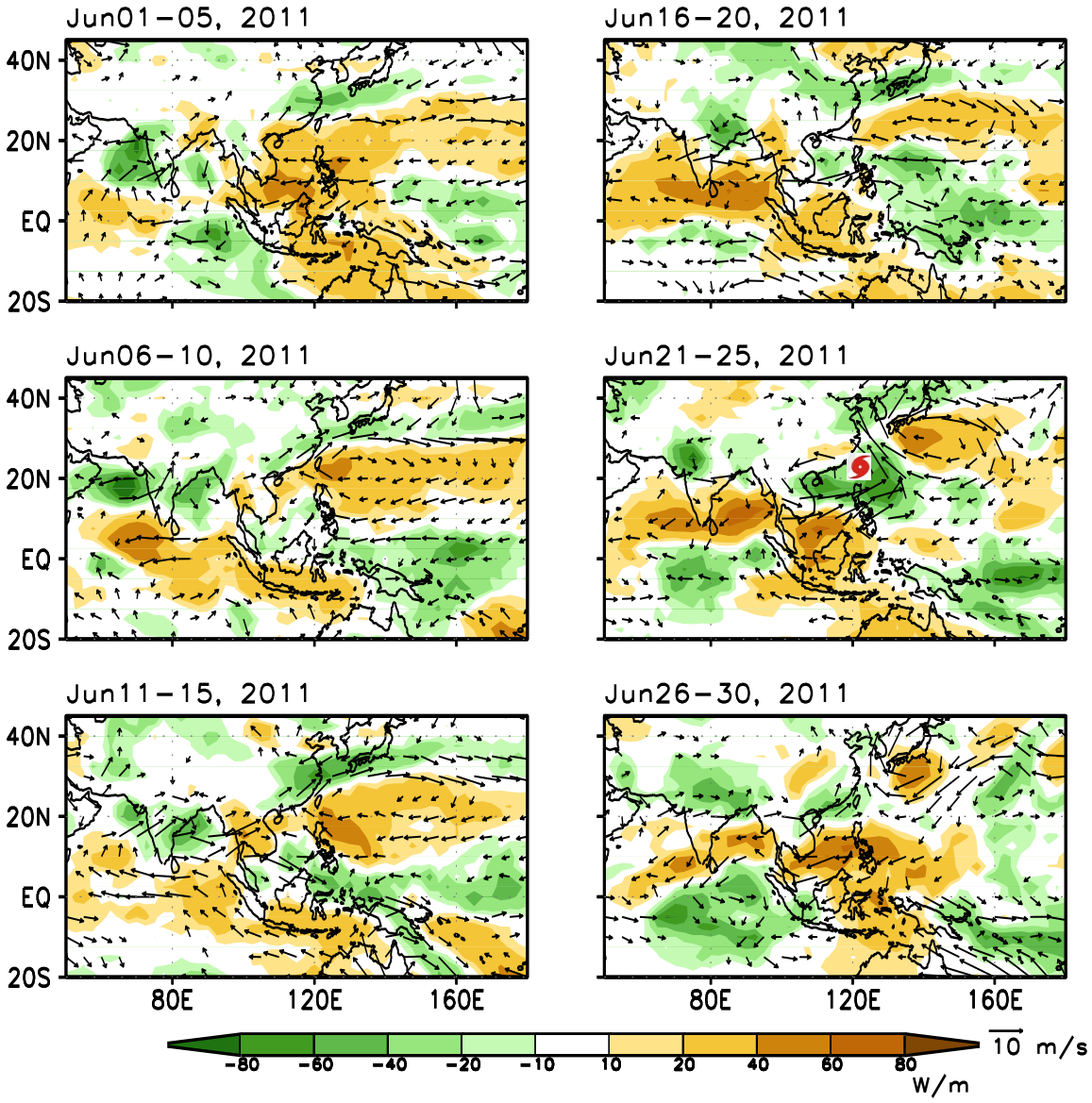
http://iprc.soest.hawaii.edu/users/jylee/clipas.htm

Supporters

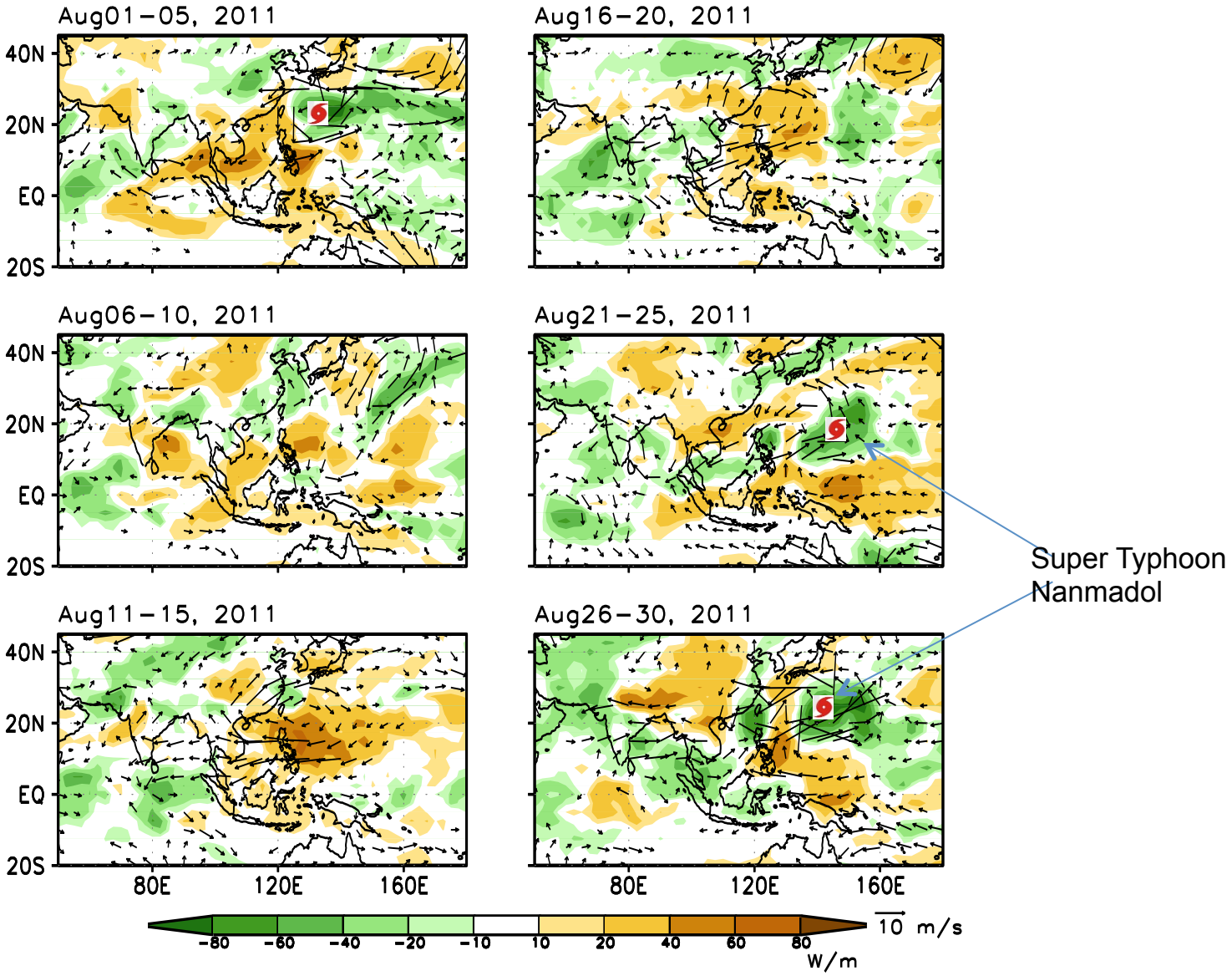
Normalized Monsoon Indices/ 2010



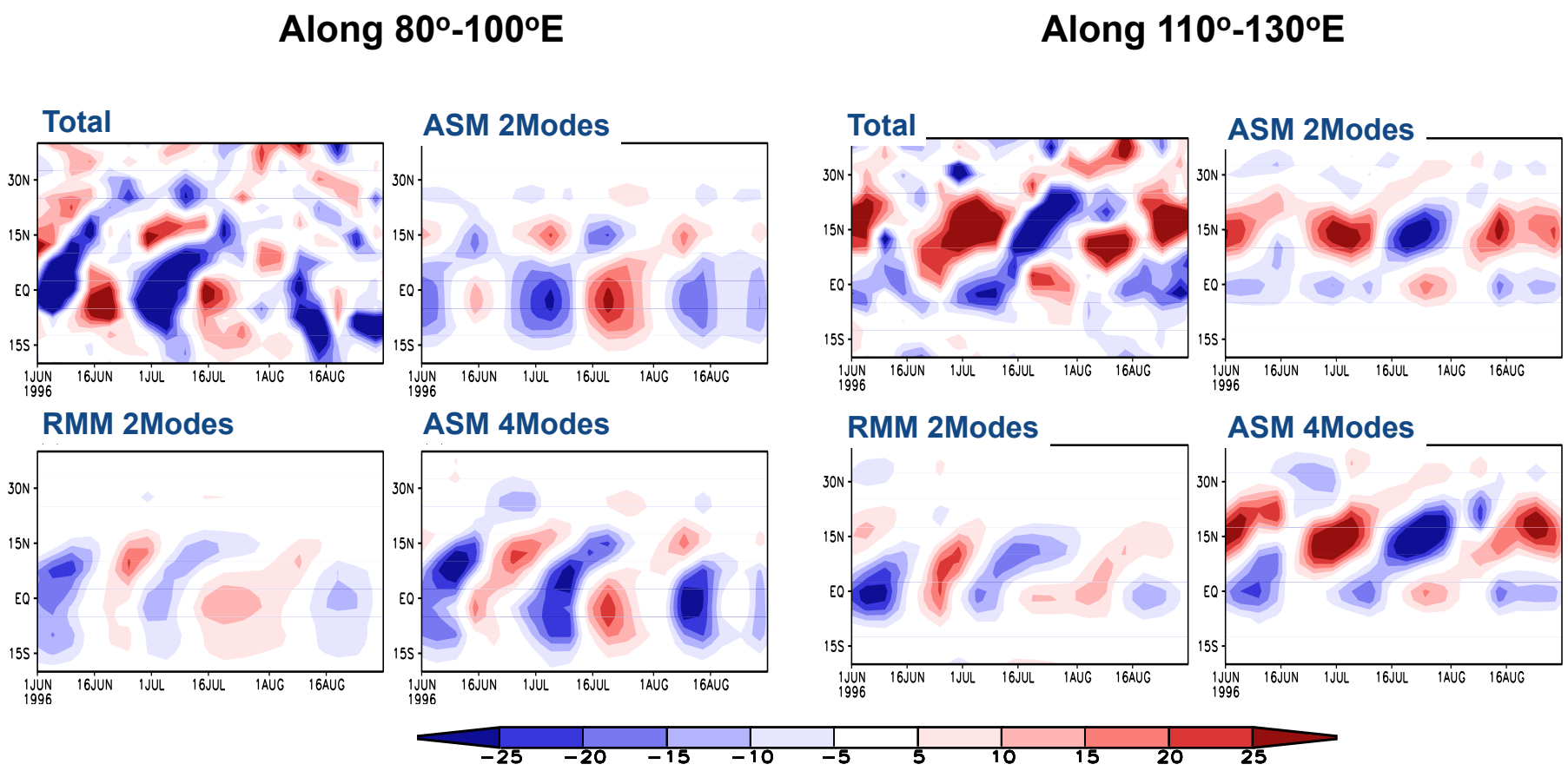
OLR and 850-hPa Wind Anomaly / June 2011



OLR and 850-hPa Wind Anomaly / Aug 2011



Northward Propagation of Pentad OLR Anomaly



ASM EOF 4 modes better capture northward propagation of pentad OLR anomaly.