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# Dynamics of Boreal Summer Intraseasonal Variability

*H. Annamalai and K. R. Sperber*

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Climate Variability Over India  
Pune, India  
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# **Dynamics of Boreal Summer Intraseasonal Variability**

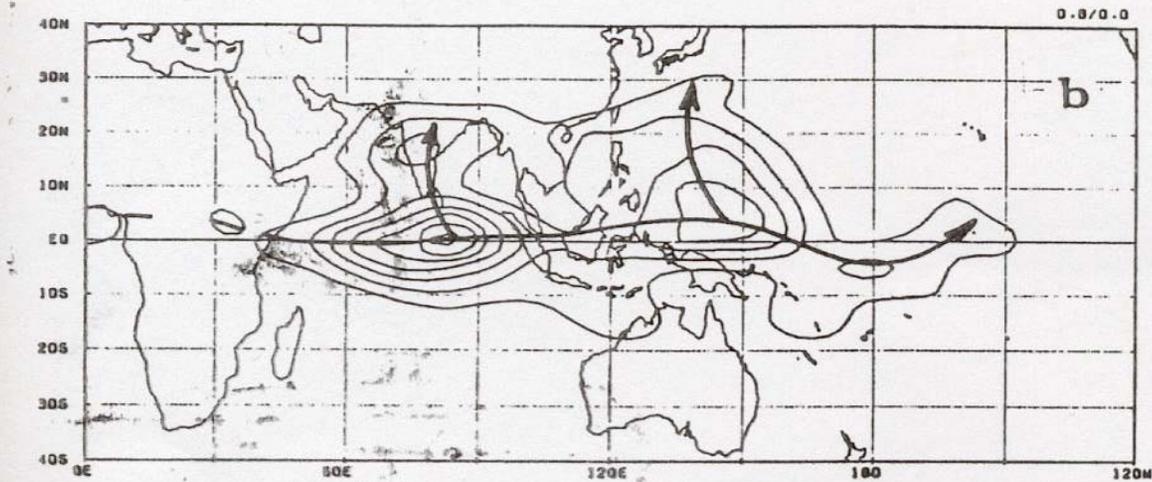
**H. Annamalai\* and K.R. Sperber#**

**\* International Pacific Research Center (IPRC)**

**# PCMDI, Lawrence Livermore National Lab.**

K.R. Sperber was supported under the auspices of the U.S. Department of Energy by University of California, Lawrence Livermore National Laboratory under contract W-7405-Eng-48.

## Wang and Rui (1990)



Three modes  
of BSISV

# Life-cycle of 30-50 day mode: POP analysis on OLR

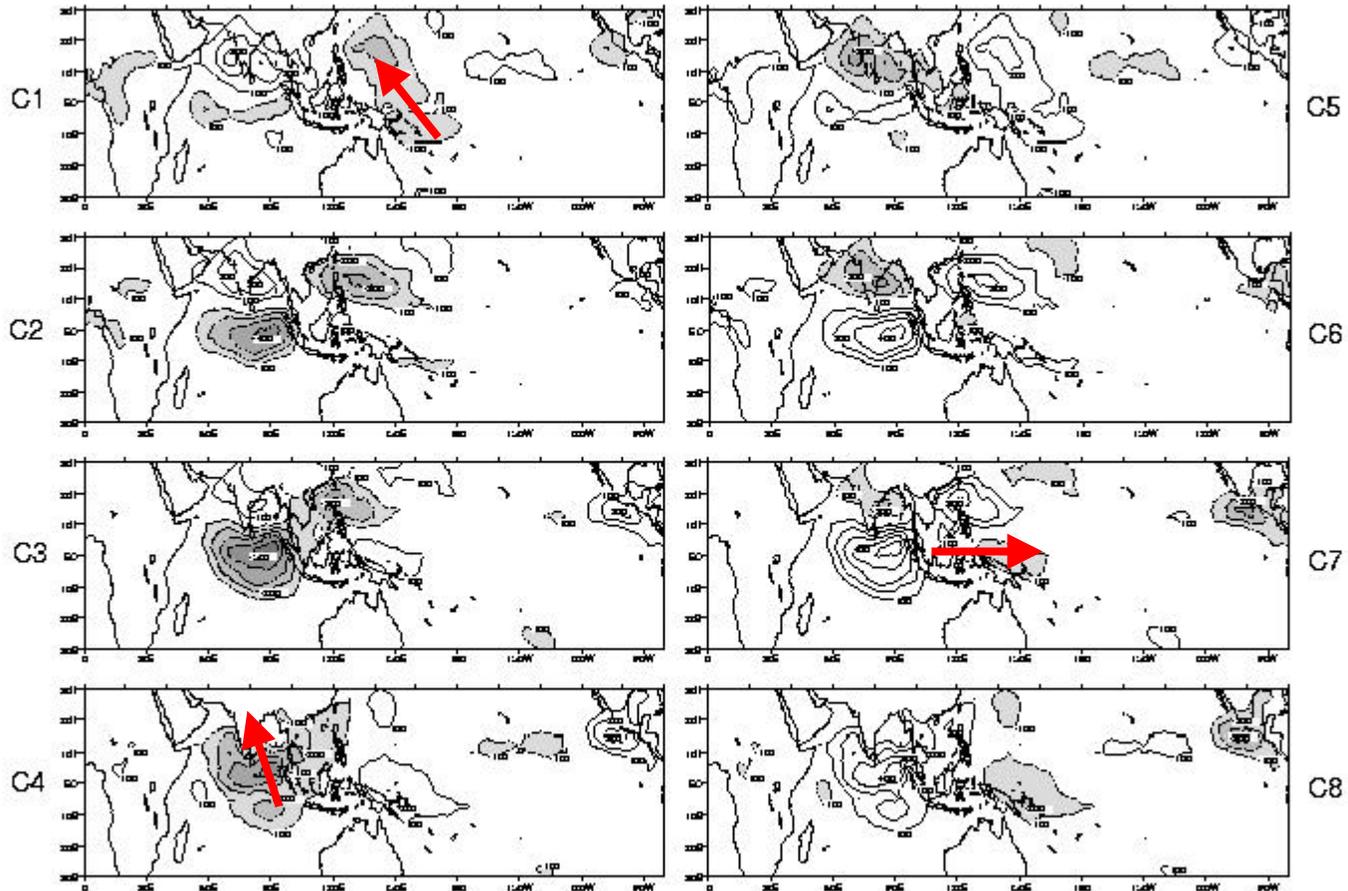


Figure 10

**Annamalai and Slingo (2001, Climate Dynamics)**

# Main Focus

**Mutual influence among the three modes**

**Convective and circulation anomalies over the west Pacific exert considerable influence on the convective and circulation anomalies over the Indian longitudes and vice-versa.**

# Data

- (i) NCEP-NCAR reanalysis (1979-95)**
- (ii) Daily OLR from AVHRR**
- (iii) Pentad rainfall from CMAP**

# Method

CsEOF (Cyclo-stationary EOF analysis)

## Salient Features

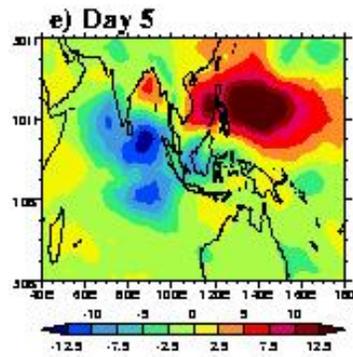
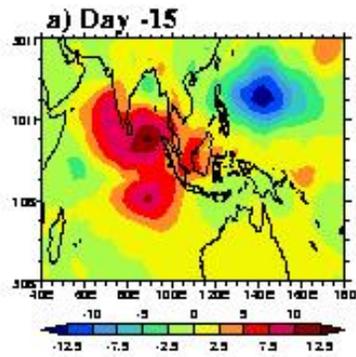
- (a) extract space-time evolution
- (b) nested period
- (c) high-frequency is built in the spatial domain
- (d) PCs represent low-frequency part – not useful for regression analysis.

# Simple Linear Atmospheric Model

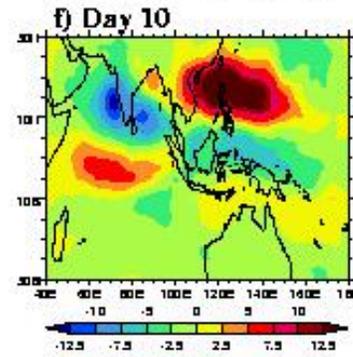
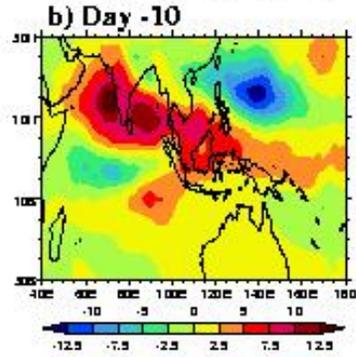
(Watanabe and Kimoto (2000))

- Global, time-dependent, primitive-equation model
- Linearized about the boreal fall observed climatology
- Horizontal Resolution T21, with 20 vertical levels
- Diabatic heating proportional to OLR/Precipitation anomalies  
used as forcing

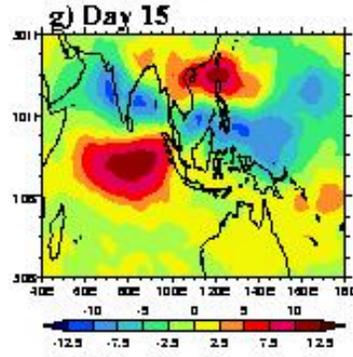
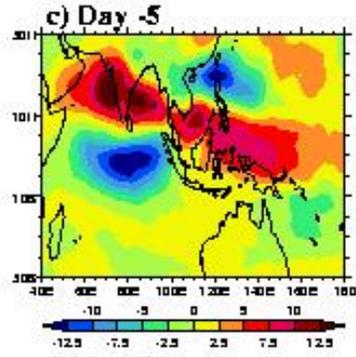
**Initiation**



**Poleward - India**

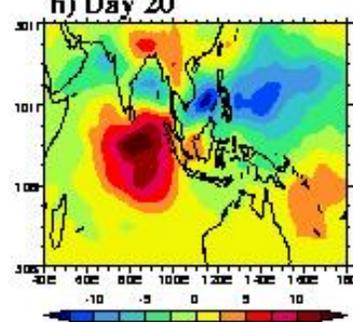
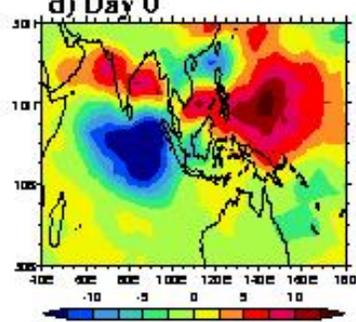


**Eastward – W. Pacific**



**Quadra-pole**

**Amplification**



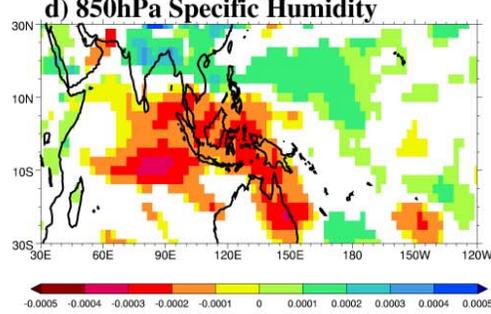
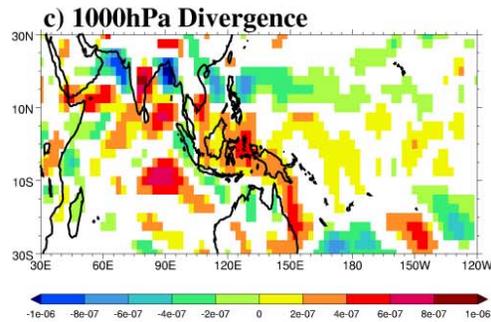
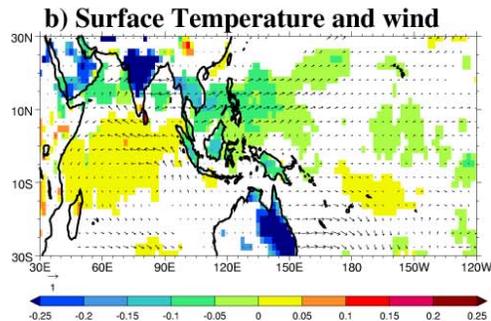
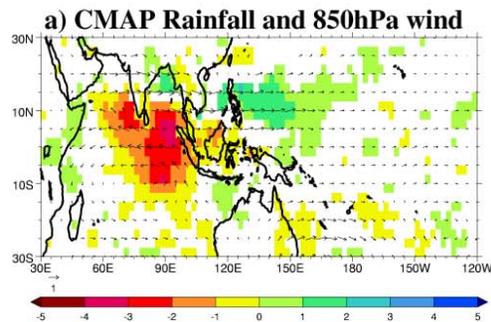
**Poleward – W. Pacific**

# Major Points

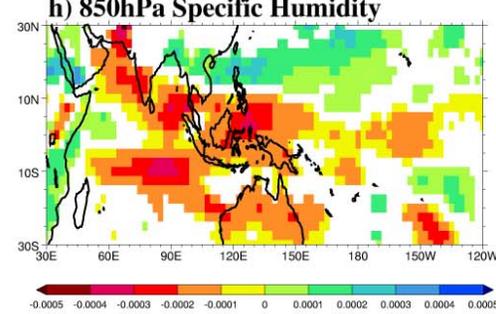
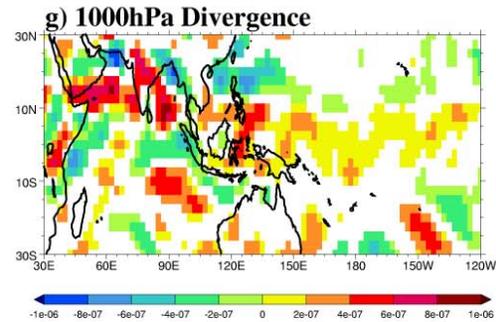
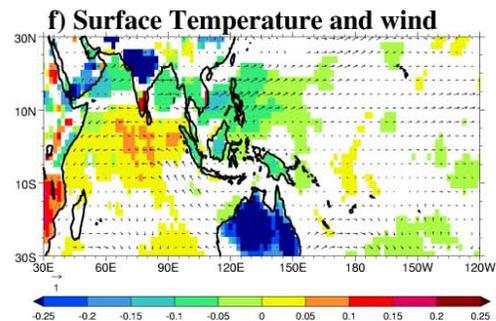
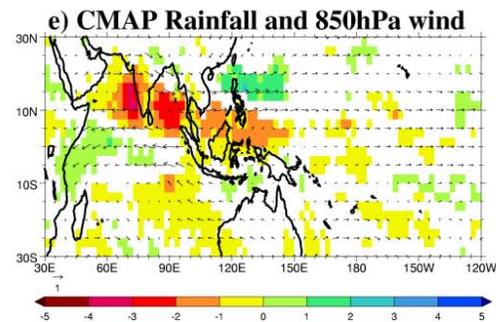
- Initiation of convection over the western Indian Ocean
- Active phase over west Pacific and break initiation over India
- Role of equatorial mode in the active/break phases over west Pacific

**Initiation of convection over  
Western Indian Ocean**

Day -15



Day -10



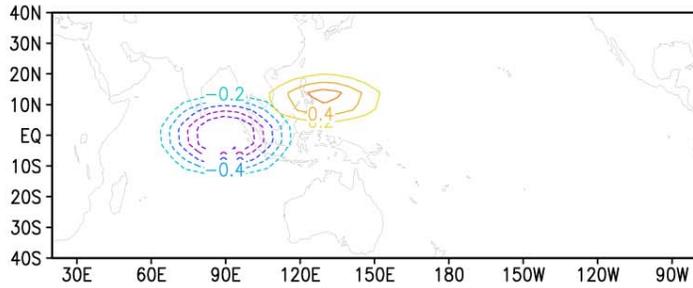
Easterlies – Eq. IO  
Against the mean flow

SST warms – EIO

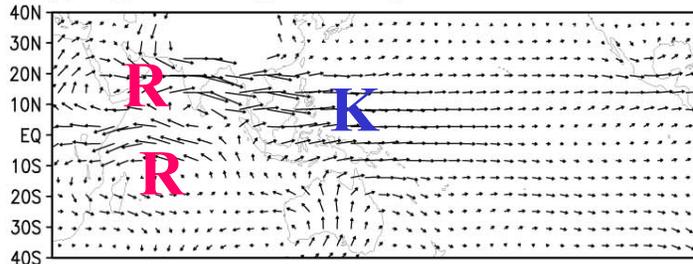
Convergence – WIO

BL Moisture builds up

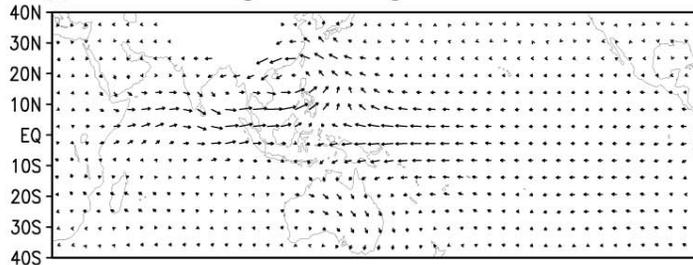
(a) Column Integrated heating



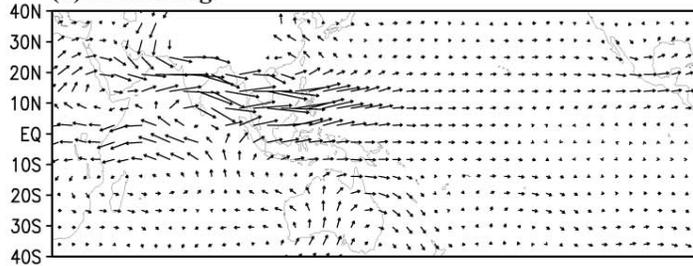
(b) Negative heating over the equatorial Indian Ocean



(c) Positive heating over the tropical west Pacific

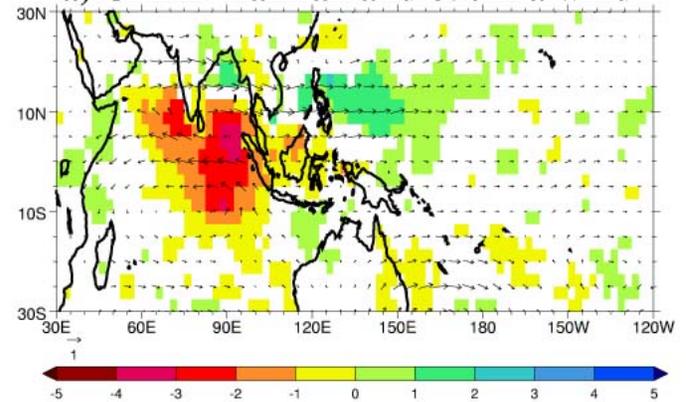


(d) All heatings



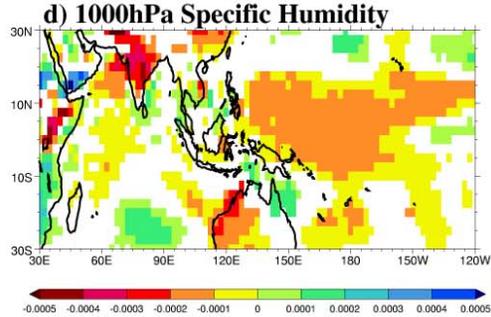
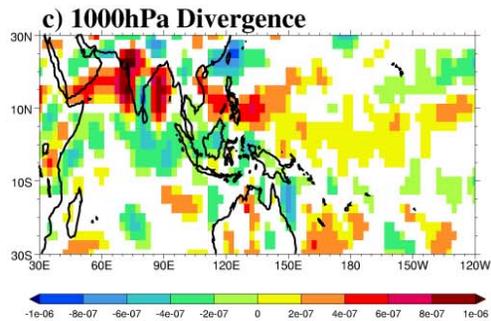
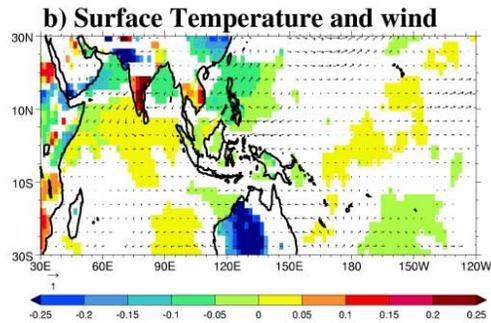
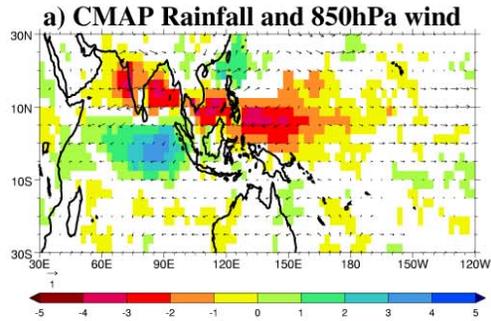
Day -15

a) CMAP Rainfall and 850hPa wind

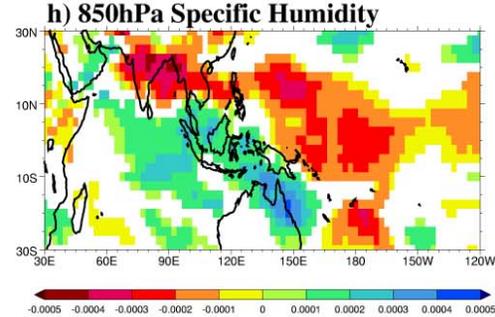
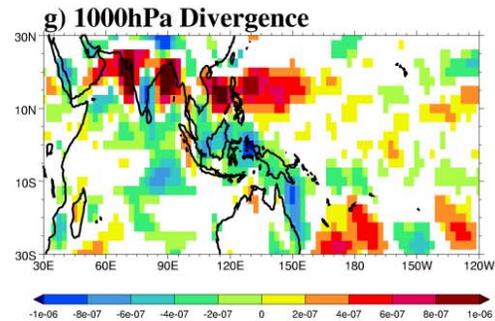
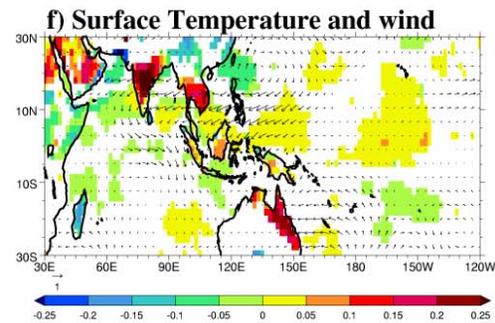
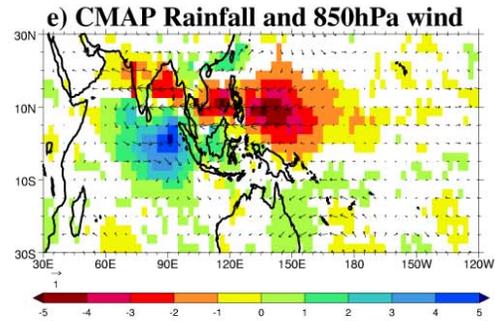


“mimics” observed flow pattern

Day -5



Day 0



**Active phase over west Pacific and**

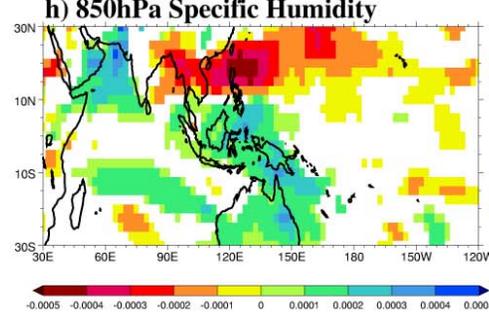
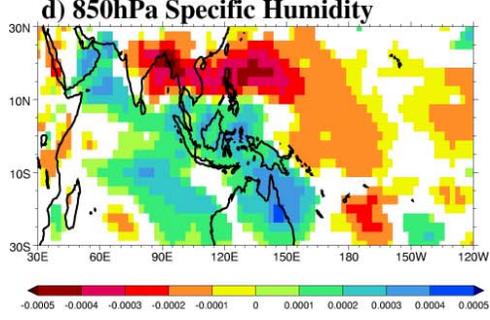
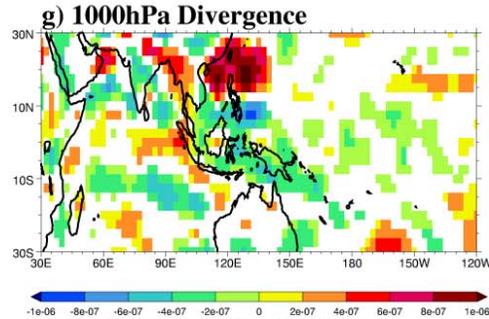
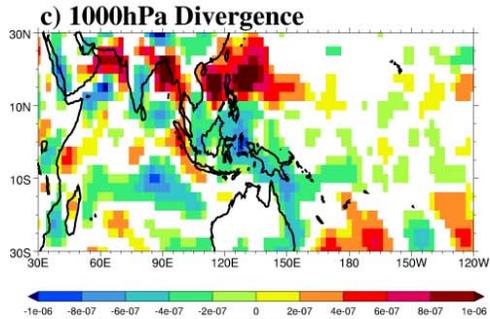
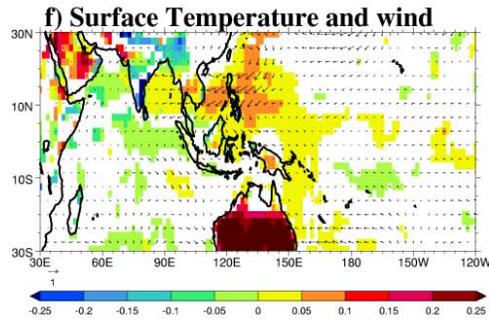
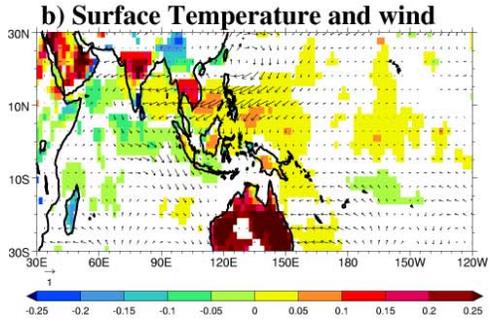
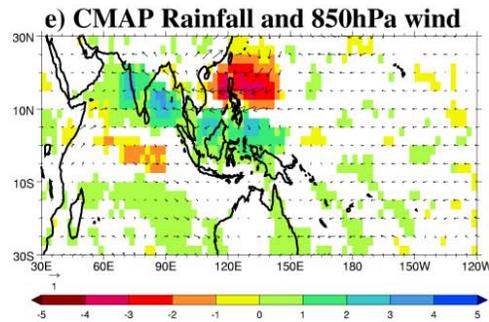
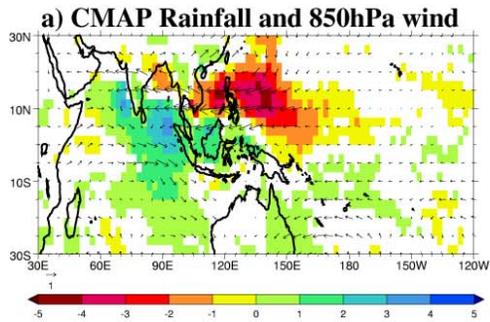
**Break initiation over India**

Day 5

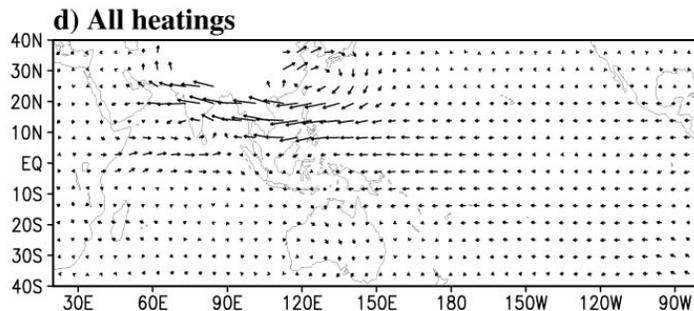
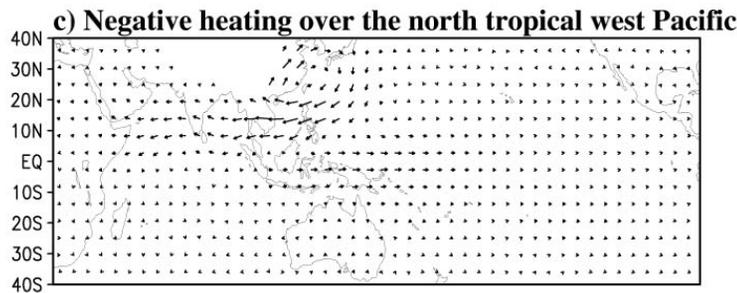
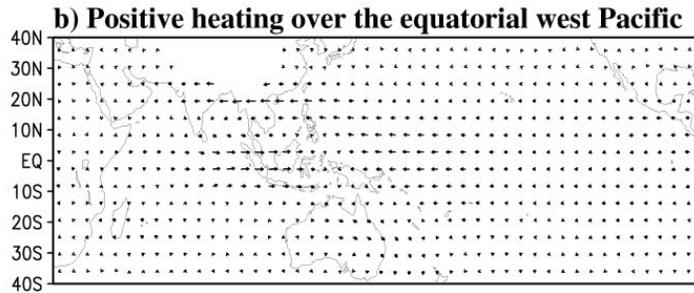
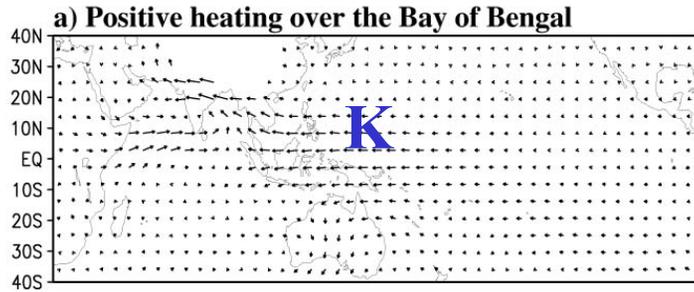
Day 10

Easterlies over W. Pacific  
Against the mean flow

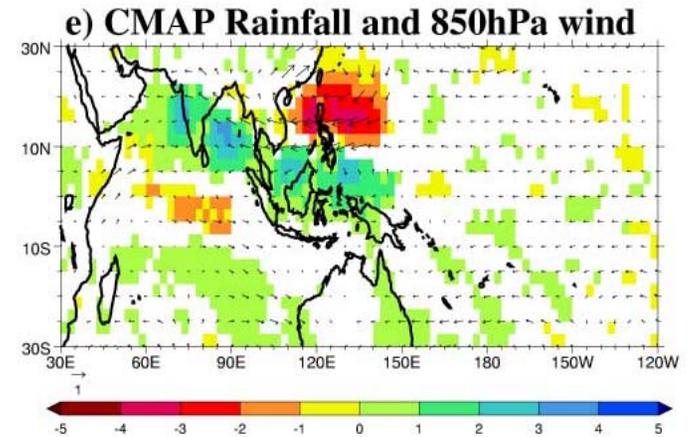
SST warms over W. Pacific  
Amplitude > Eq. IO



# Easterlies over W. Pacific

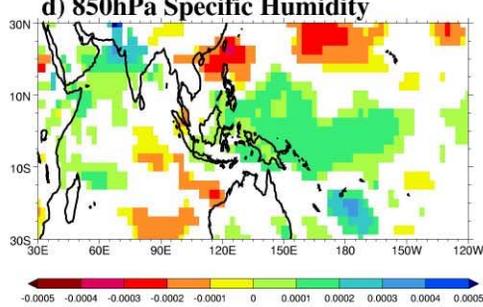
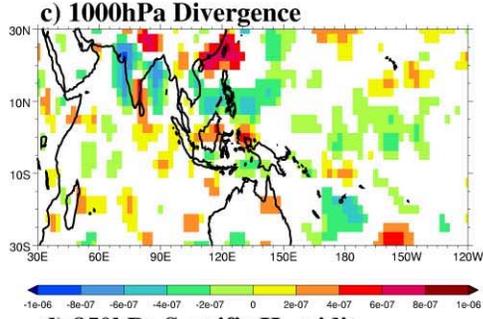
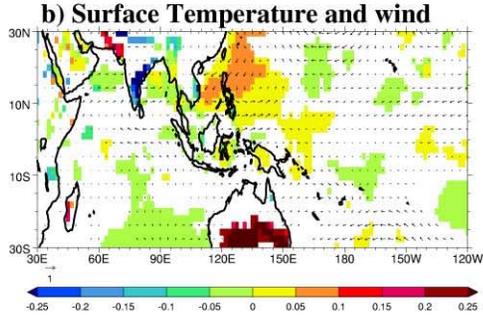
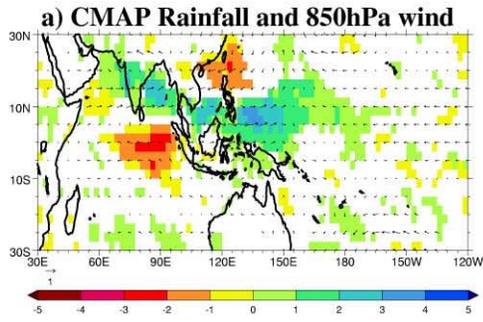


Day 10

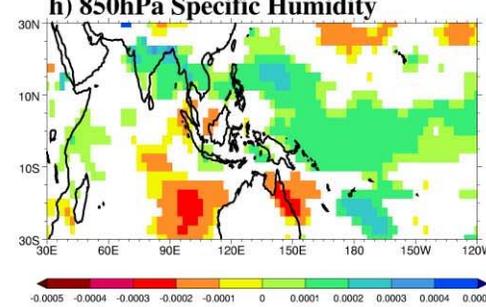
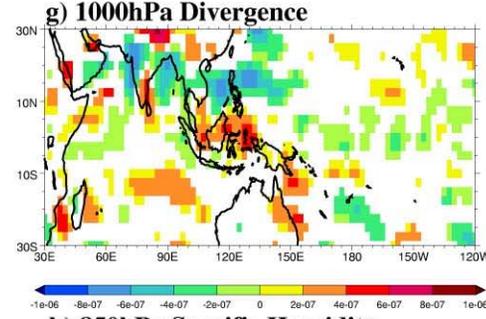
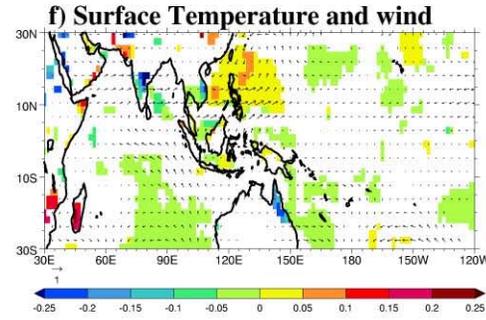
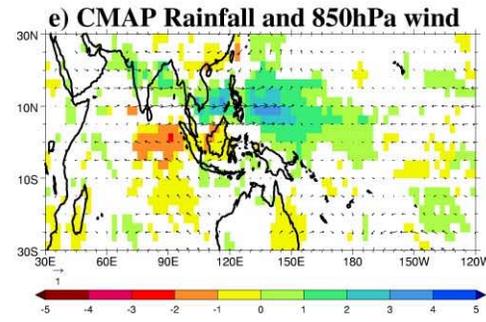


Weaken  
ISM

Day 15

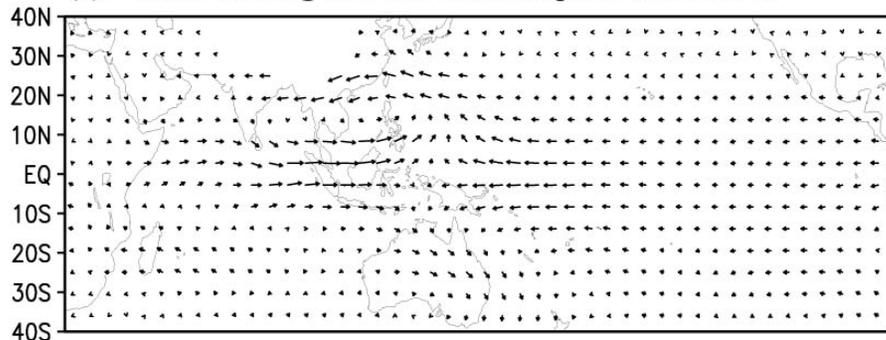


Day 20

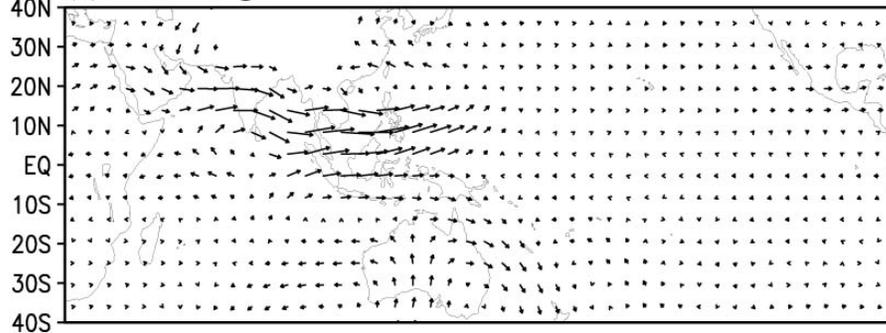


Avoid  
India

(a) Positive heating over the north tropical west Pacific

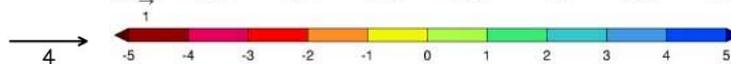
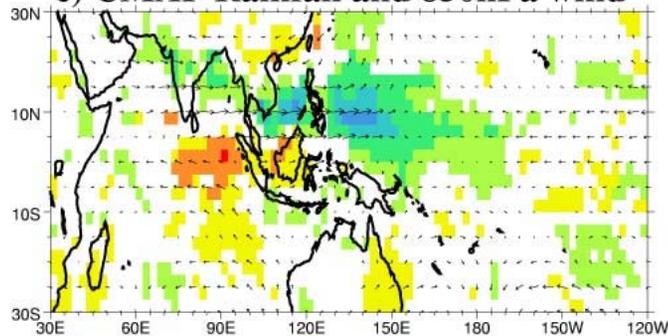


(b) All heatings

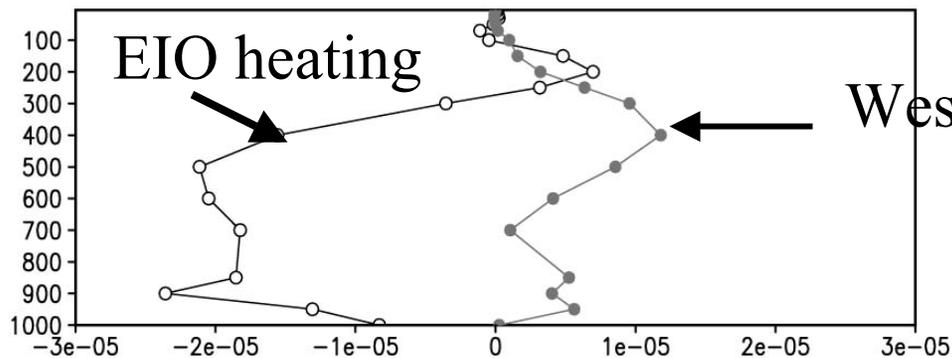


Day 20

e) CMAP Rainfall and 850hPa wind



(c)  $\omega$  anomalies over India

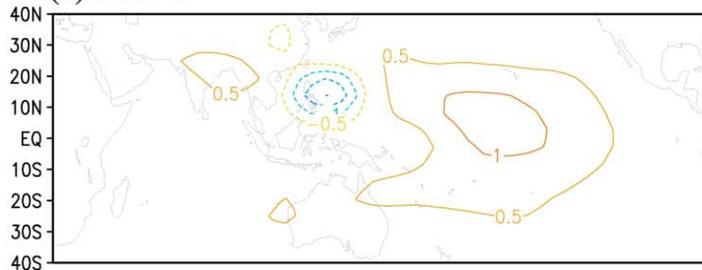


Geopotential Height anomalies at 700 hPa

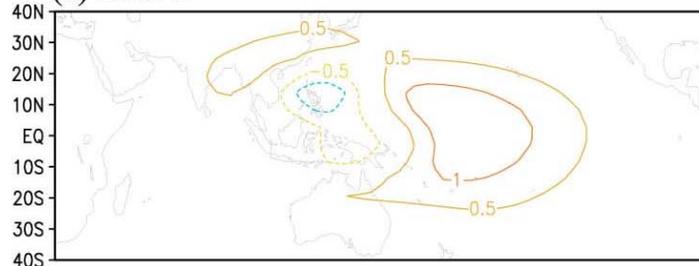
# W. Pacific Heating

Geopotential Height anomalies at 700 hPa

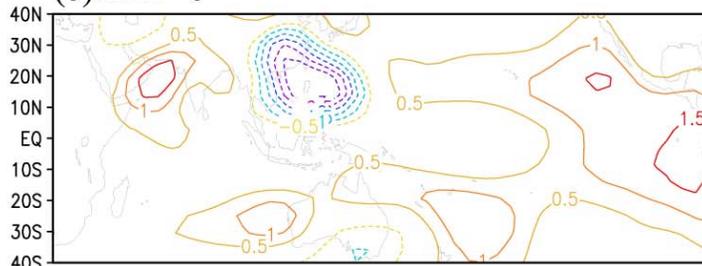
(a) DAY 3



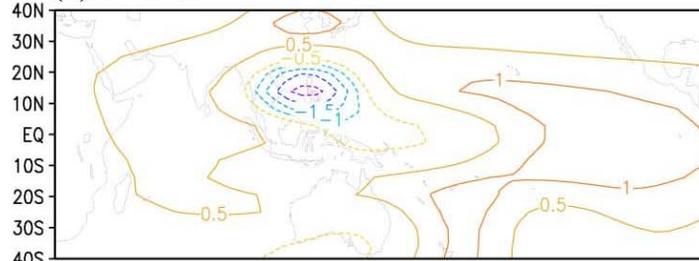
(a) DAY 3



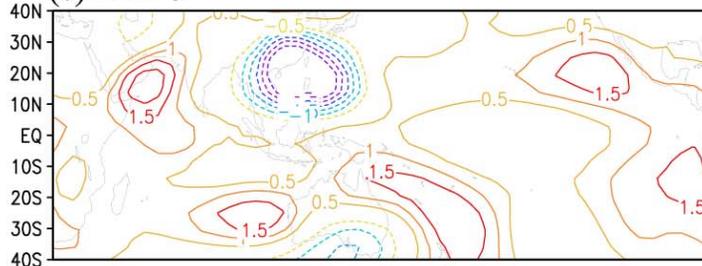
(b) DAY 6



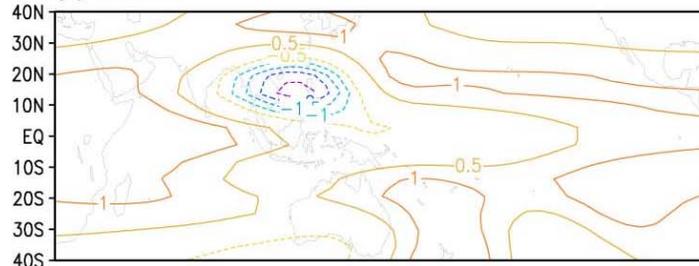
(b) DAY 6



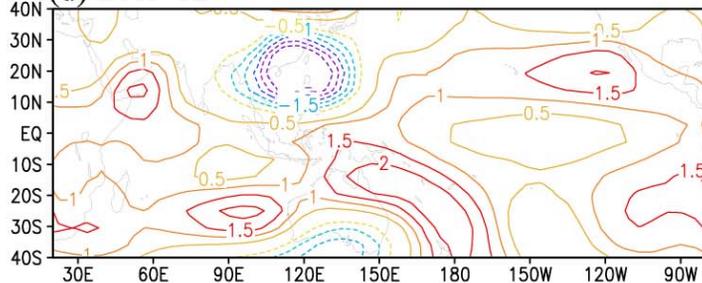
(c) DAY 9



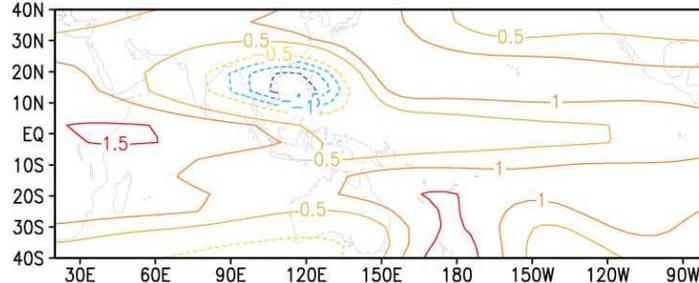
(c) DAY 9



(d) DAY 12



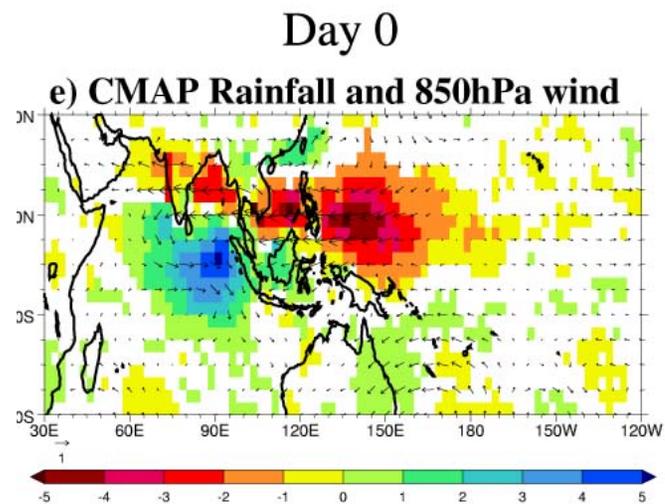
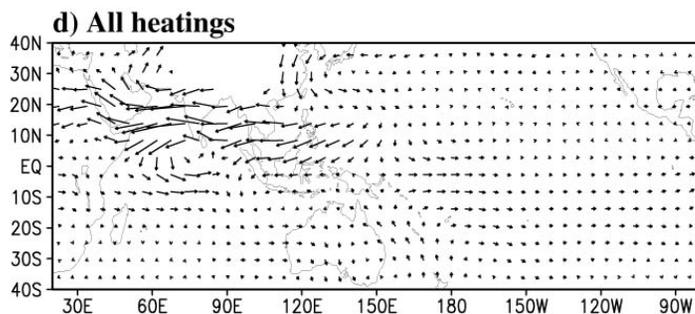
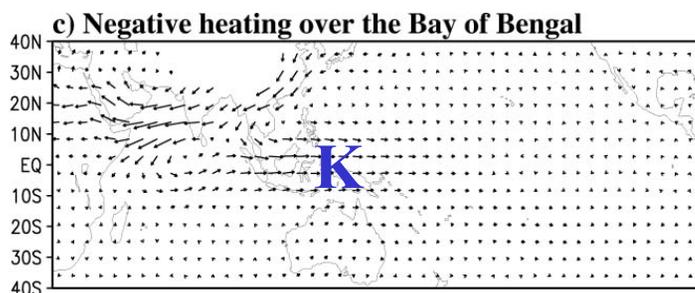
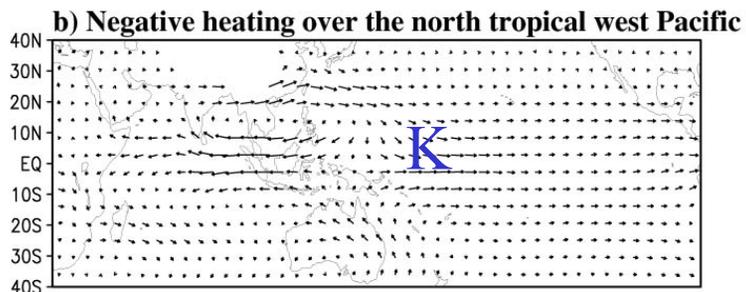
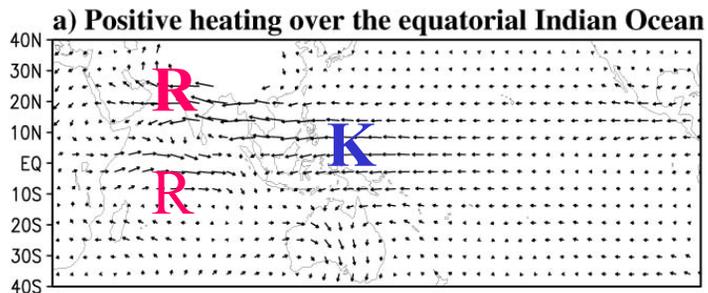
(d) DAY 12



**Realistic basic flow**

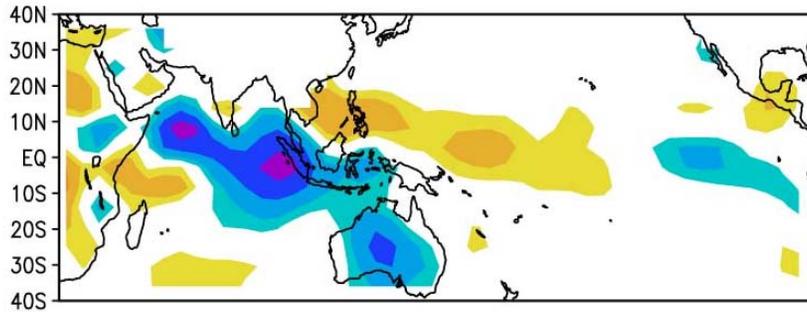
**Zonal mean basic flow**

**Role of equatorial mode in the  
Active/break phases over west Pacific**

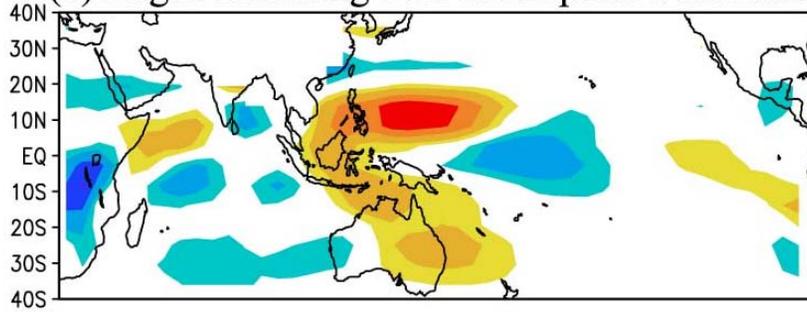


Day 20 – Mirror image

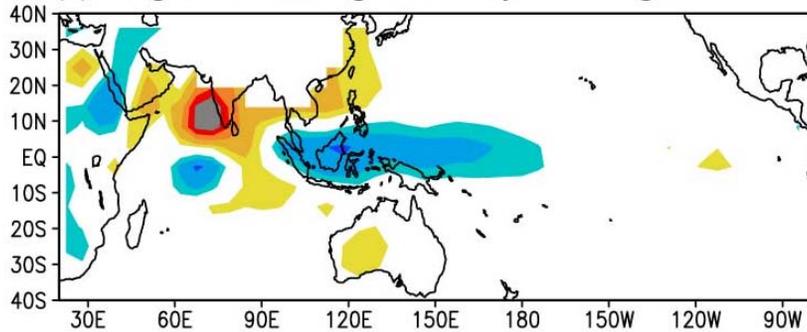
(a) Positive heating over the equatorial Indian Ocean



(b) Negative heating over the tropical west Pacific

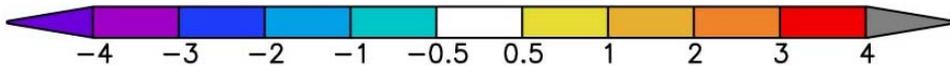
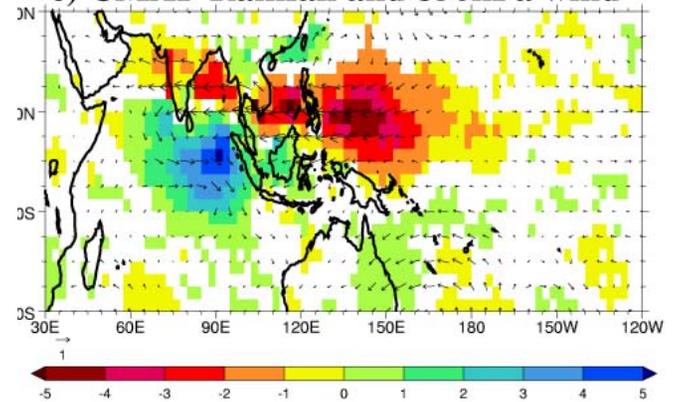


(c) Negative heating over Bay of Bengal



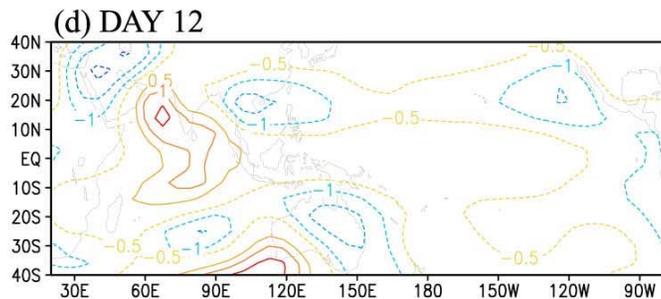
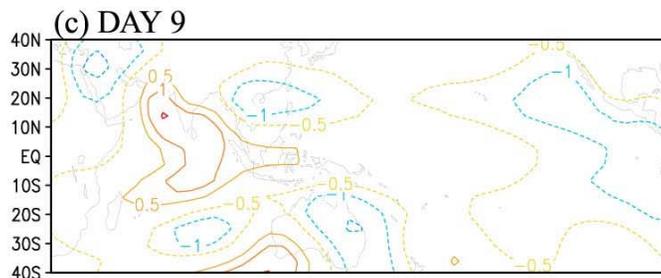
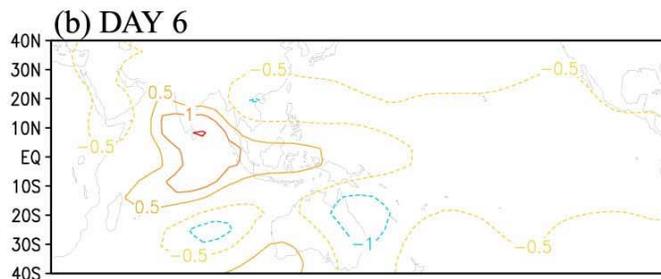
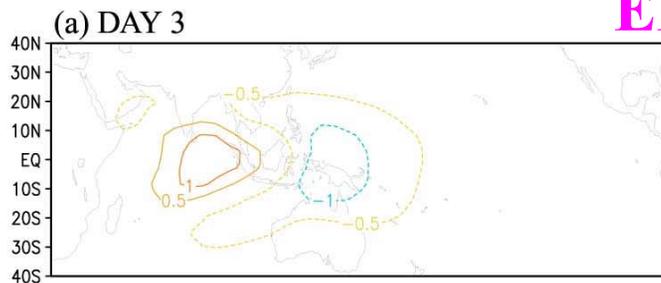
Day 0

e) CMAP Rainfall and 850hPa wind



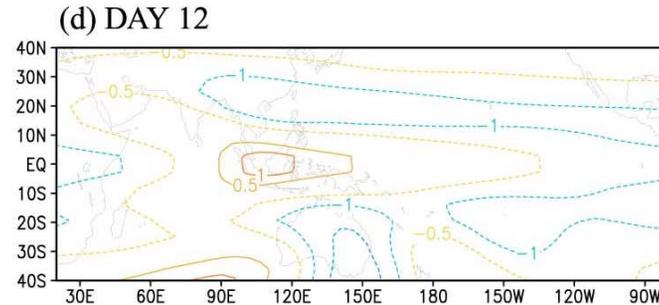
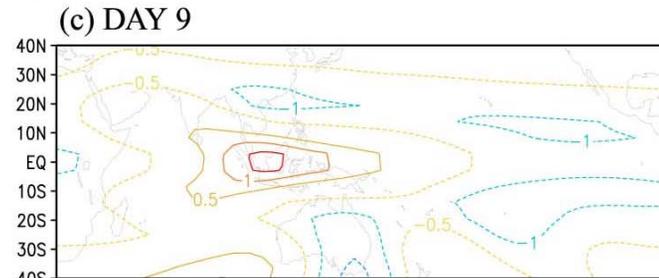
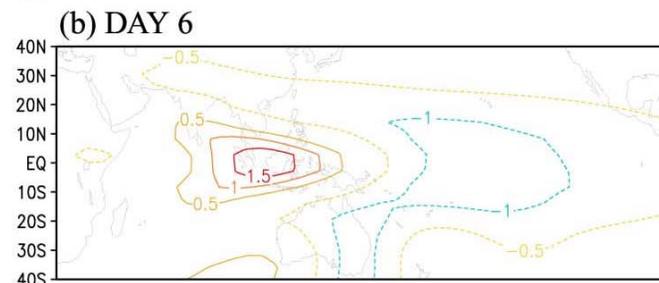
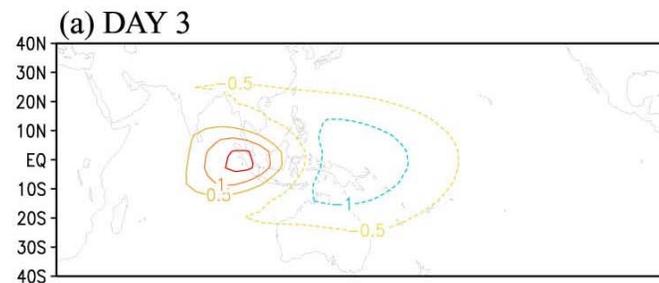
Geopotential Height anomalies at 700 hPa

# EIO Heating



**Realistic basic flow**

Geopotential Height anomalies at 700 hPa



**Zonal mean basic flow**

# Summary

- **Three modes of the BSISV influence each-other**
- **Initiation of next active phase depends on the dry convective anomalies associated with the previous phase**
- **Convective activity over the Indian longitudes is modulated by the convective activity over the west Pacific and vice-versa**
- **Our results are constrained by linear solutions to prescribed heating rather than employing an interactive or moving heat source**