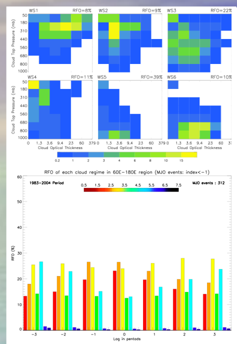


Interaction of Tropical Deep Convection with the Large-Scale Circulation in the MJO

Eric Tromeur and William B. Rossow

NOAA/CREST at the City College of New York

ISCCP 25th Anniversary Symposium, NASA Goddard Institute for Space Studies, 23-25 July 2008

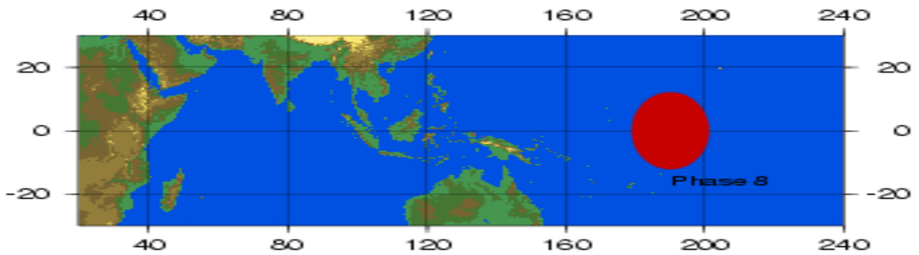
Principle of the Madden-Julian Oscillation

Planetary scale wave

- Referred as the 30-60 day wave
- Large-scale oscillation in the equatorial region
- Origin over the Indian Ocean

Characterization

- Eastward propagation of tropical deep convection
- Travelling wave at 10 m/s



Wheeler and Hendon, MWR, 2004

Impacts

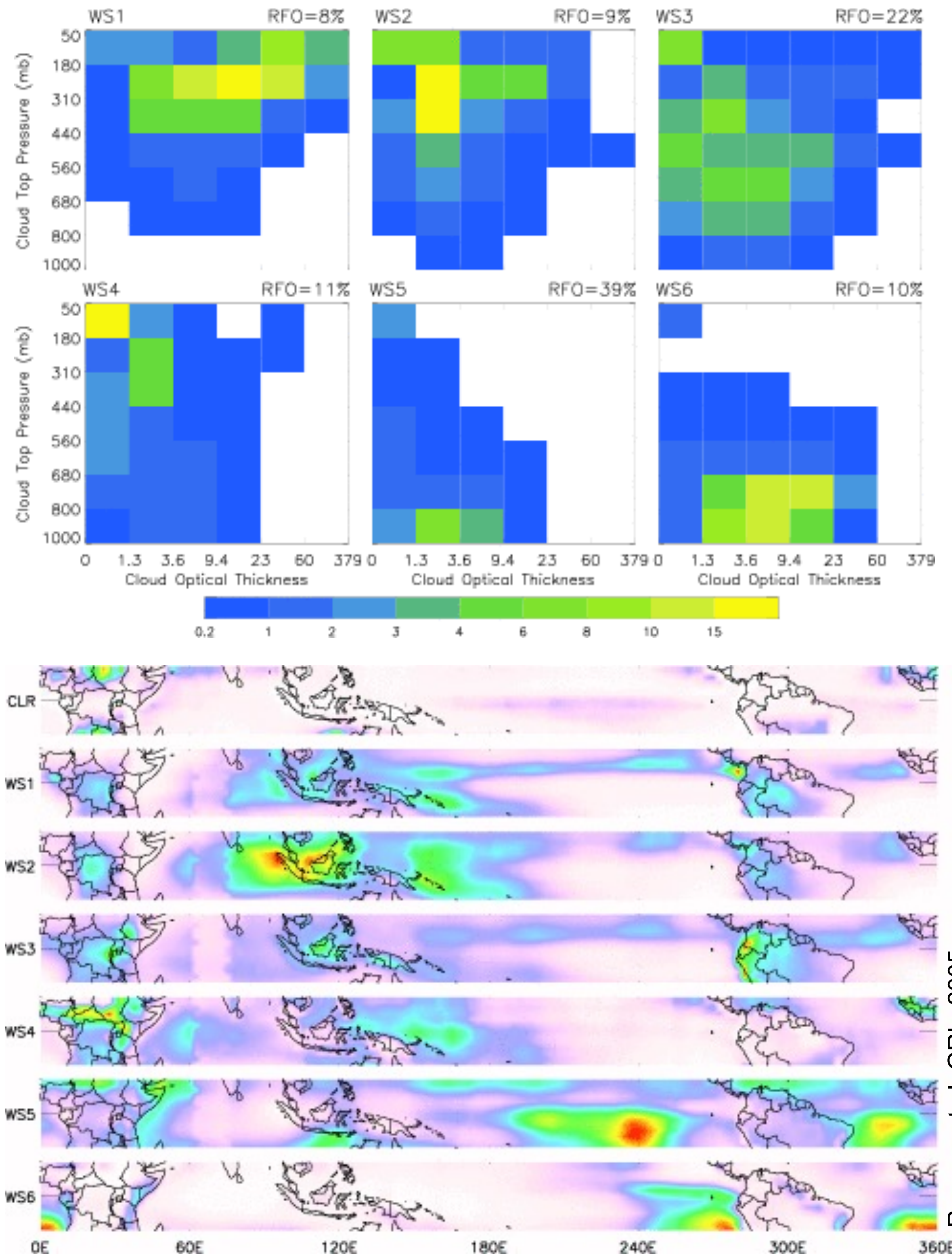
- Affects intensity and break periods of monsoons
- Life time of MJO dependent on the state of ENSO (Pohl and Matthews, J. Climate, 2007)

Outline

1. ISCCP Cluster Analysis in Tropics
2. MJO Index Threshold
3. Tropical cloud regimes and MJO phase
4. Results
5. Conclusion and perspectives

ISCCP PC - TAU histogram pattern and Map in Tropics over 21.5 years

1983 - 2004 time period



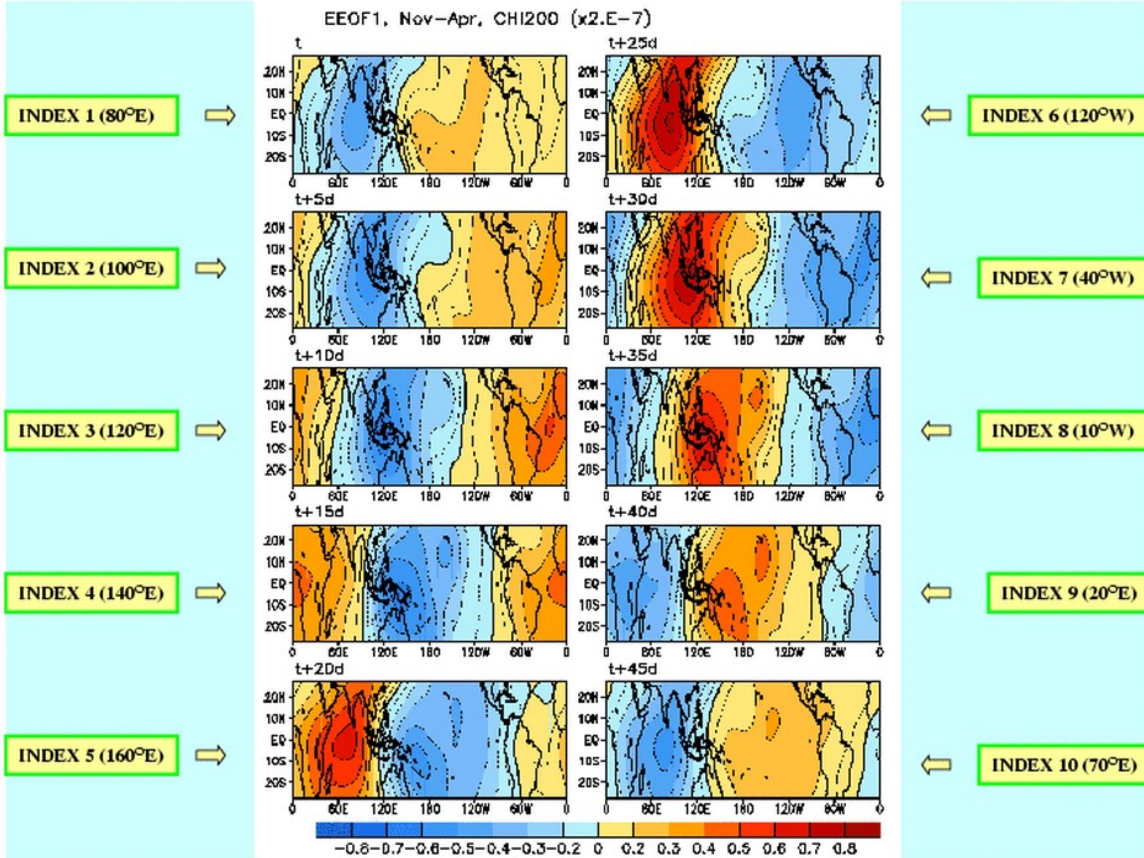
Rossow et al, GRL, 2005

Cluster Analysis + ISCCP D1 data

- WS1 : Deep cumulus clouds
- WS2 : Anvils clouds
- WS3 : Congestus clouds
- WS4 : Cirrus clouds
- WS5 : Shallow cumulus clouds
- WS6 : Stratocumulus clouds

MJO Index in Tropics

Ten time-lagged patterns of the first EEOF of pentad CHI200 anomalies



National Weather Service / Climate Prediction Center

MJO index : 10 components

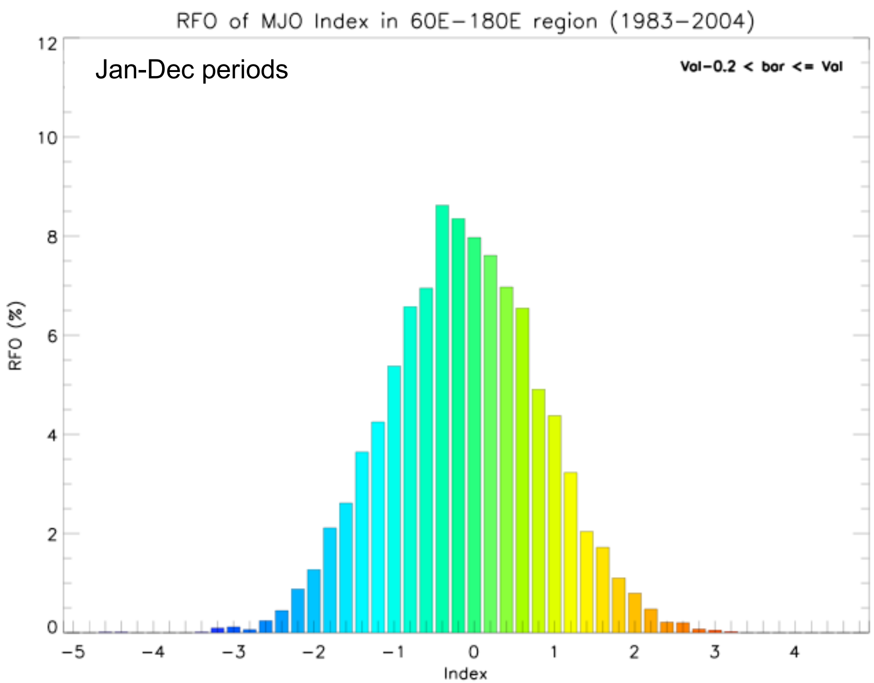
Negative values : enhanced convection

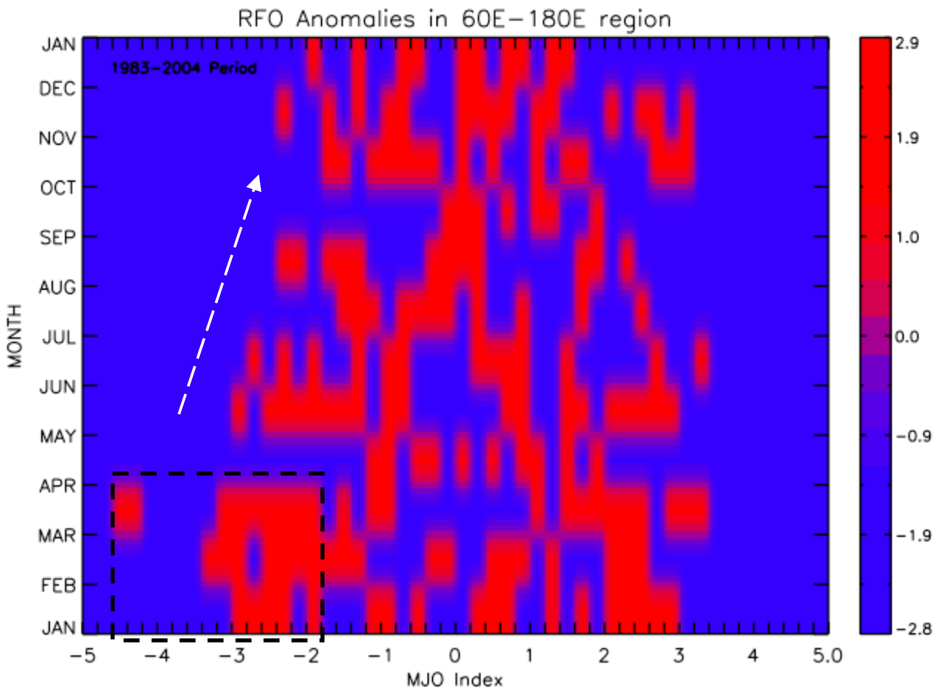
Positive values : suppressed convection

Composite of cloud regimes function of MJO phase (Chen and Del Genio, 2008)

- Consider a strong MJO event to be one when index < -1
- Focus on the Indo-Pacific warm pool and the boreal winter (November-April)

RFO of MJO Index in 60E - 180 E region (1983 - 2004)





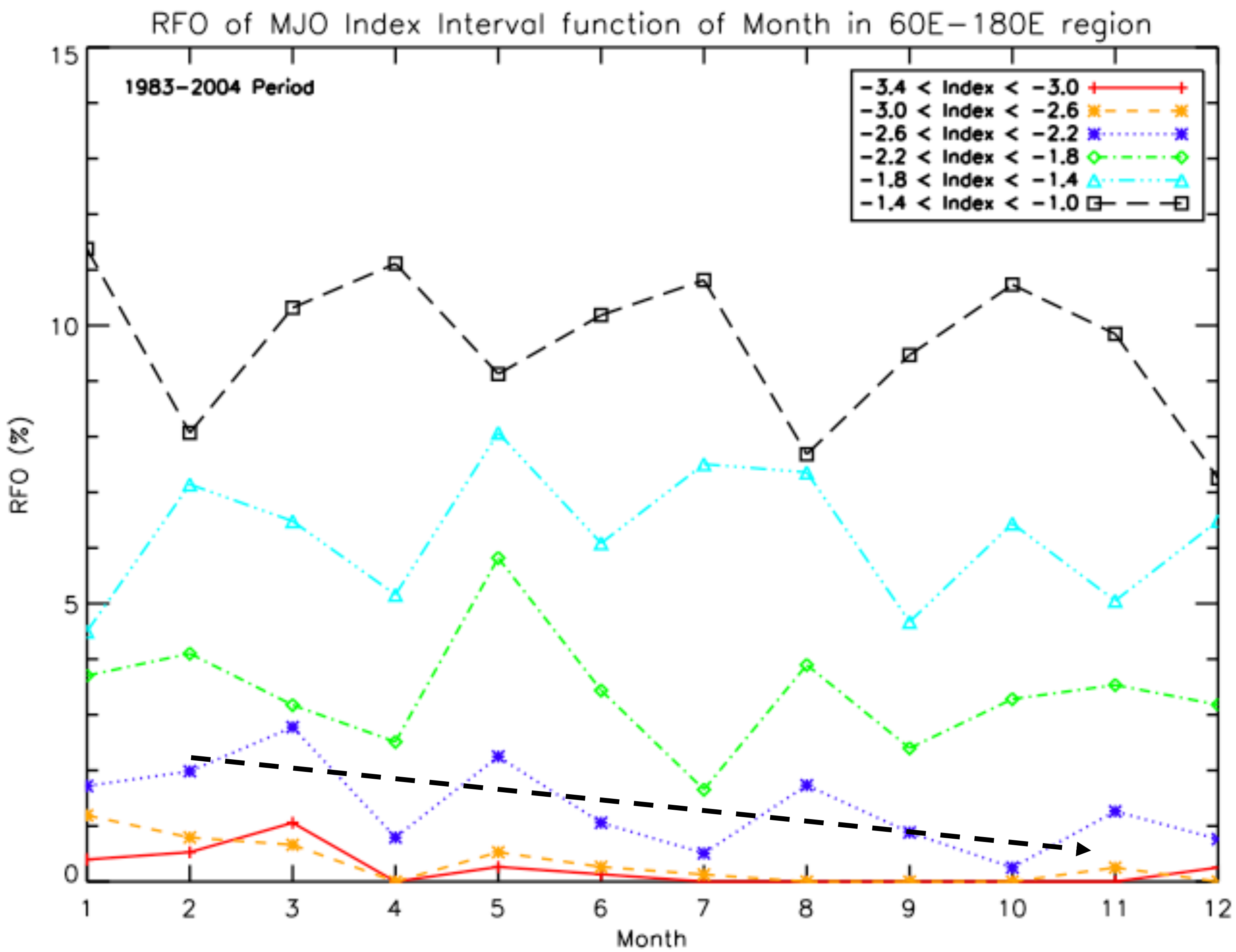
Continuum of MJO index values

MJO signal all over the year

More extreme MJO Index values during the Boreal Winter

Signature of strong MJO

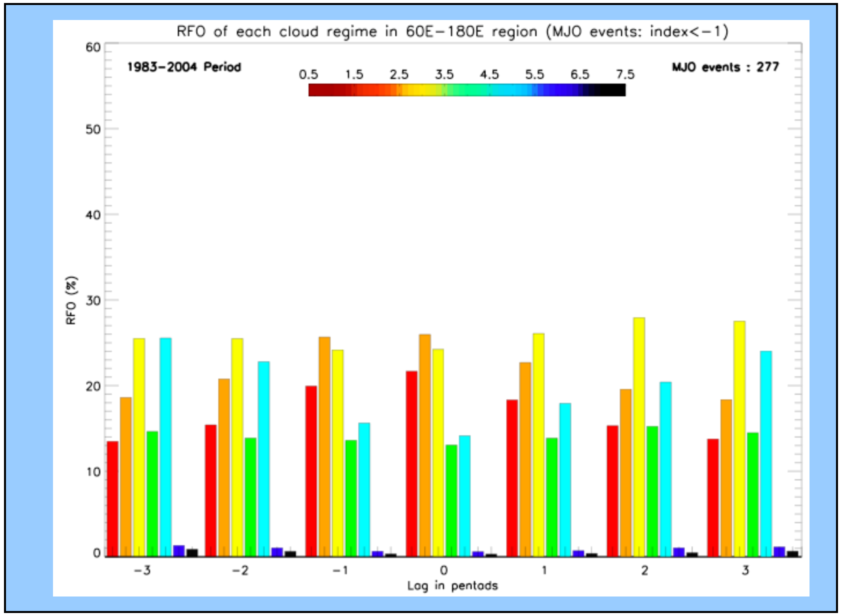
RFO of MJO Index Interval in 60E - 180 E region (1983 - 2004)



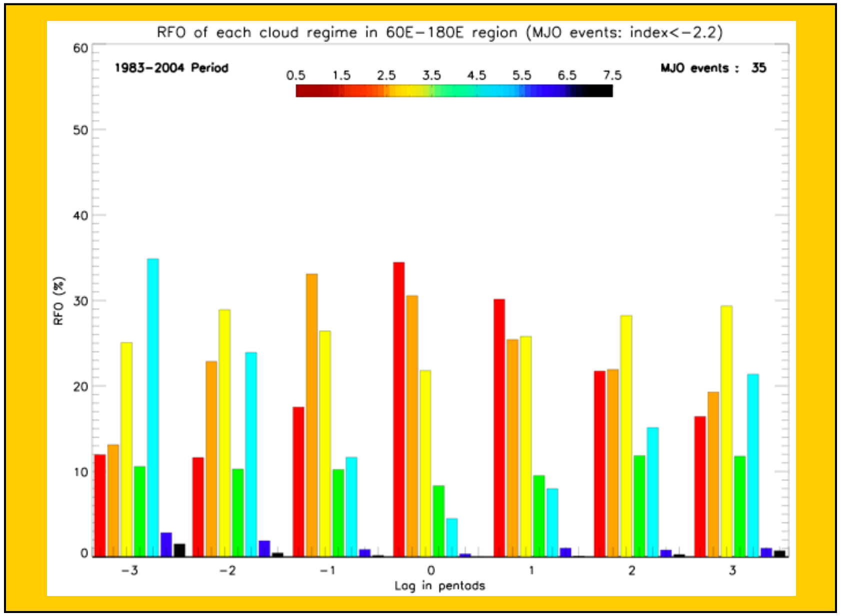
RFO of each cloud regime in 60E-180E region / 5S-5N latitude band

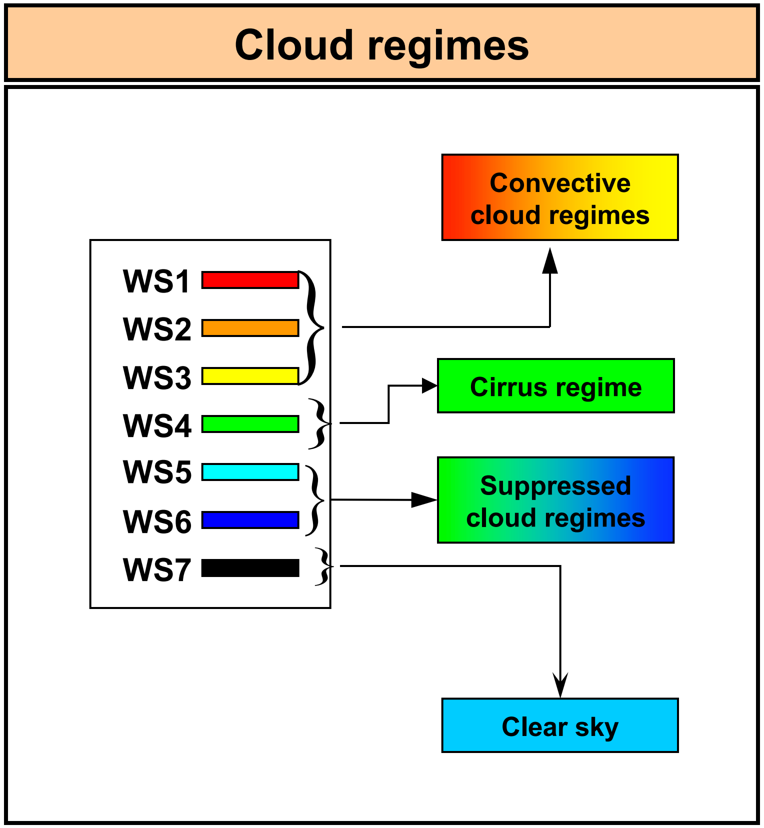
(MJO events in November-April periods from 1983 - 2004)

Weak MJO (index < -1)



Strong MJO (index < -2.2)





Interaction between MJO and deep convection ?

Atmospheric diabatic heating

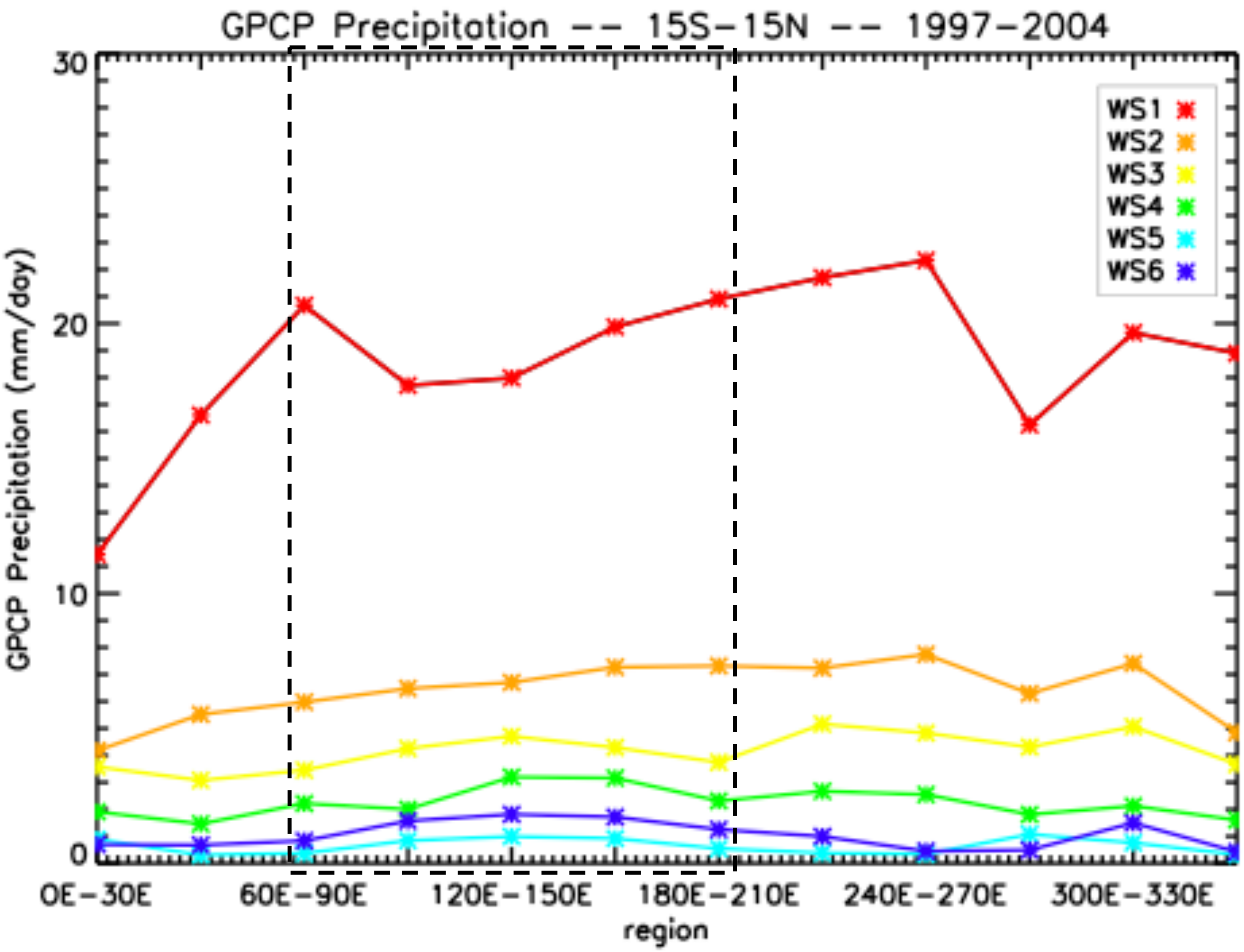
- GPCP Precipitation (1997-2004)
- ISCCP-FD Radiative Fluxes (1997-2004)
- GSSTF2 Surface Heat fluxes (1989-2000)

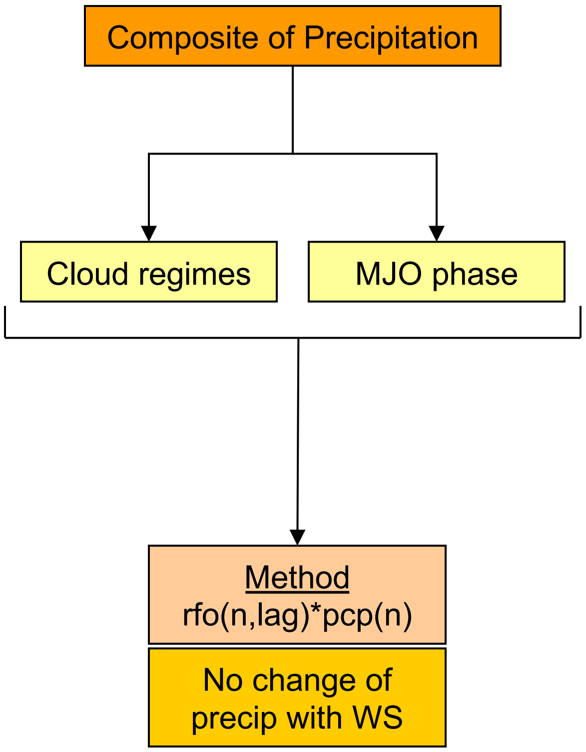
NCEP/NCAR Reanalysis (1983-2004)

- NCEP/NCAR Omega at 200mb
- NCEP/NCAR Omega at 500mb
- NCEP/NCAR Omega at 850mb

- GPCP : Global Precipitation Climatology Project
- ISCCP : International Satellite Cloud Climatology Project
- GSSTF2 : Goddard Satellite-Based Surface Turbulent Fluxes, version 2
- NCEP/NCAR : National Centers for Environmental Prediction / National Center for Atmospheric Research

Composite of precipitation in Tropics (1997 - 2004)

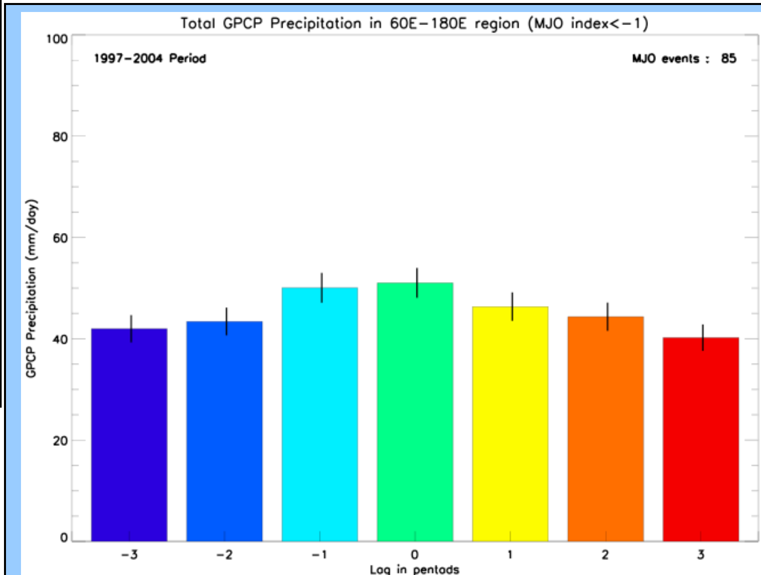


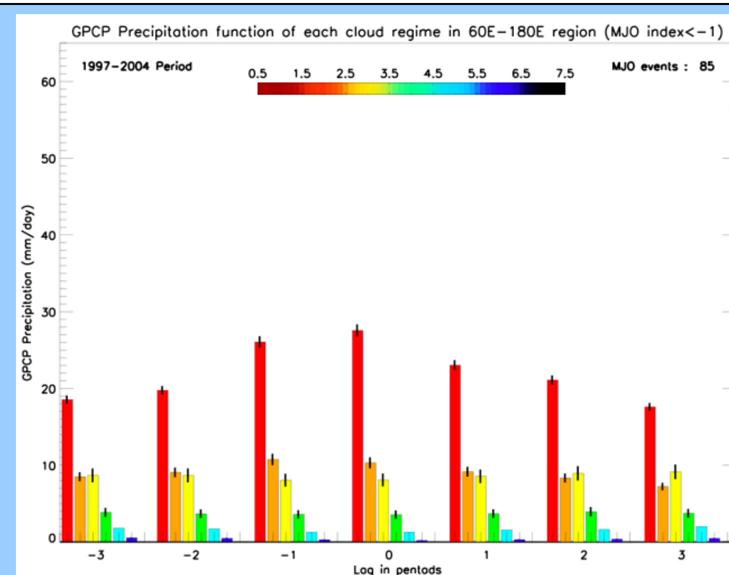


GPCP Precipitation and cloud regimes in 60E-180E region / 5S-5N latitude band

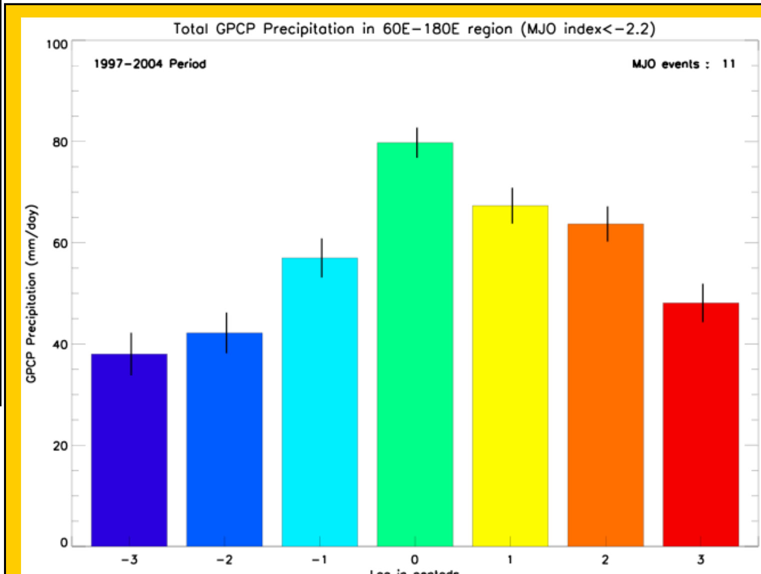
(MJO events in November-April periods from 1997 - 2004)

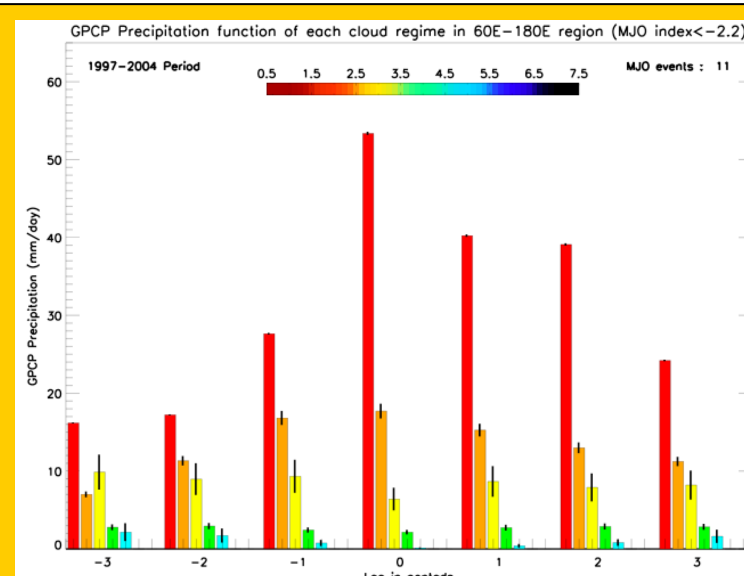
Weak MJO (index < -1)





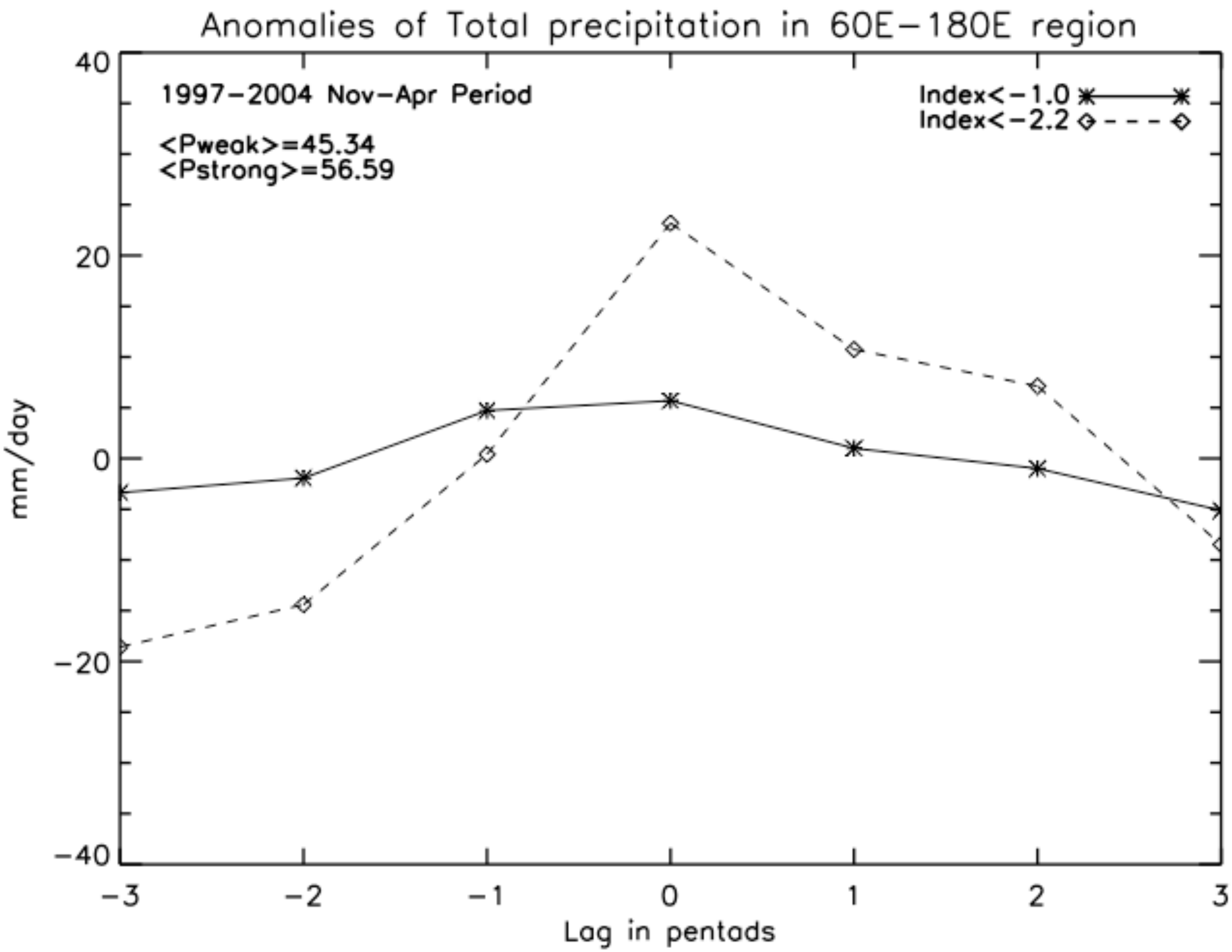
Strong MJO (index < -2.2)





Composite of Total Precipitation Anomalies in 60E-180E region / 5S-5N latitude band

(MJO events in November-April periods from 1997 - 2004)

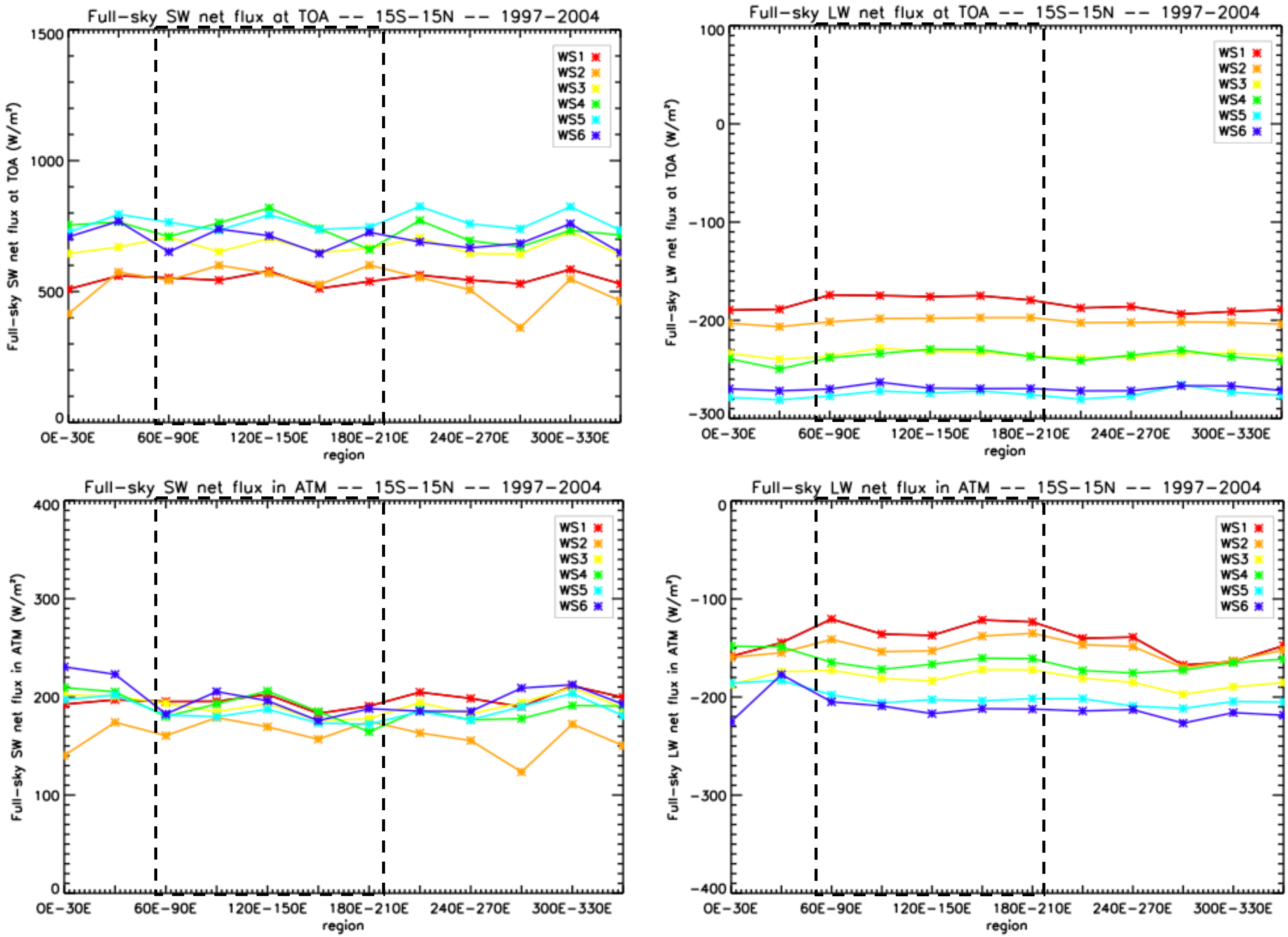


Composite of Radiative net fluxes in Tropics (1997 - 2004)

Shortwave net flux | **Longwave net flux**

Net flux at TOA

Net flux in ATM

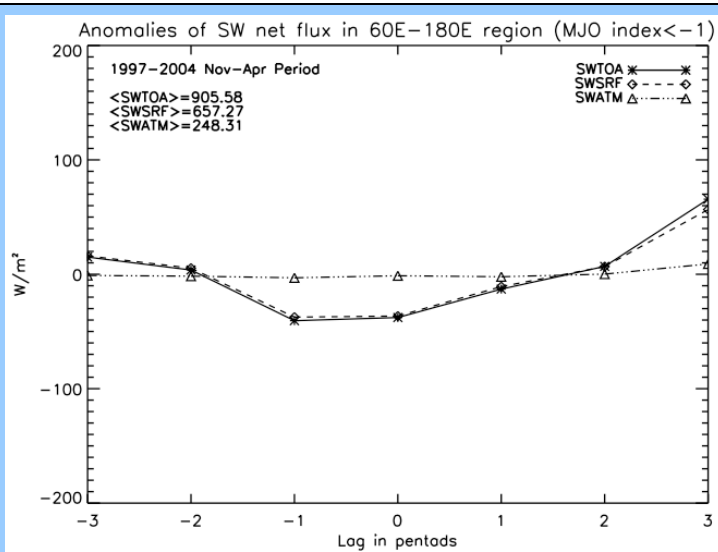


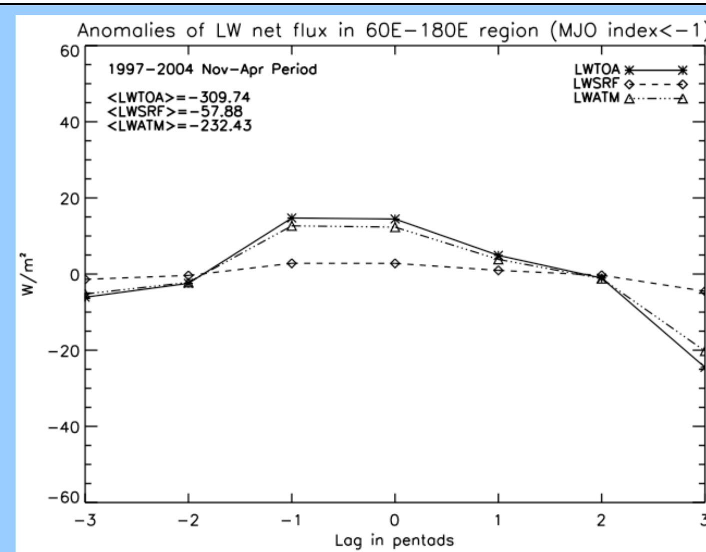
Composite of Anomalies of Total net flux in 60E-180E region / 5S-5N latitude band

(MJO events in November-April periods from 1997 - 2004)

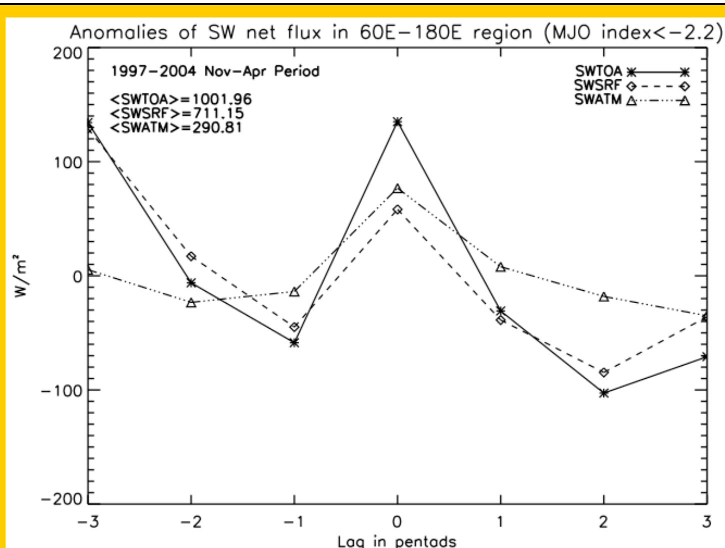
Shortwave net flux anomalies | **Longwave net flux anomalies**

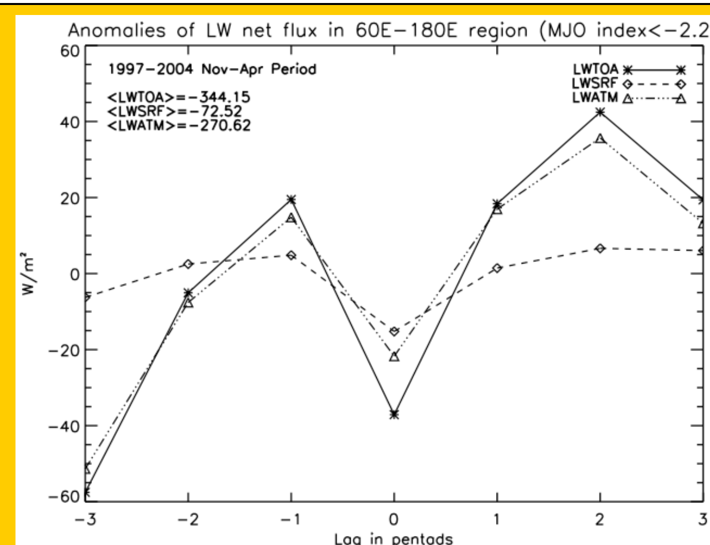
Weak MJO (index < -1)





Strong MJO (index < -2.2)



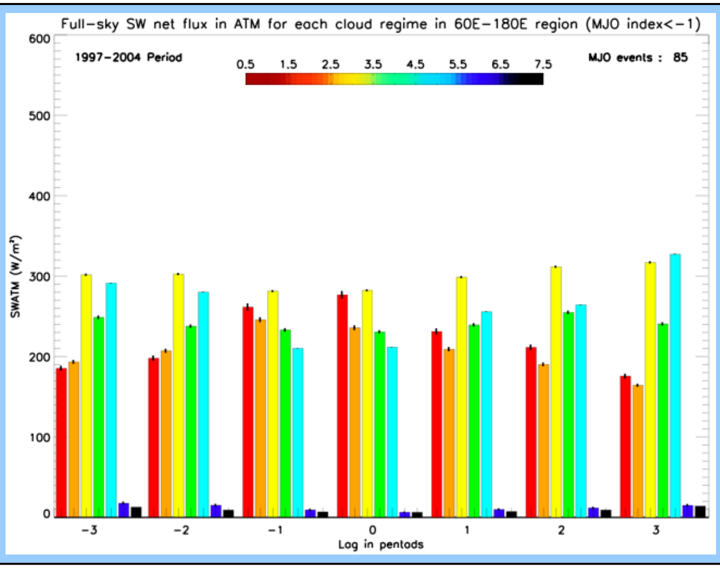


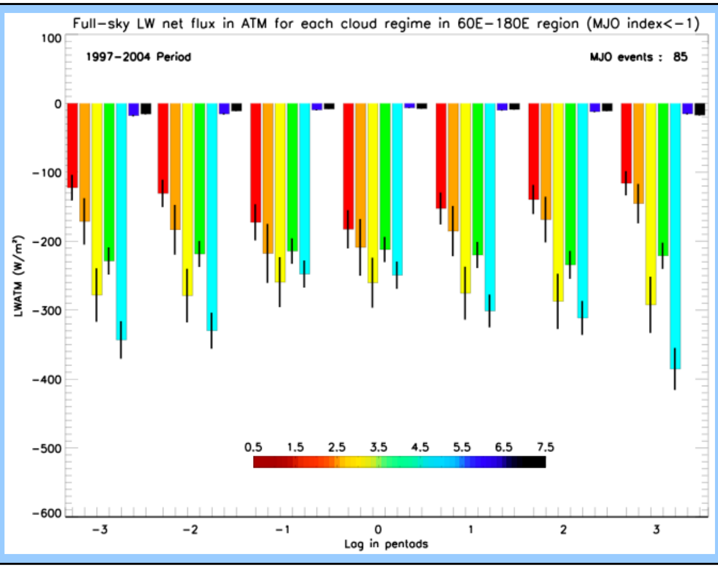
Composite of Radiative net flux in ATM in 60E-180E region / 5S-5N latitude band

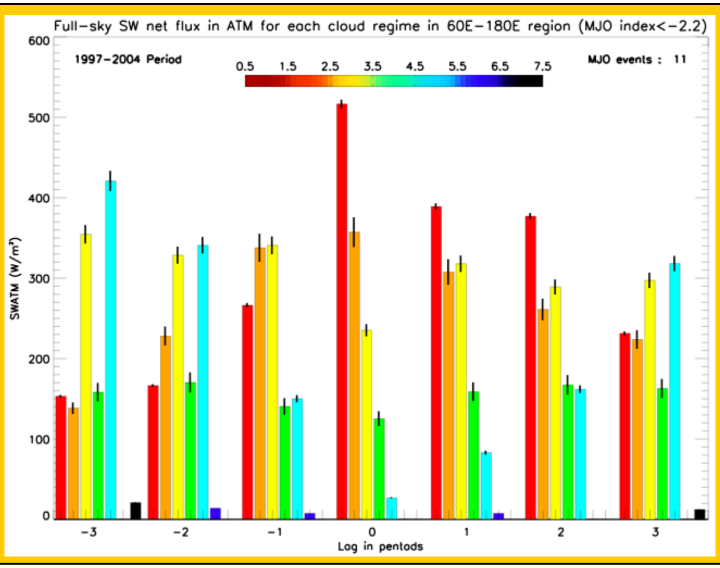
(MJO events in November-April periods from 1997 - 2004)

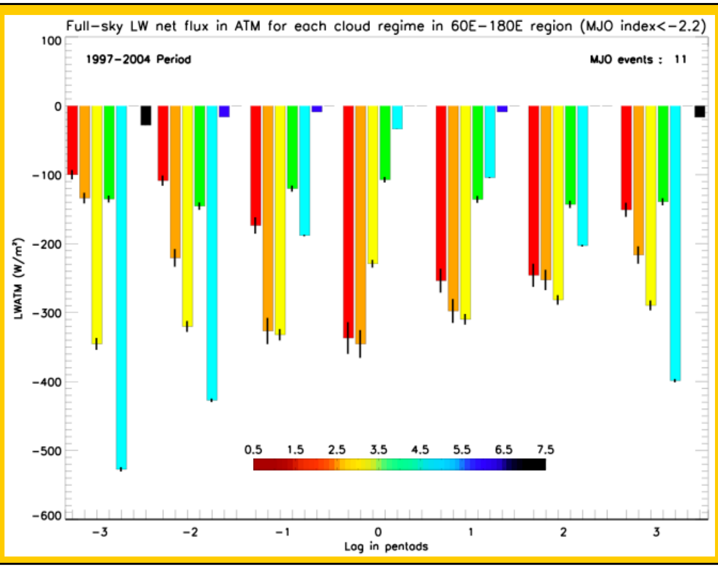
Shortwave net flux | **Longwave net flux**

Weak MJO (index < -1) | **Strong MJO (index < -2.2)**



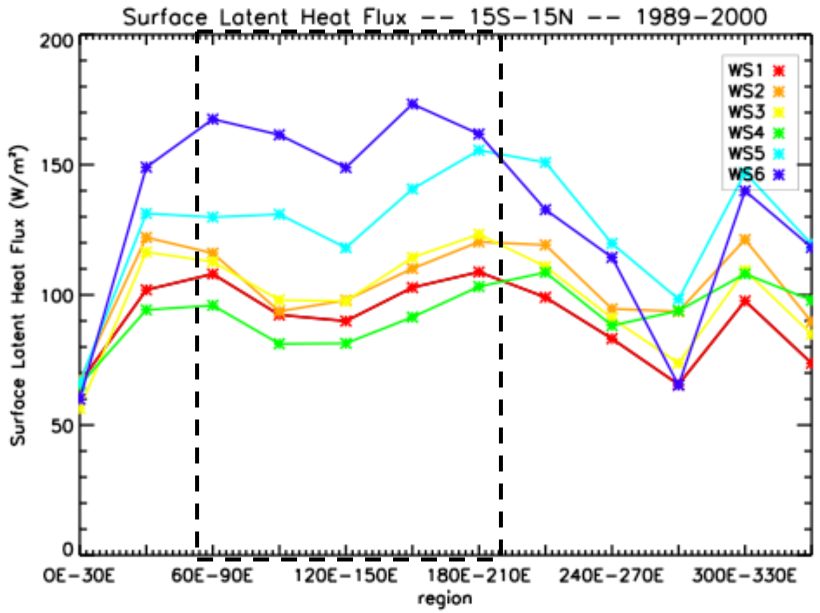


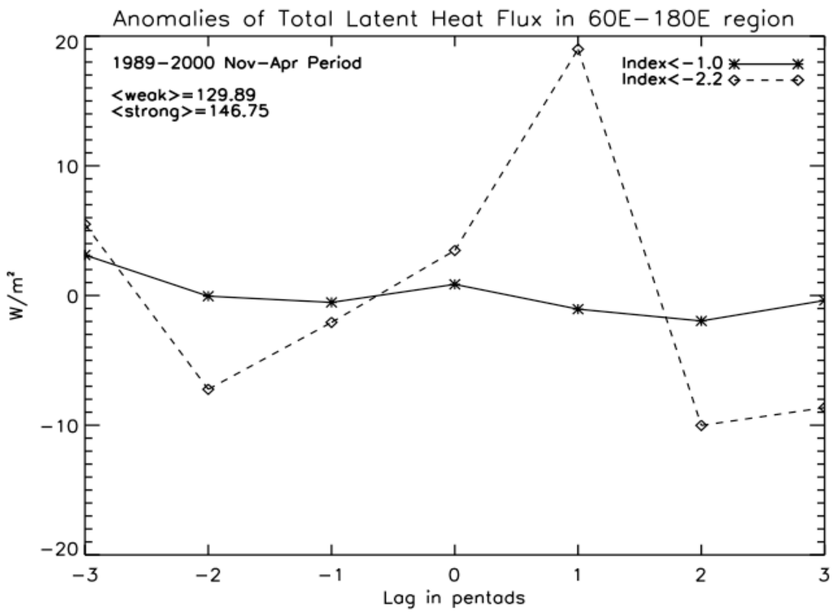




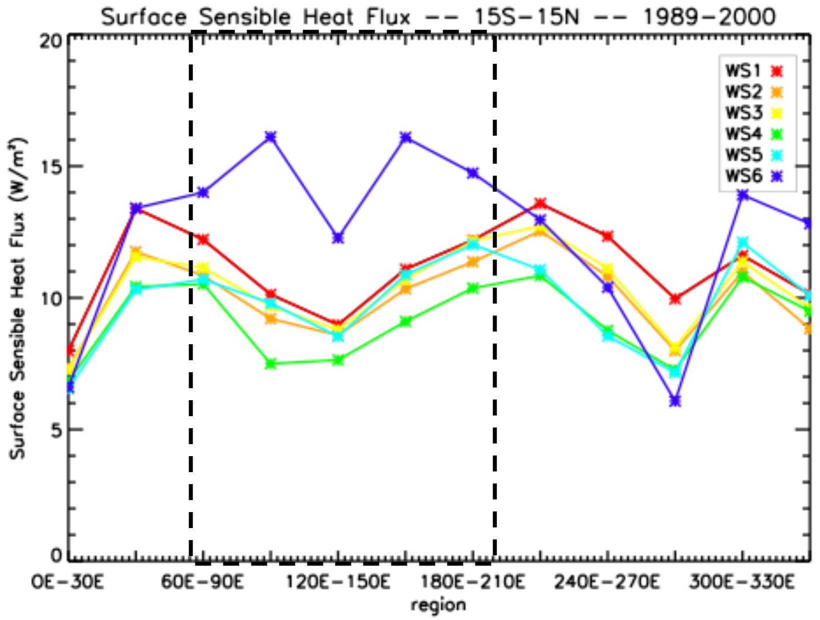
Composite of Surface Fluxes in Tropics (1989 - 2000)

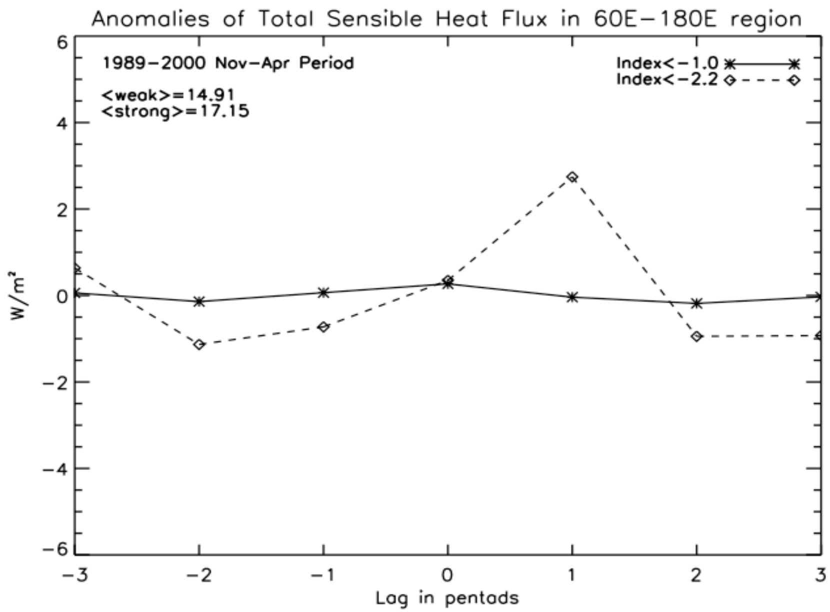
Latent Heat Flux





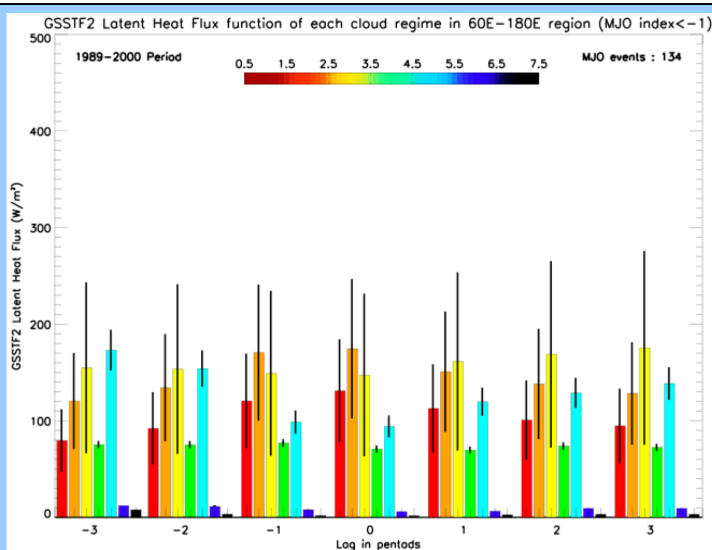
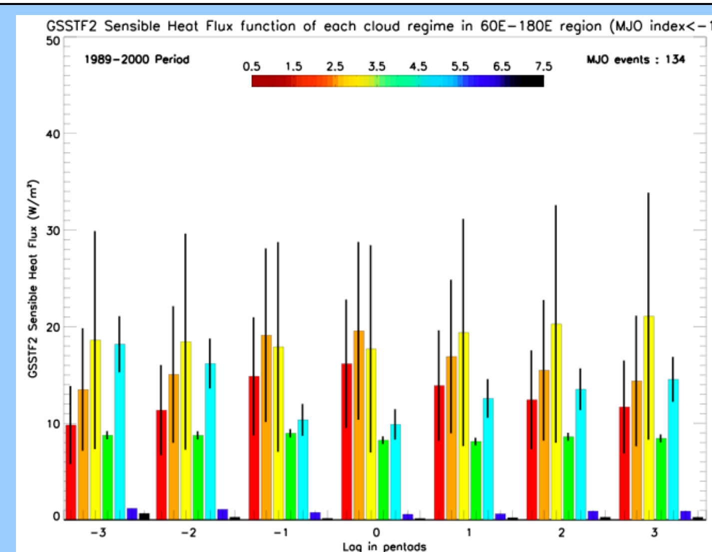
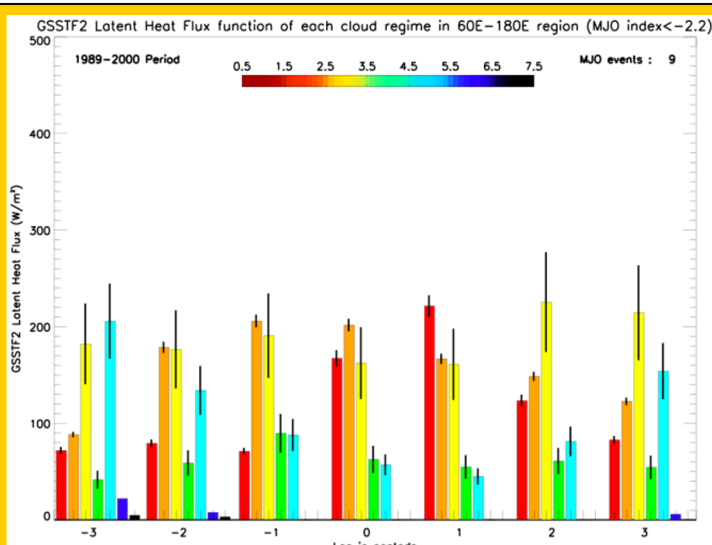
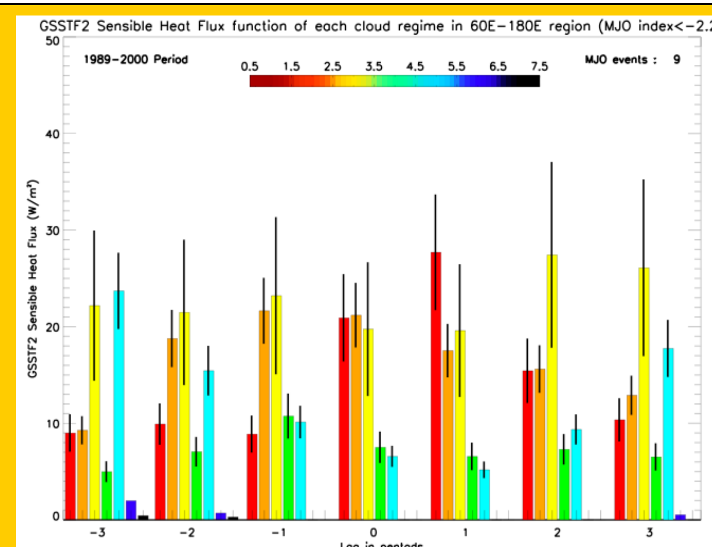
Sensible Heat Flux





Composite of Surface fluxes in 60E-180E region / 5S-5N latitude band

(MJO events in November-April periods from 1989 - 2000)

	Latent Heat flux	Sensible Heat flux
Weak MJO (index < -1)		
Strong MJO (index < -2.2)		

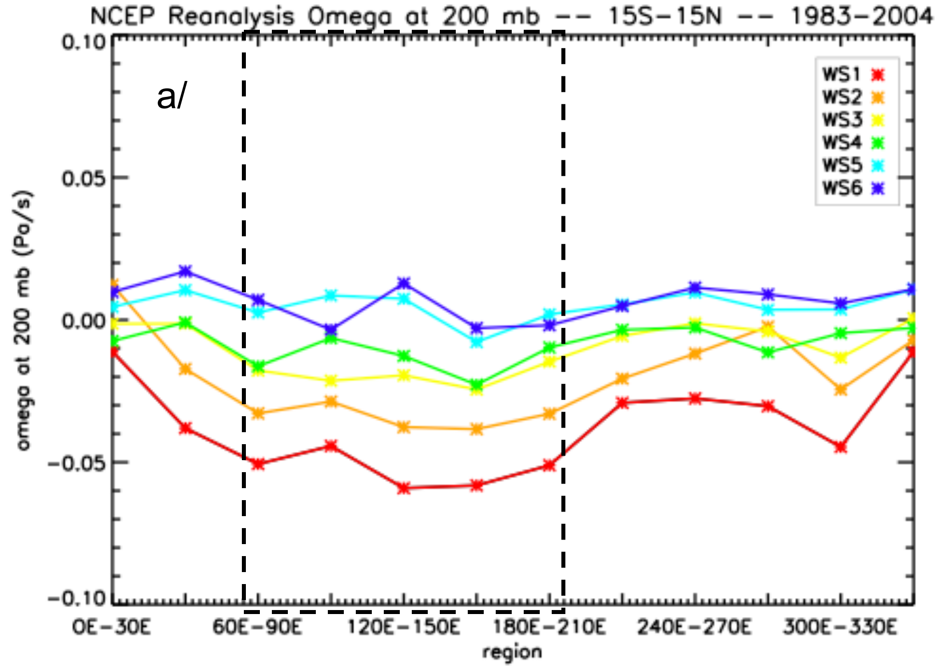
Composite of Omega in Tropics (1983 - 2004)

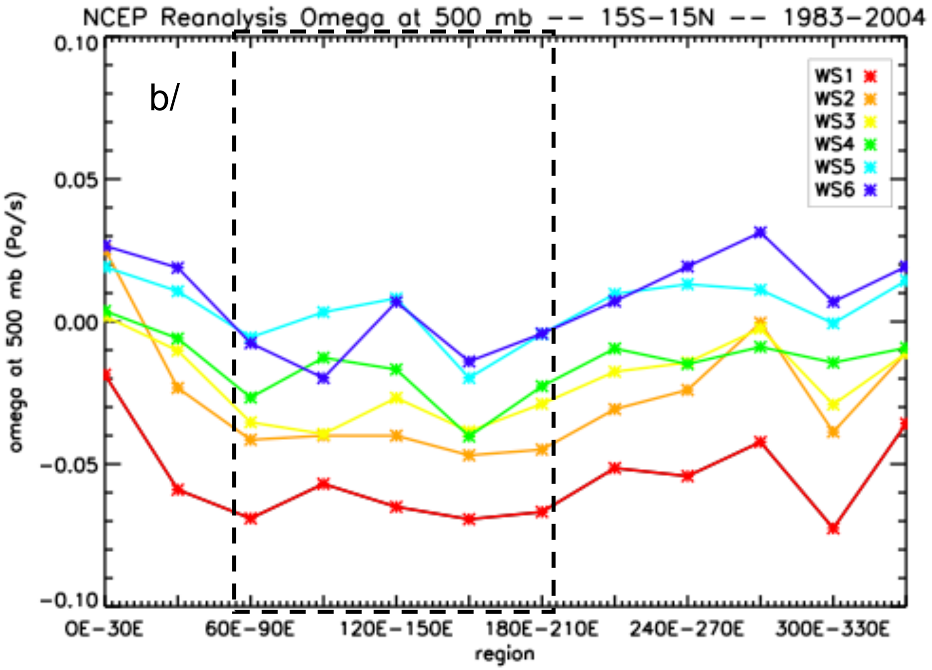
NCEP/NCAR Reanalysis

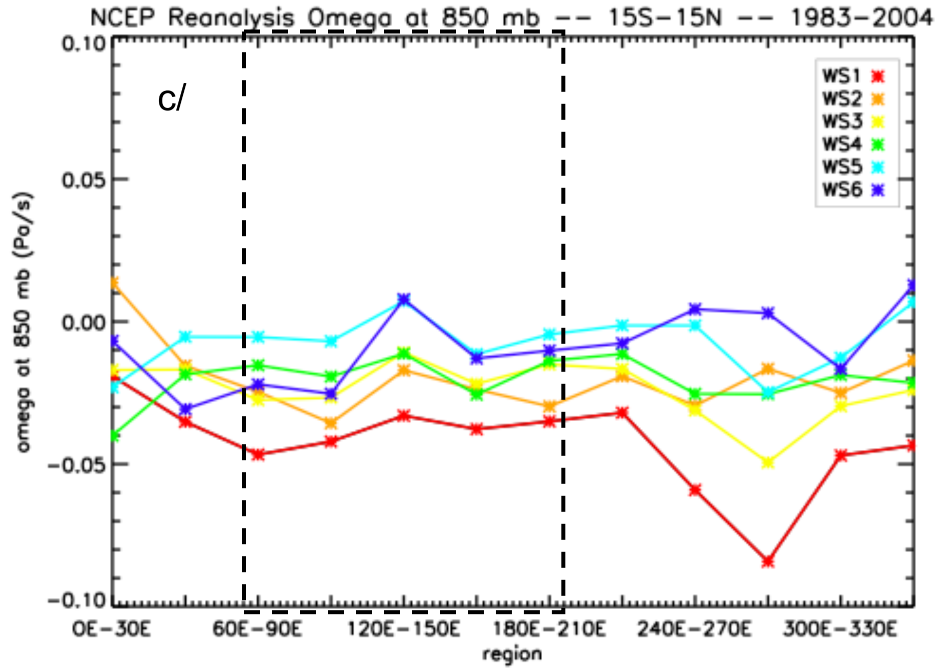
a/ Omega at 200mb

b/ Omega at 500mb

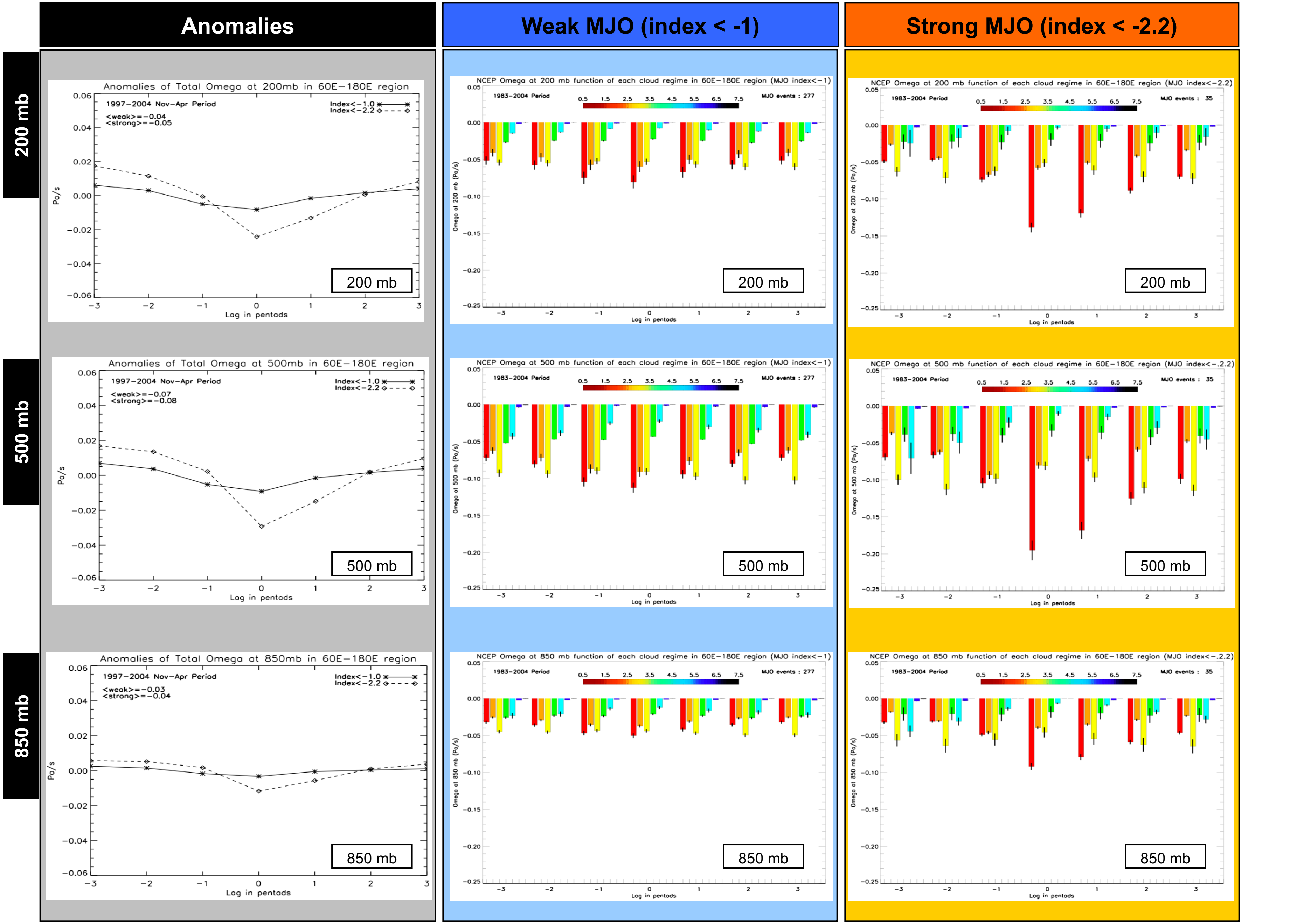
c/ Omega at 850mb







Composite of Omega in 60E-180E region / 5S-5N latitude band (1983 - 2004)



Conclusion

MJO Index

- Continuum of MJO Index values
- MJO Index thresholds : weak and strong MJO

Weather State variation with MJO

- Characterization of organized and disorganized convection as a function of MJO phase

What we learnt !

- Most of precipitation come from WS1
- OLR is not a precise quantity to study convection
- Variation of energy transfer in the atmosphere associated with both the MJO phase and Weather States
- Surface fluxes lag convection
- Strong updrafts correlated with the MJO peak

Strong interaction between MJO and deep convection

Perspectives

- Build a new MJO index based on cloud regimes
- Analysis of cloud regimes in the wavenumber-frequency domain
- Test of different theories
  - daily lags
  - vertical structures
  - cloud Tracking life cycle composites

Thank you

for

your attention