

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

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NOAA/CREST at the City College of New York

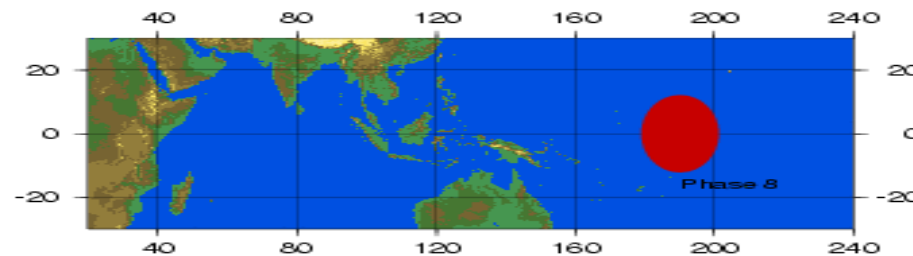
Principle of the Madden-Julian Oscillation

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

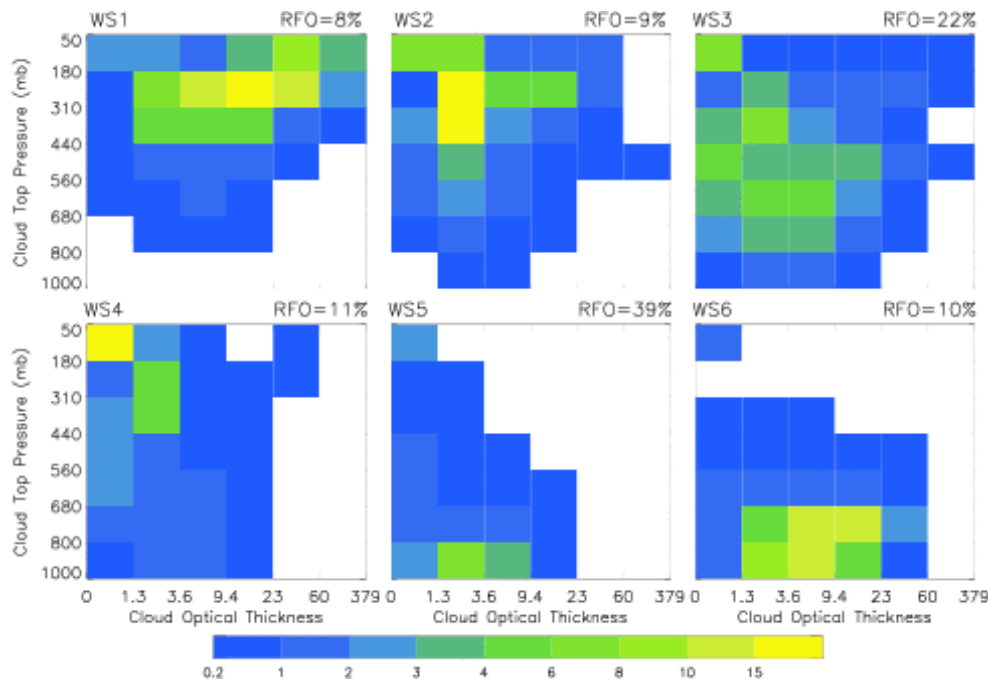
- Affects intensity and break periods of monsoons
- Life time of MJO dependent on the state of ENSO (Pohl and Matthews, J. Climate, 2007)

Outline

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

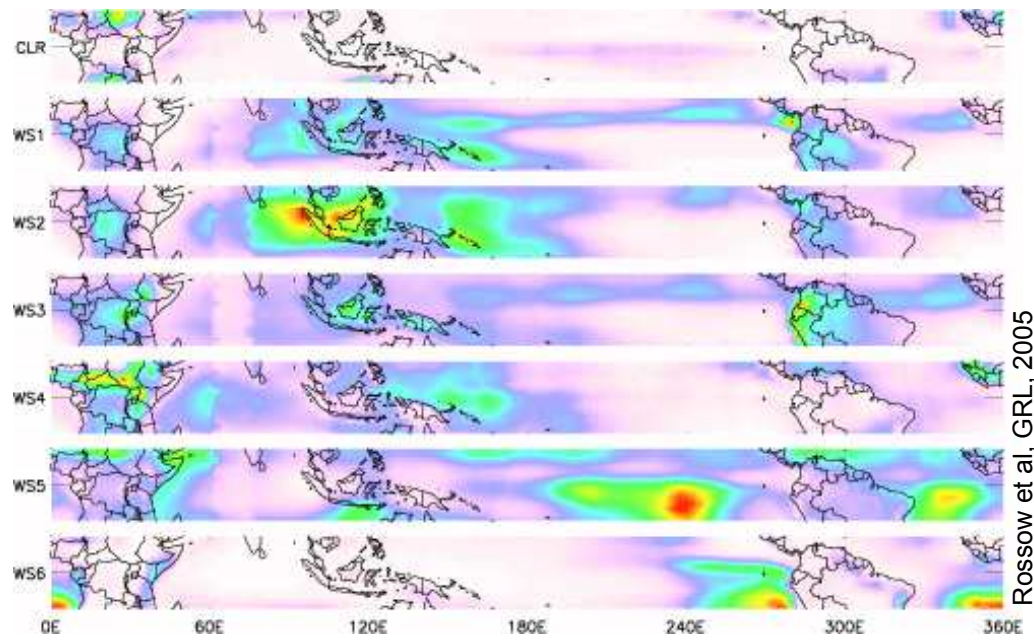
ISCCP PC - TAU histogram pattern and Map in Tropics over 21.5 years

1983 - 2004 time period



Cluster Analysis + ISCCP D1 data

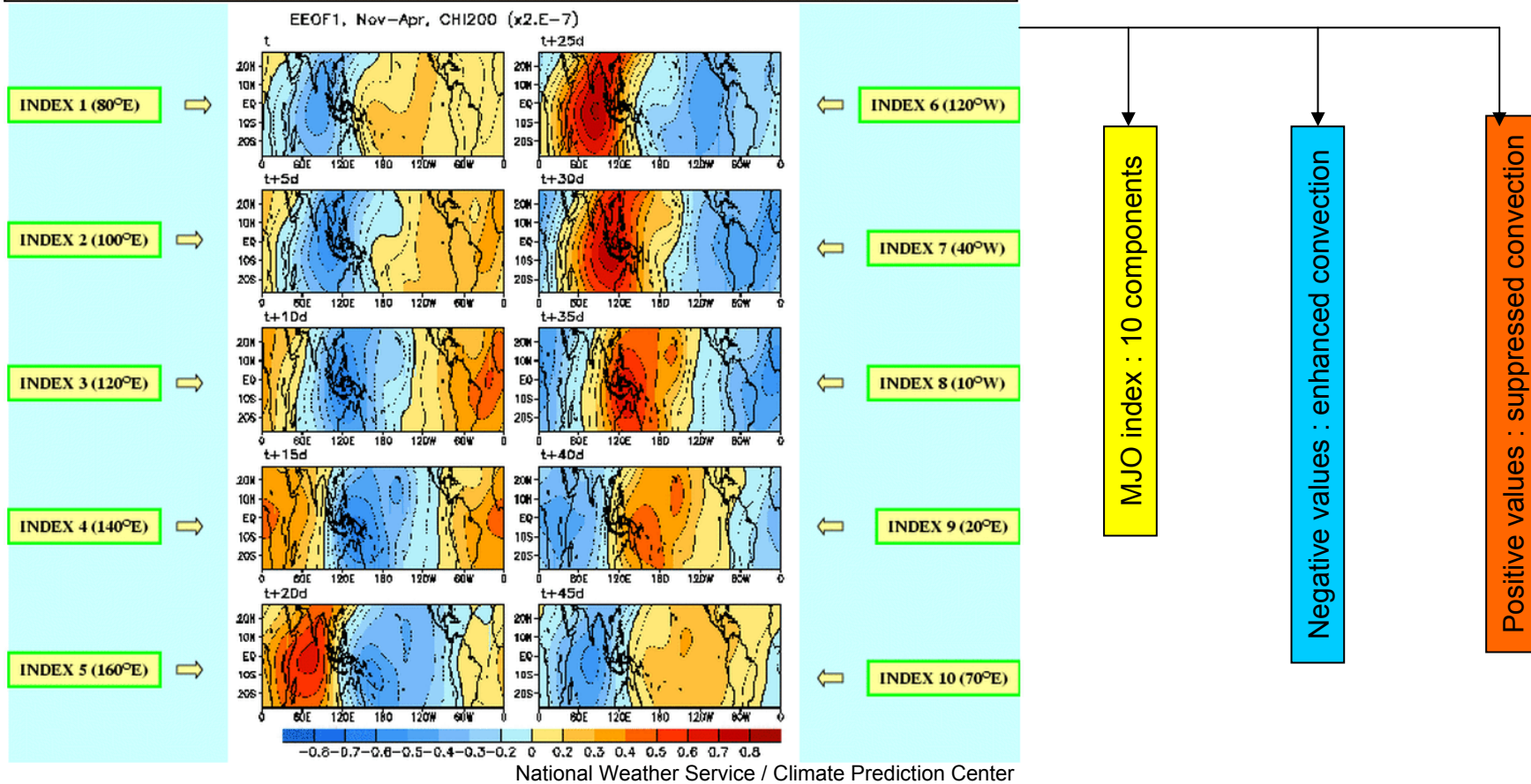
- WS1 : Deep cumulus clouds
- WS2 : Anvils clouds
- WS3 : Congestus clouds
- WS4 : Cirrus clouds
- WS5 : Shallow cumulus clouds
- WS6 : Stratocumulus clouds



Rossow et al, GRL, 2005

MJO Index in Tropics

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

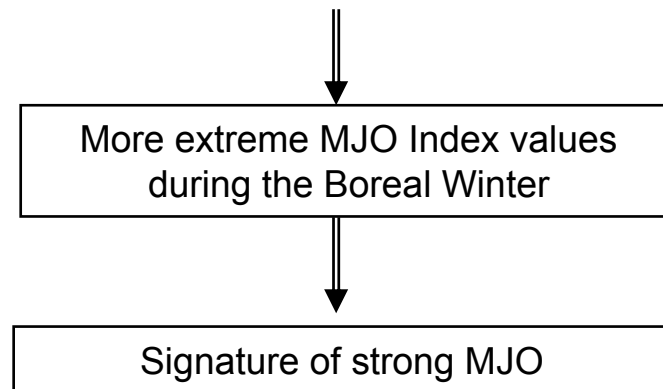
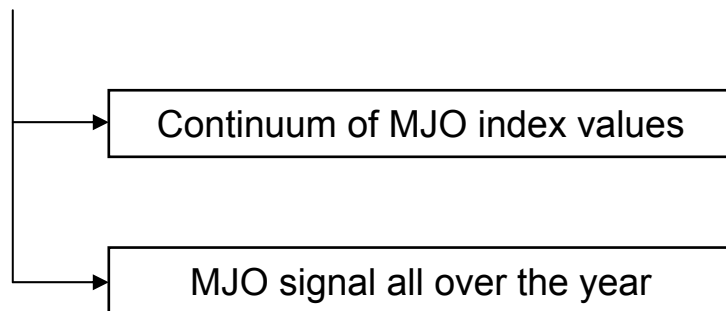
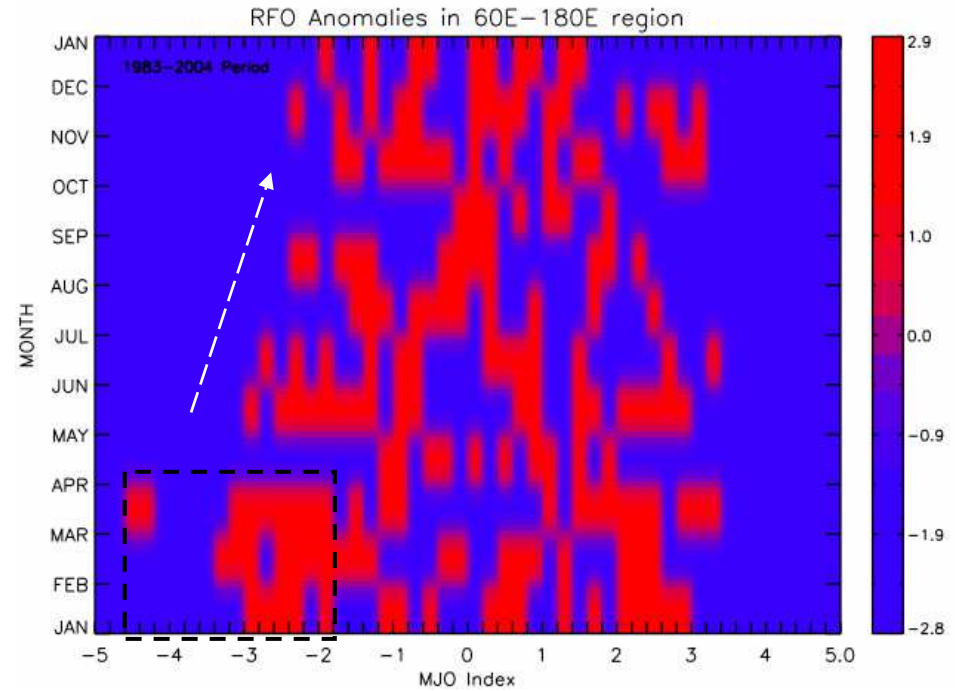
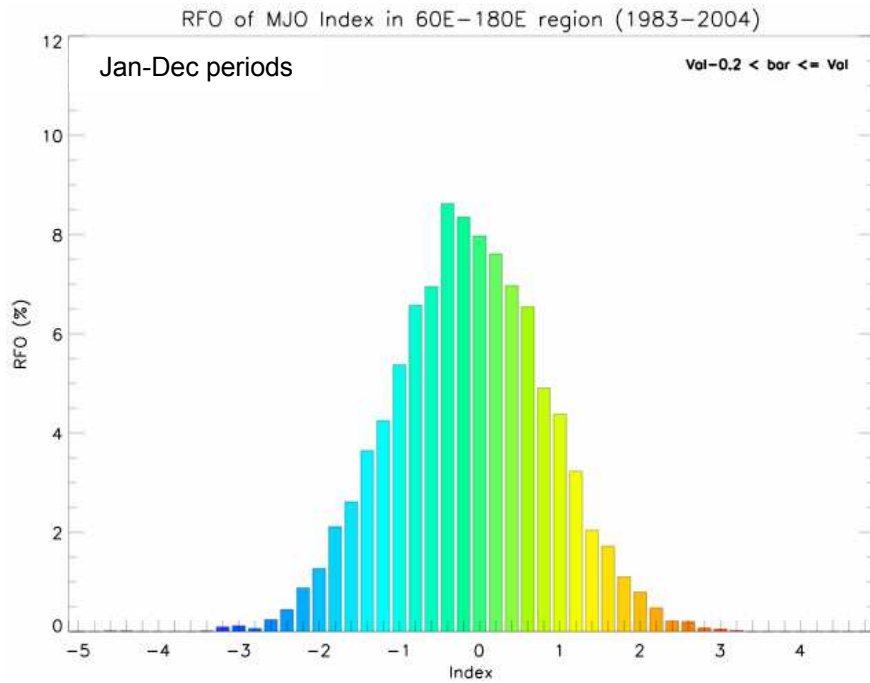


Composite of cloud regimes function of MJO phase (Chen and Del Genio, 2008)

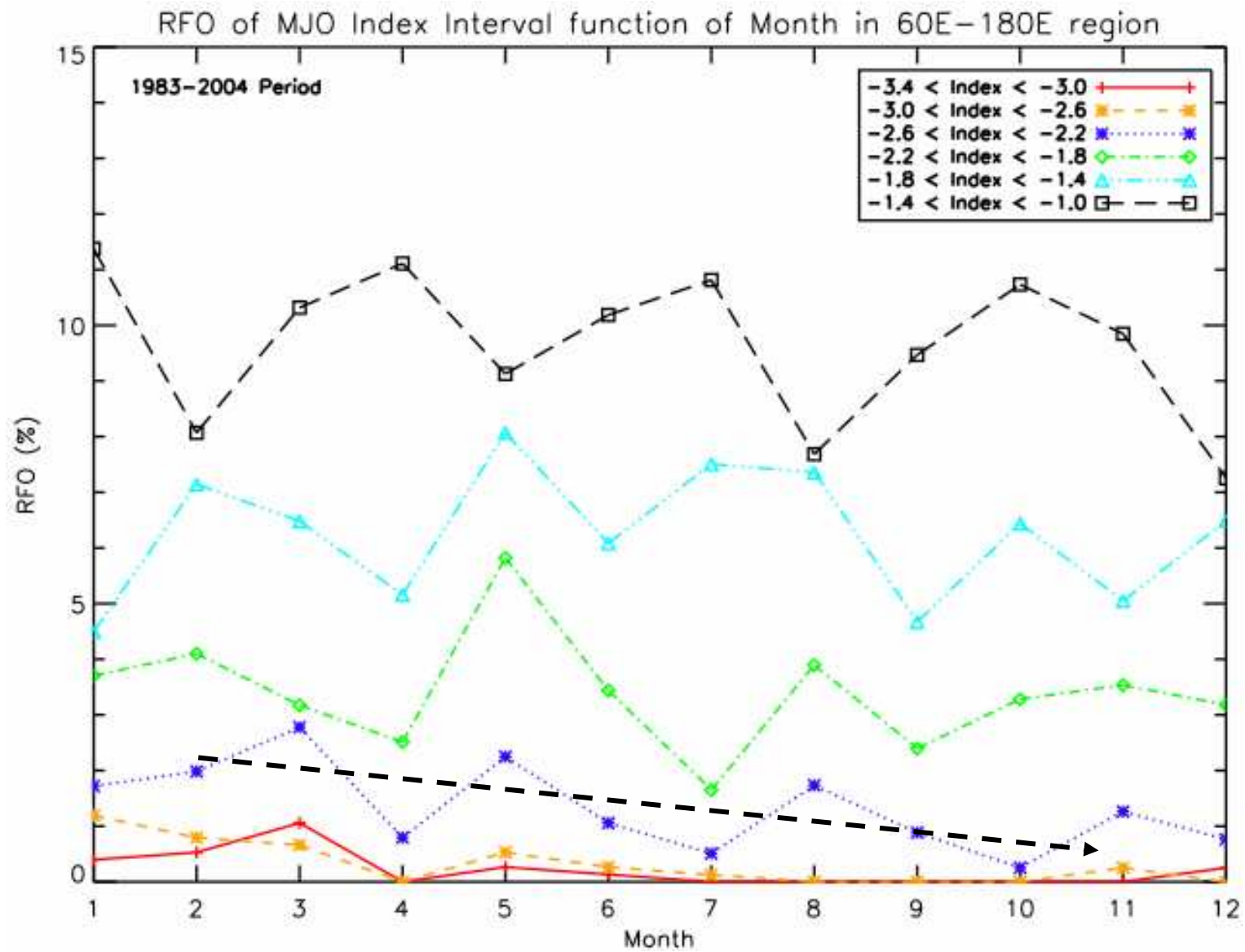
→ Consider a strong MJO event to be one when index < -1

→ Focus on the Indo-Pacific warm pool and the boreal winter (November-April)

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



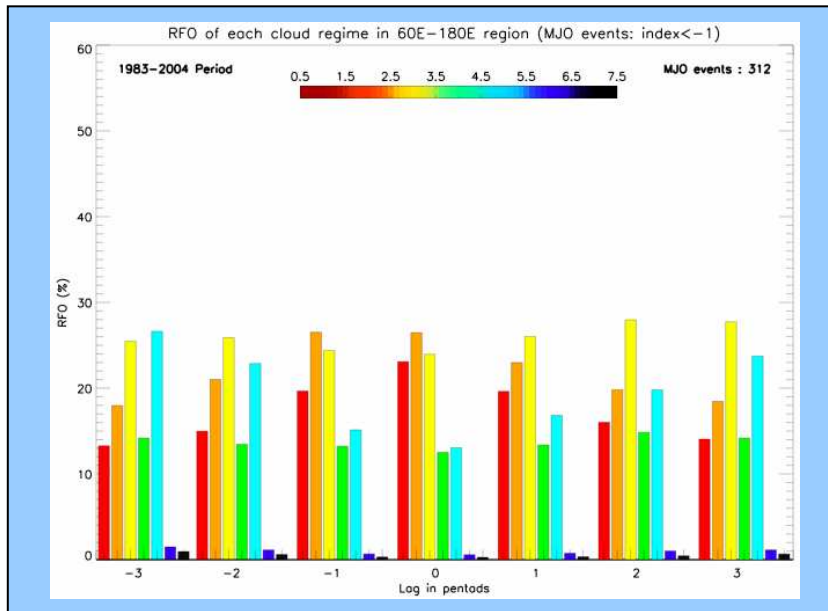
RFO of MJO Index Interval in 60E - 180 E region (1983 - 2004)



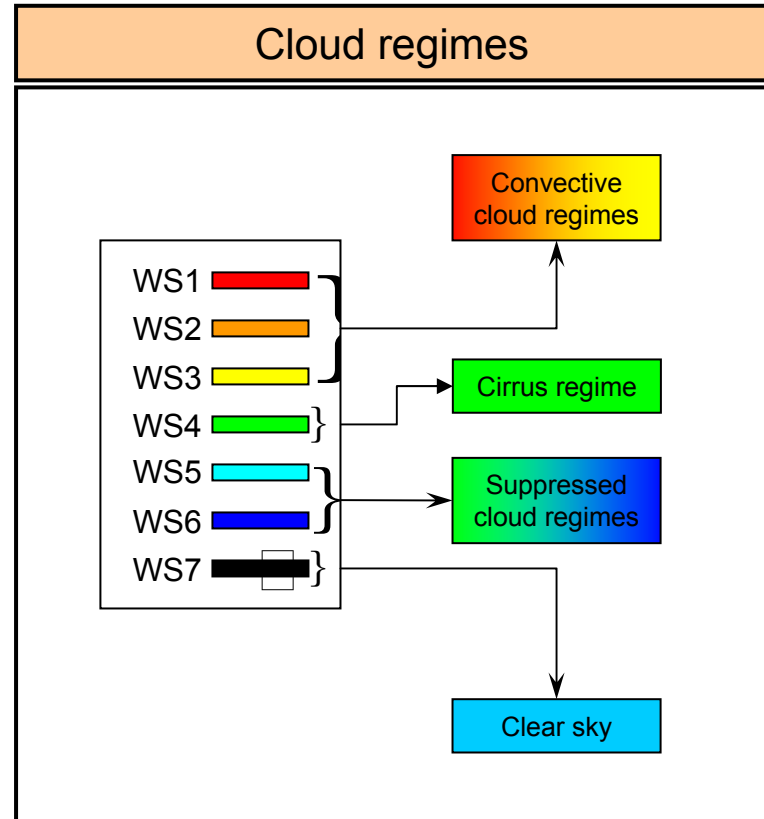
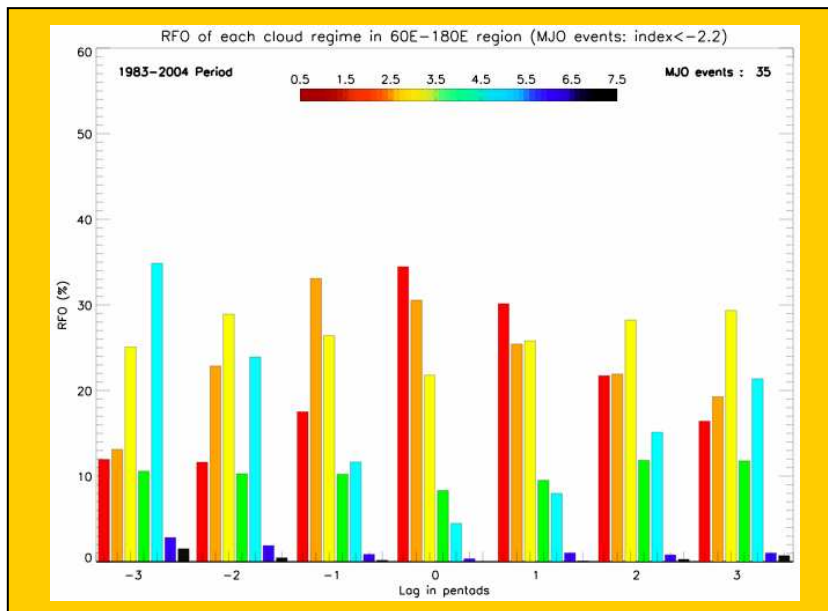
RFO of each cloud regime in 60E-180E region / 5S-5N latitude band

(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

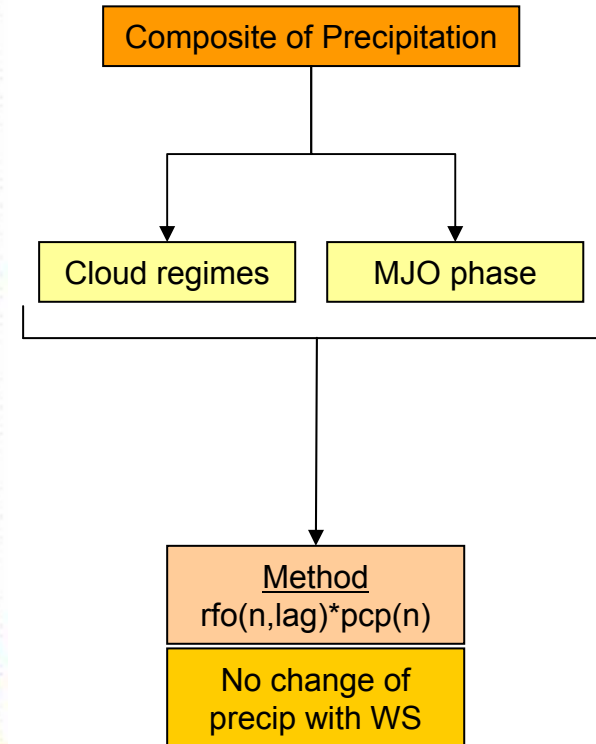
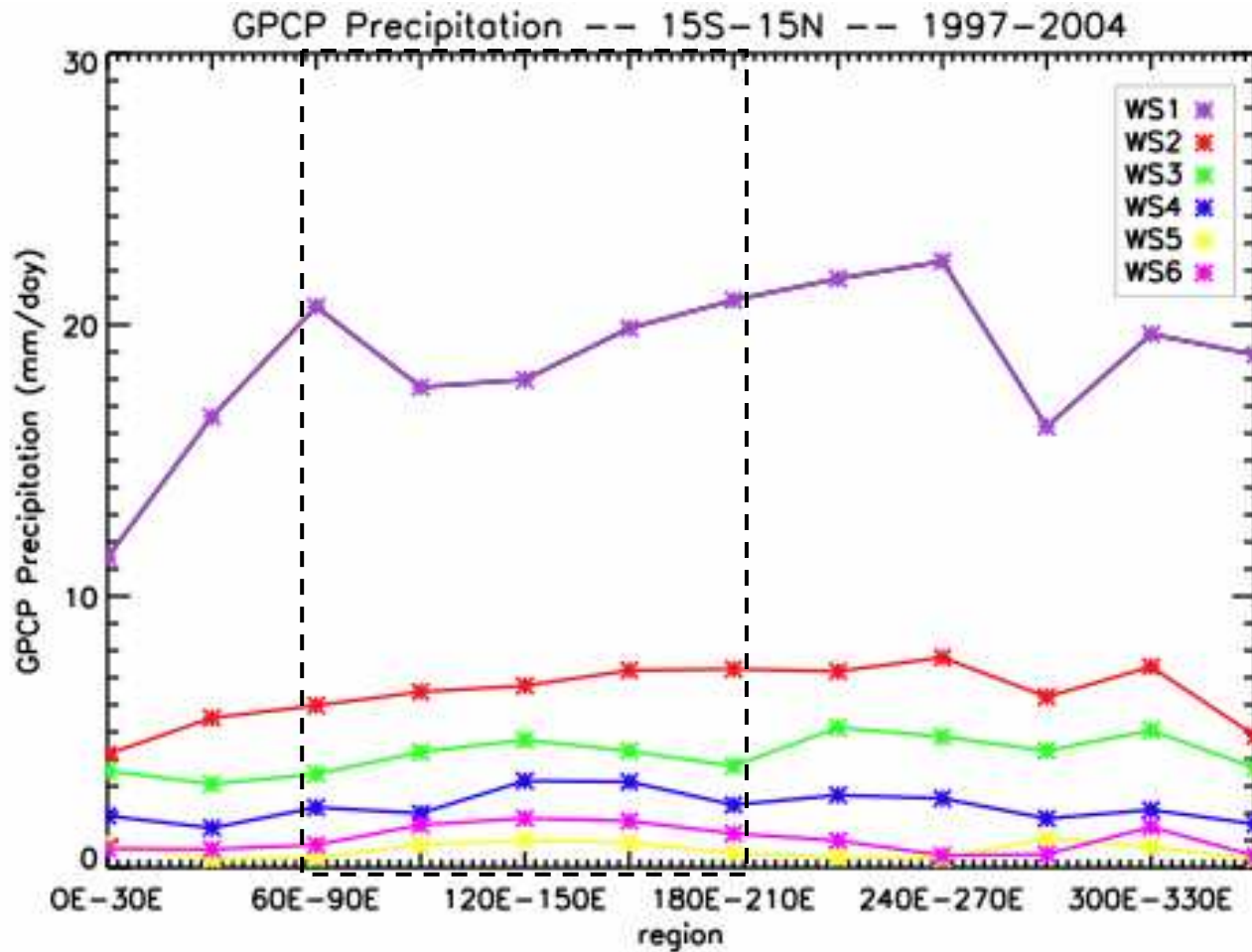
- GPCP Precipitation (1997-2004)
- ISCCP-FD Radiative Fluxes (1997-2004)
- GSSTF2 Surface Heat fluxes (1989-2000)

NCEP/NCAR Reanalysis (1983-2004)

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

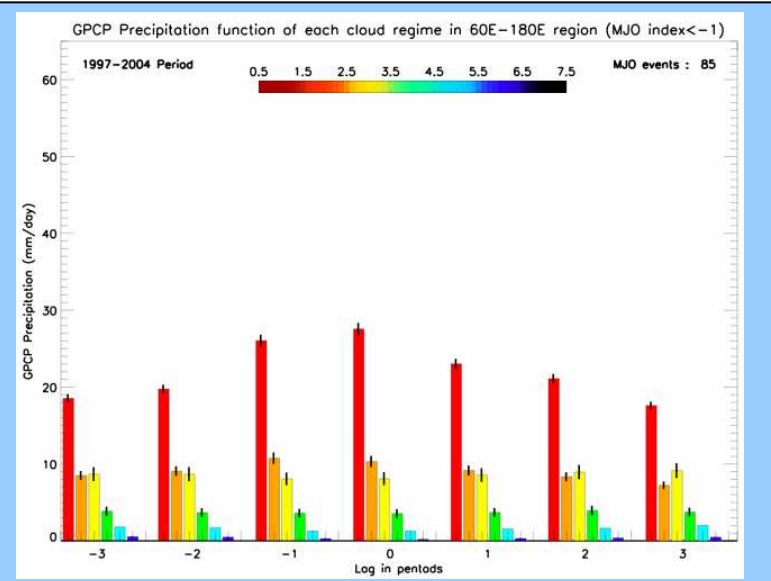
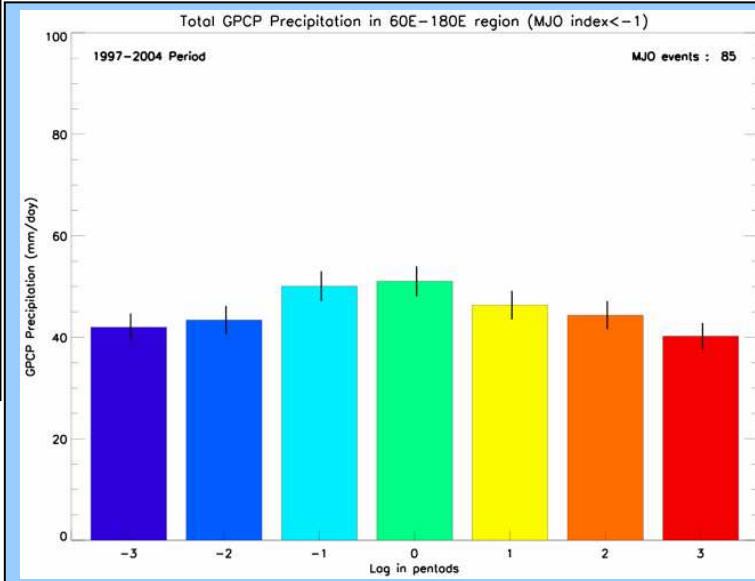
- GPCP : Global Precipitation Climatology Project
- ISCCP : International Satellite Cloud Climatology Project
- GSSTF2 : Goddard Satellite-Based Surface Turbulent Fluxes, version 2
- NCEP/NCAR : National Centers for Environmental Prediction / National Center for Atmospheric Research

Composite of precipitation in Tropics (1997 - 2004)

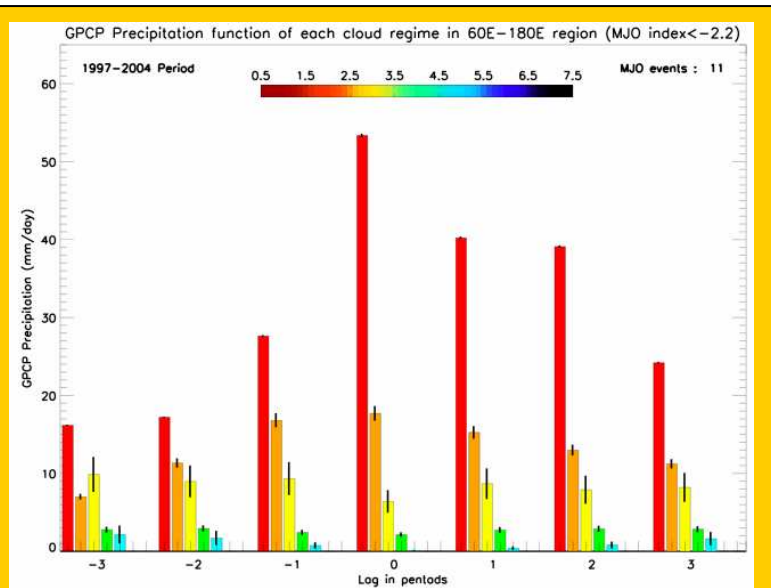
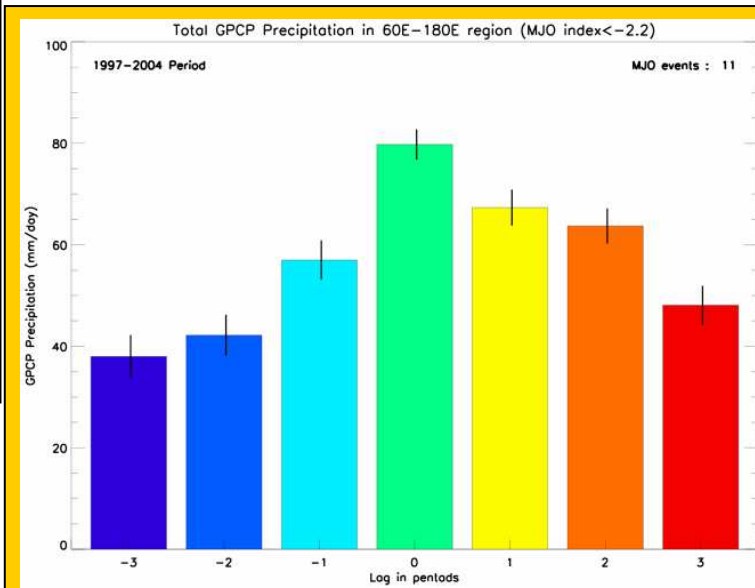


GPCP Precipitation and cloud regimes in 60E-180E region / 5S-5N latitude band (MJO events in November-April periods from 1997 - 2004)

Weak MJO (index < -1)



Strong MJO (index < -2.2)



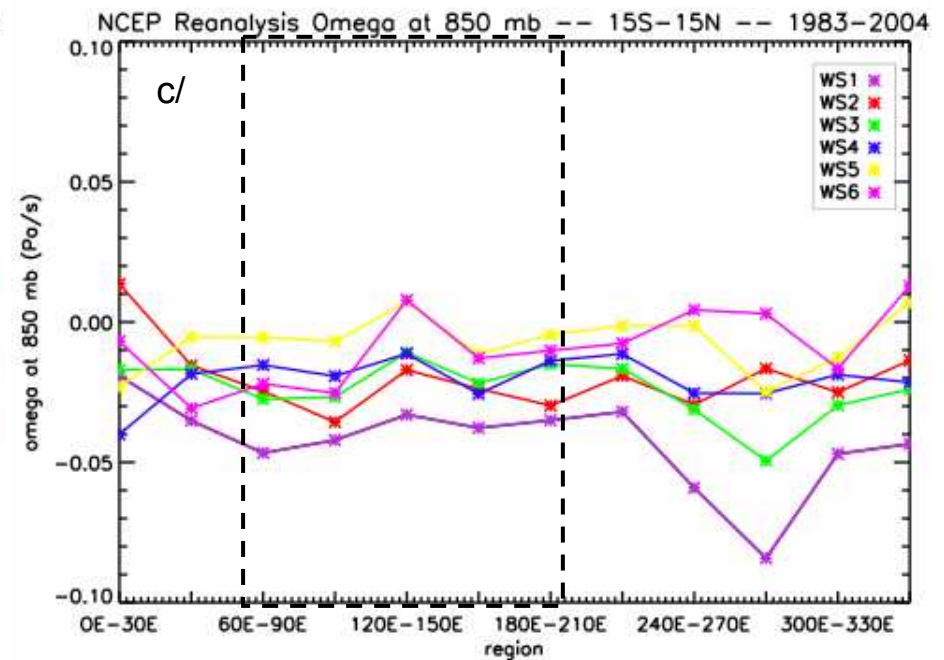
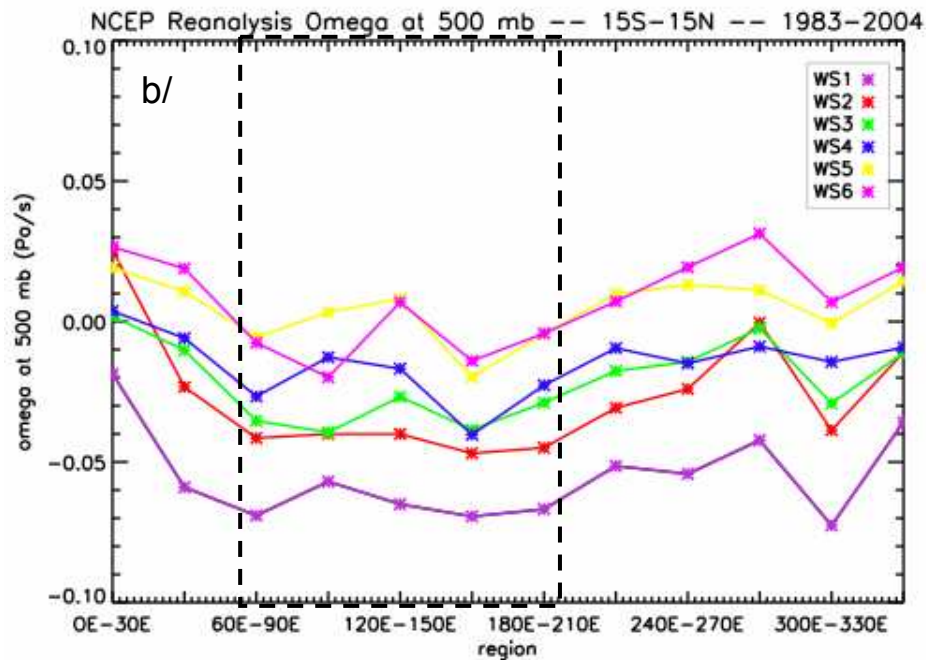
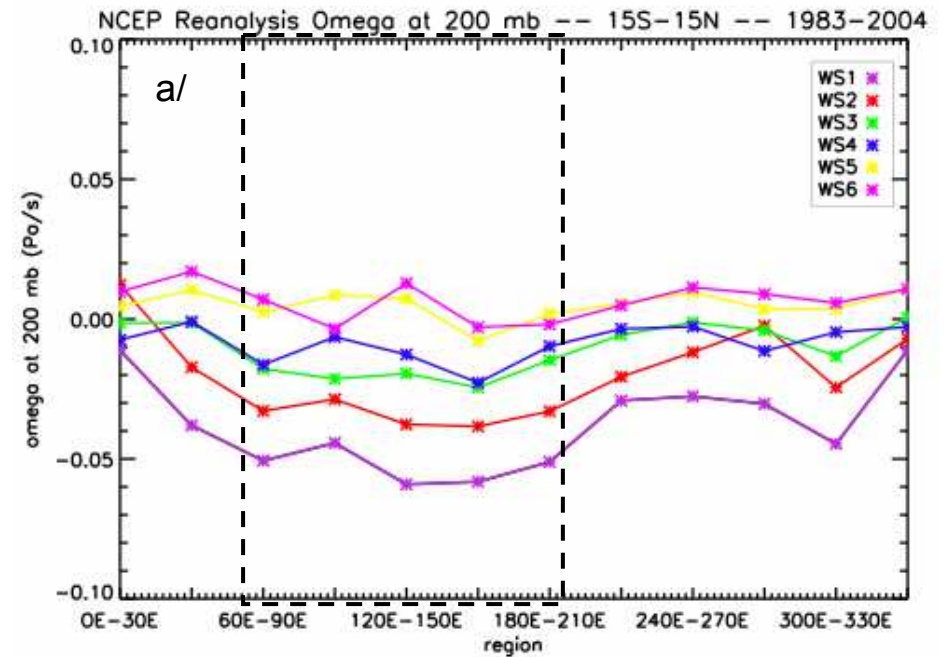
Composite of Omega in Tropics (1983 - 2004)

NCEP/NCAR Reanalysis

a/ Omega at 200mb

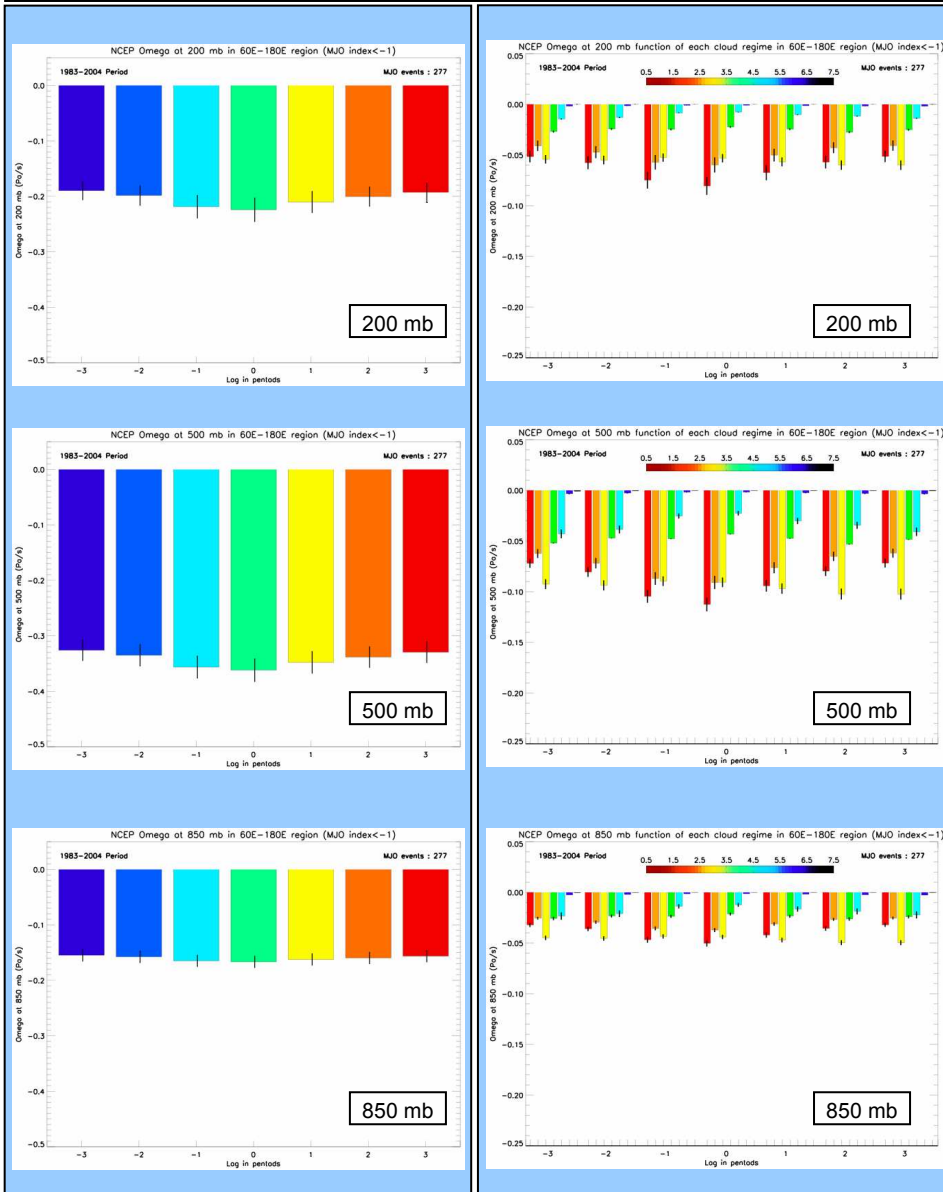
b/ Omega at 500mb

c/ Omega at 850mb

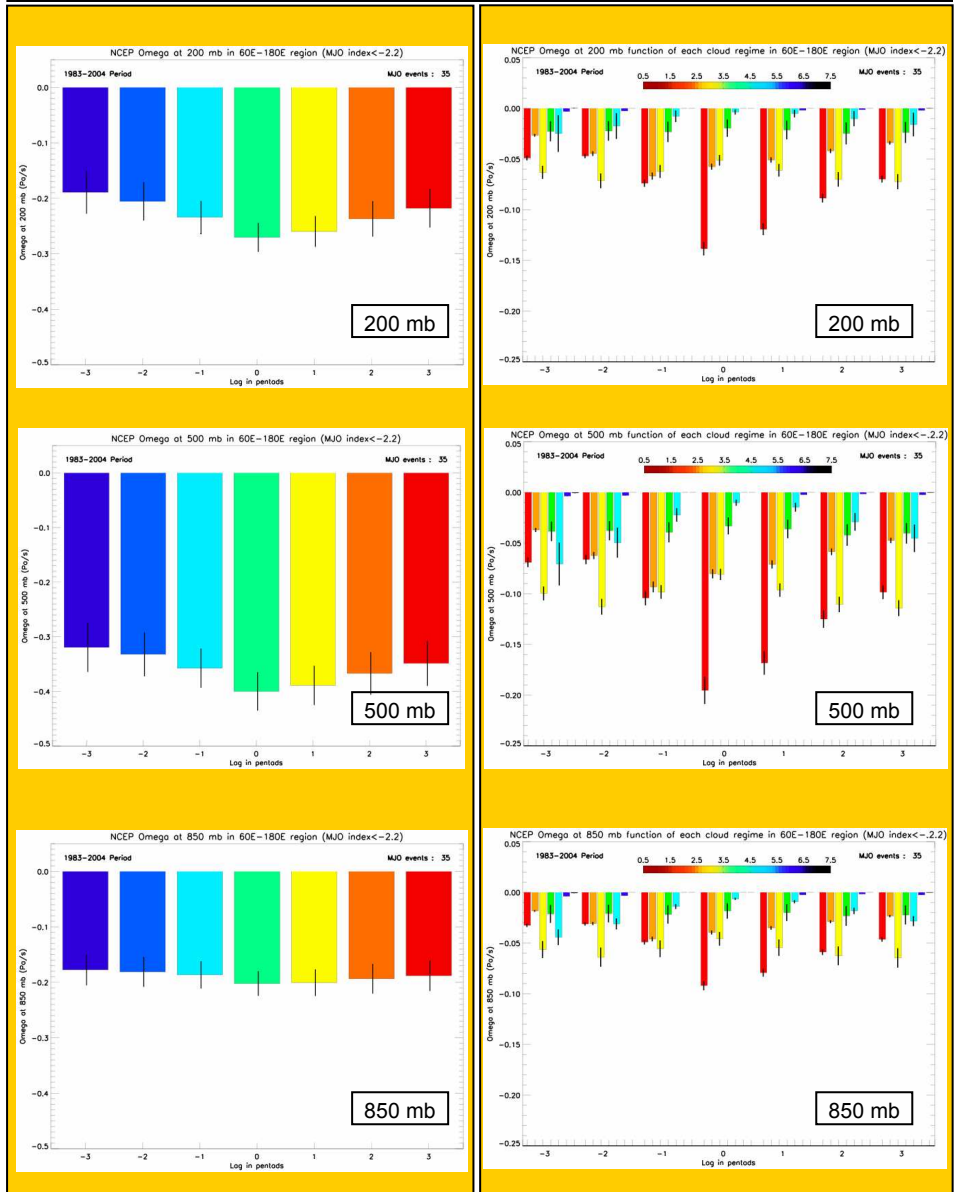


Composite of Omega in 60E-180E region / 5S-5N latitude band (1983 - 2004)

Weak MJO (index < -1)



Strong MJO (index < -2.2)



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
- Increase of surface flux contribution from organized convection at MJO peak
- 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

The background of the slide is a photograph of a sunset over a vast body of water. The sky is a deep blue with wispy white clouds, and the sun is low on the horizon, creating a bright, colorful glow that reflects on the water's surface. The water transitions from a lighter blue near the horizon to a darker blue in the foreground. A solid blue rectangular box with a thin white border is centered on the slide, containing the text "Thank you for your attention" in white, sans-serif font.

Thank you
for
your attention