Variation of Energy Transfer to the Atmosphere associated with the MJO

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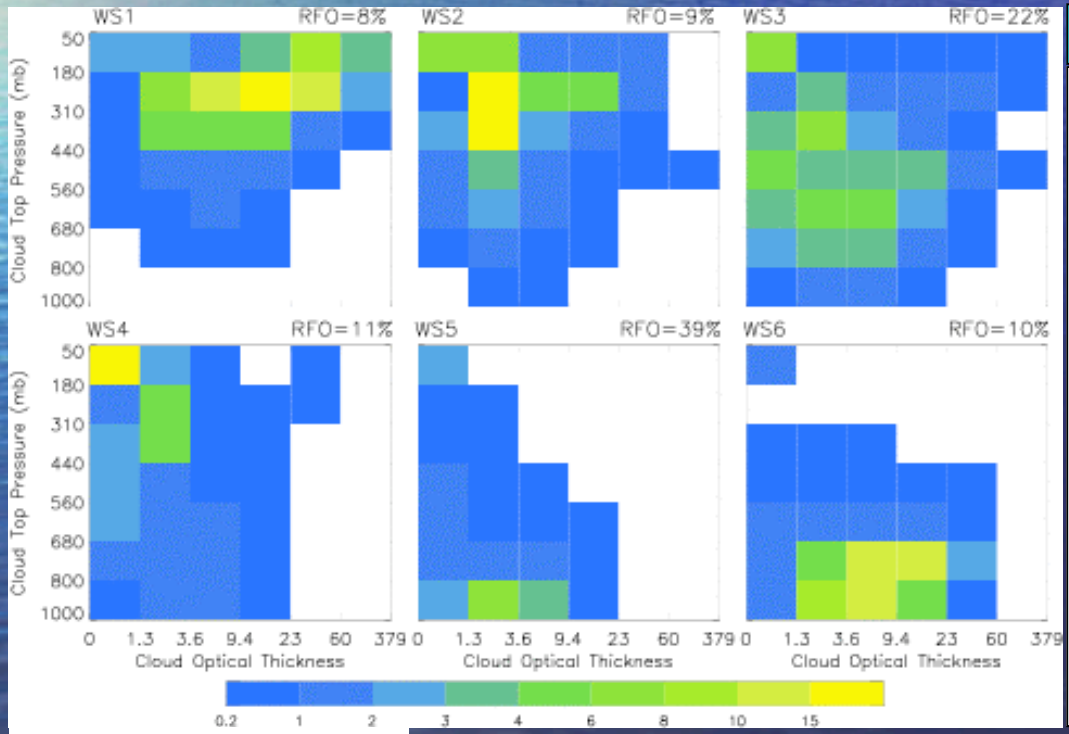
Background

ISCCP Cluster Analysis

- ISCCP D1 data covering 21.5 years
- Identification of 6 Weather States in the Tropics
- RFO as a function of longitude
- Strongest convective activity in the Indo-Pacific region



Rossow et al, GRL, 2005

Cluster Analysis + ISCCP D1 data

WS1 : Deep cumulus clouds

WS2 : Anvils clouds

WS3 : Congestus clouds

WS4 : Cirrus clouds

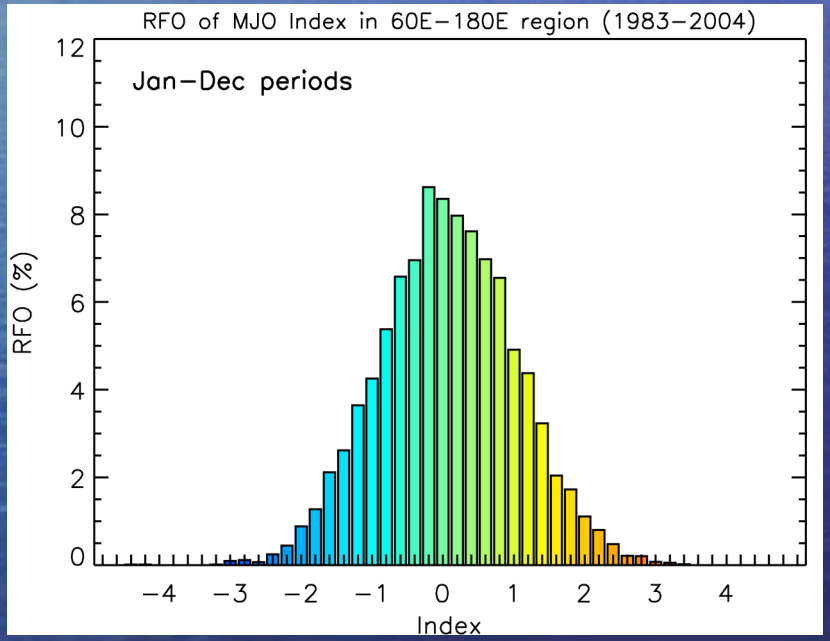
WS5 : Shallow cumulus clouds

WS6 : Stratocumulus clouds

Background

MJO Index Threshold

- MJO Index based on 200 mb velocity potentiel anomalies
- MJO signal present all over the year
- Definition of Index thresholds for weak/strong MJO events



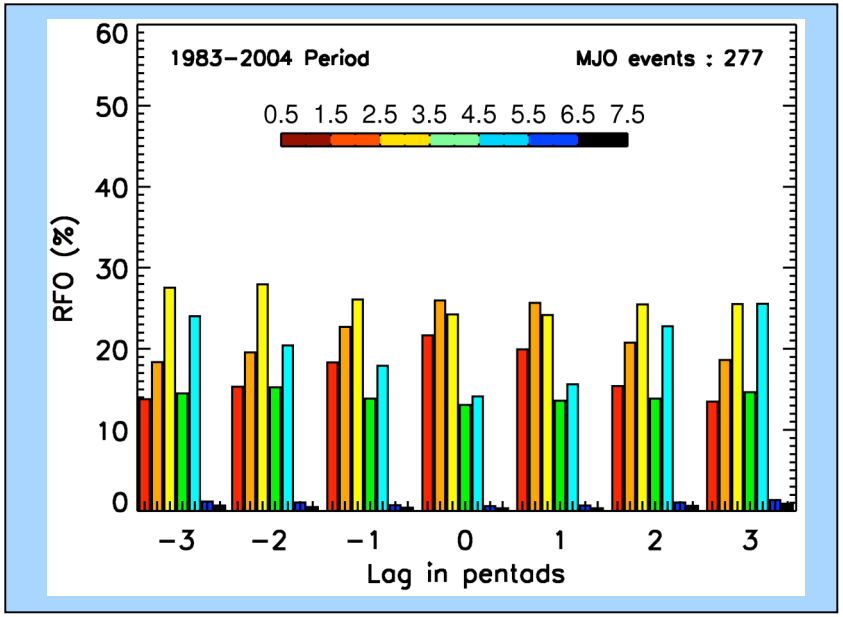
Tropical cloud regimes and MJO phase

- Characterization of organized and disorganized convection
- Less to more organized convection on the MJO scale

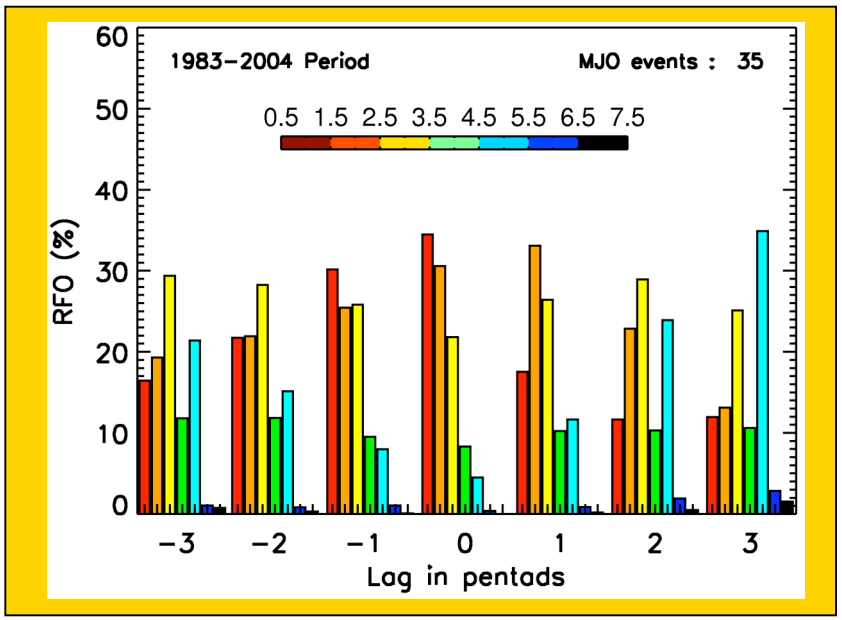
RFO of each cloud regime in 60E-180E region / 5S-5N latitude band

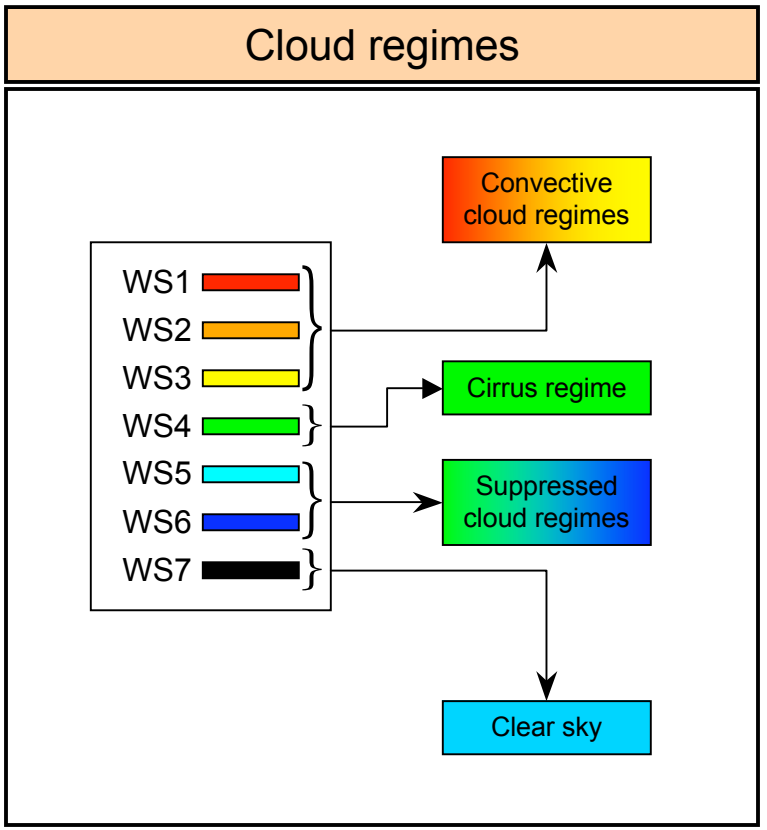
(MJO events in November-April periods from 1983 - 2004)

Weak MJO (index < -1)



Strong MJO (index < -2.2)





Outline

1. Data sources
2. Diabatic heating during MJO
3. Variation of total energy transfer
4. Tests for models

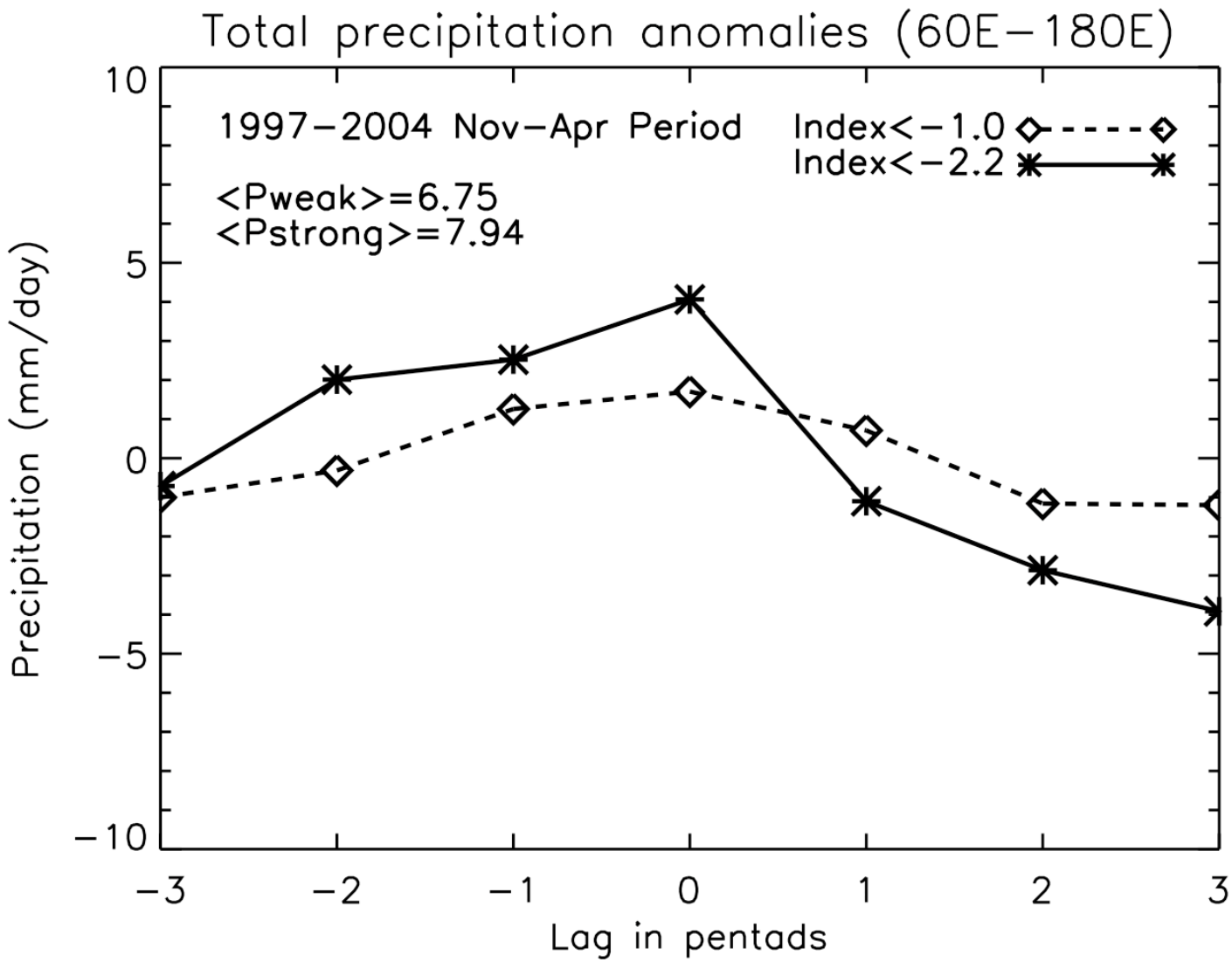
Atmospheric diabatic heating

$TV_j = \sum_{i=1}^{i=7} [RFO_{ij} \times Var_{ij}]$	GPCP	ISCCP-FD	GSSTF2
Space resolution	1° x 1°	2.5° x 2.5°	1° x 1°
Time resolution	day	3 hours	day
Temporal domain	1 Jan 1997 - 31 Dec 2004	1 Jan 1997 - 31 Dec 2004	1 Jan 1989 - 31 Dec 2000
Vertical levels	Surface	TOA, Surface, and Atmosphere	Surface
Variables	Precipitation	Radiative net fluxes	Surface fluxes

- GPCP : Global Precipitation Climatology Project
- ISCCP : International Satellite Cloud Climatology Project
- GSSTF2 : Goddard Satellite-Based Surface Turbulent Fluxes, version 2

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

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



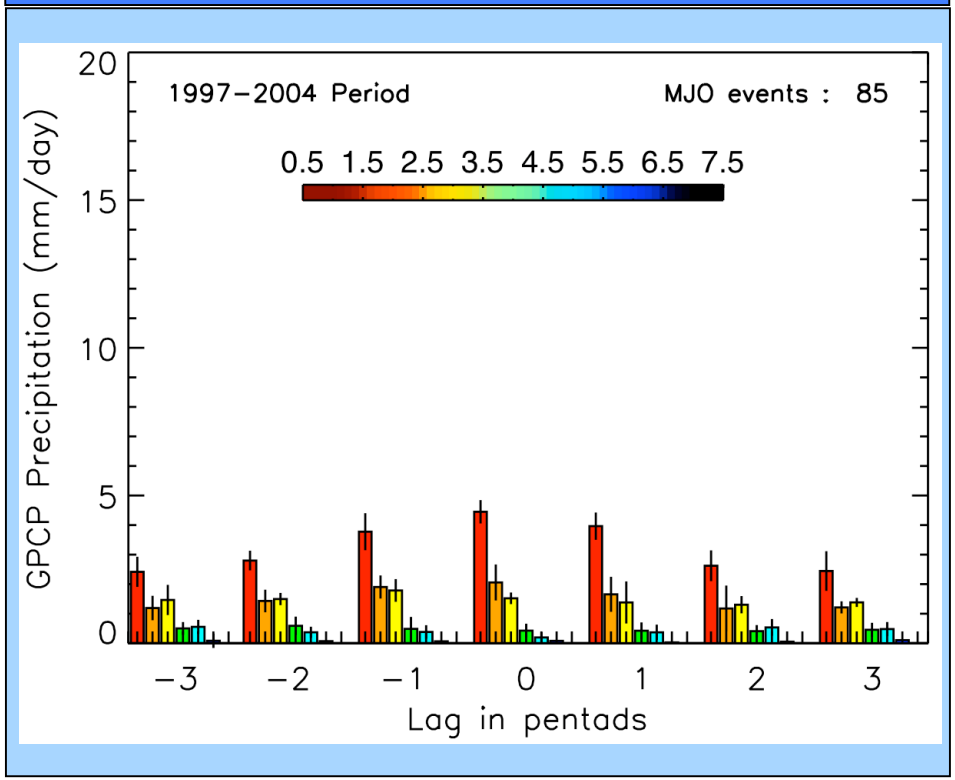
Asymmetry of total precipitation anomalies

Hint showing us that convection leads MJO

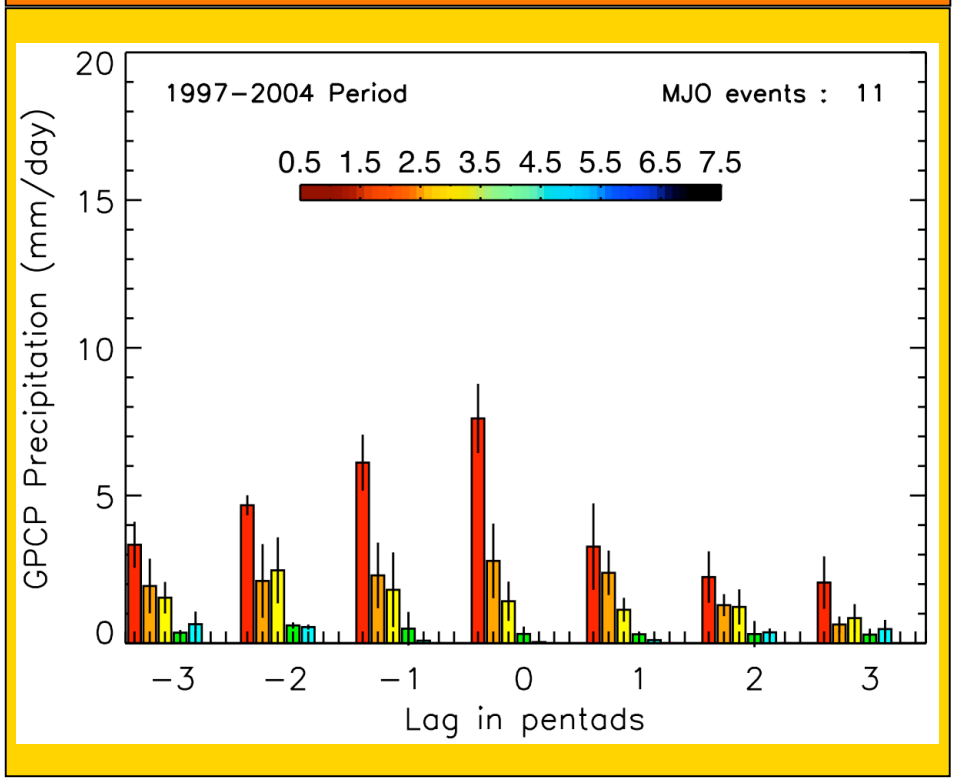
GPCP Precipitation and cloud regimes in 60E-180E region / 5S-5N latitude band

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

Weak MJO (index < -1)



Strong MJO (index < -2.2)



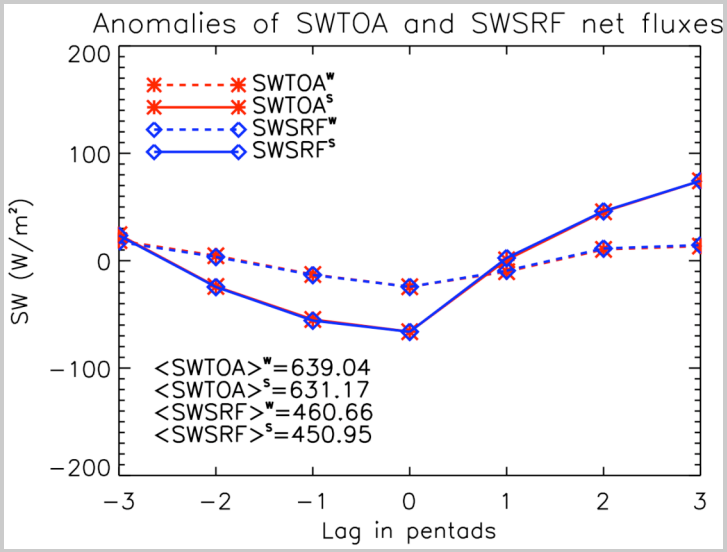
⇨ Temporal asymmetry of total precipitation anomalies due to WS1

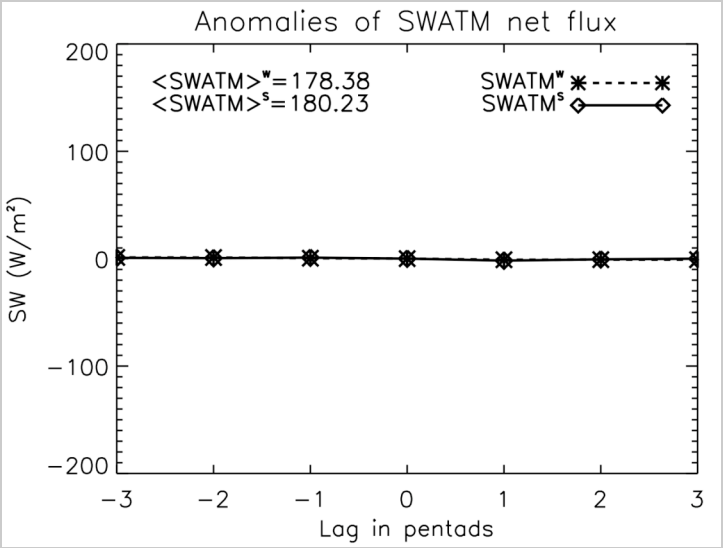
⇨ Convection could strengthen the wave

Composite total radiative net flux anomalies in 60E-180E region / 5S-5N latitude band

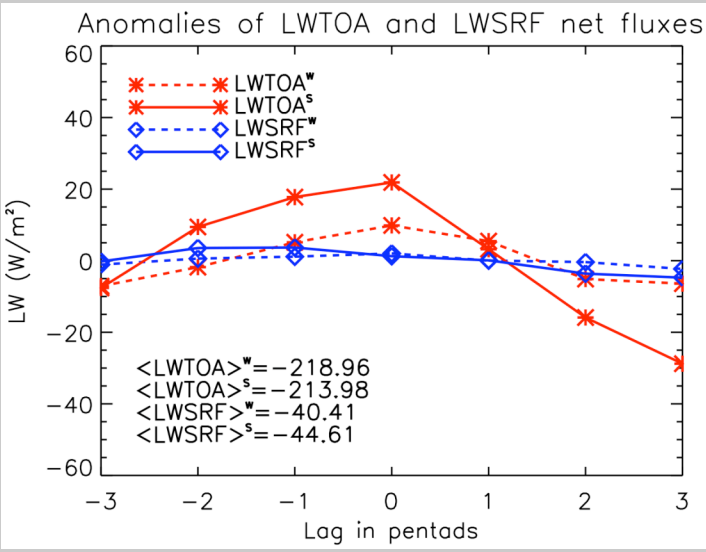
(MJO events in November-April periods from 1997 - 2004)

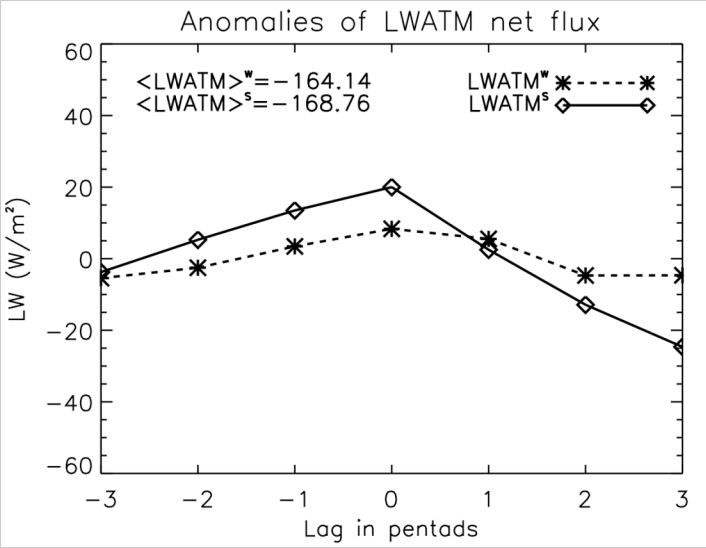
Shortwave net flux anomalies





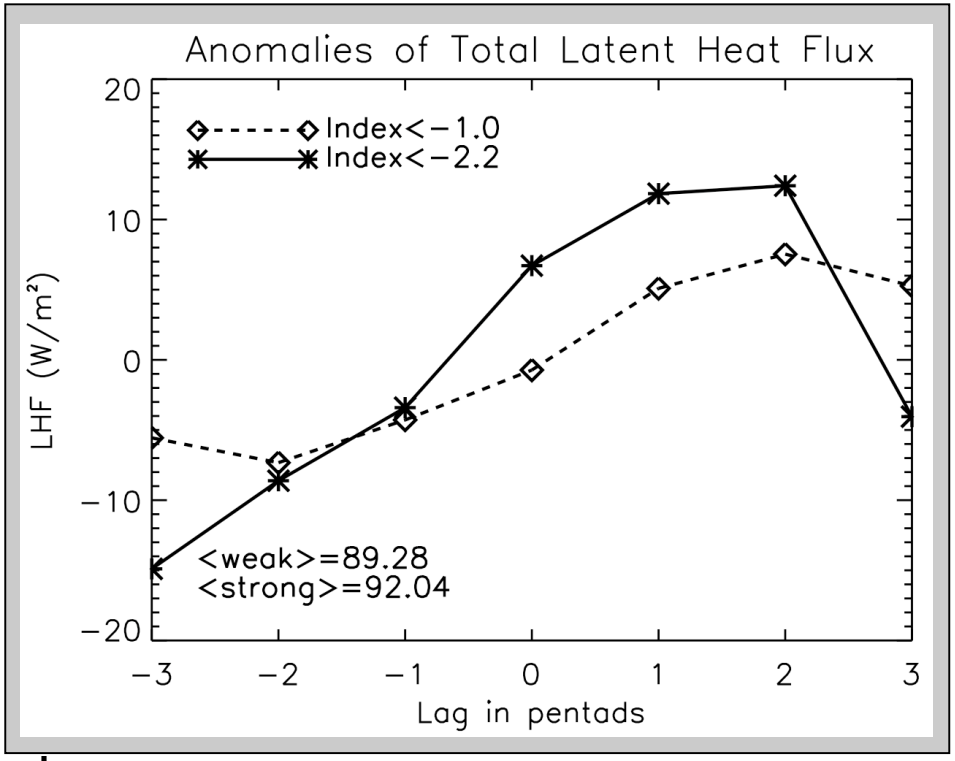
Longwave net flux anomalies





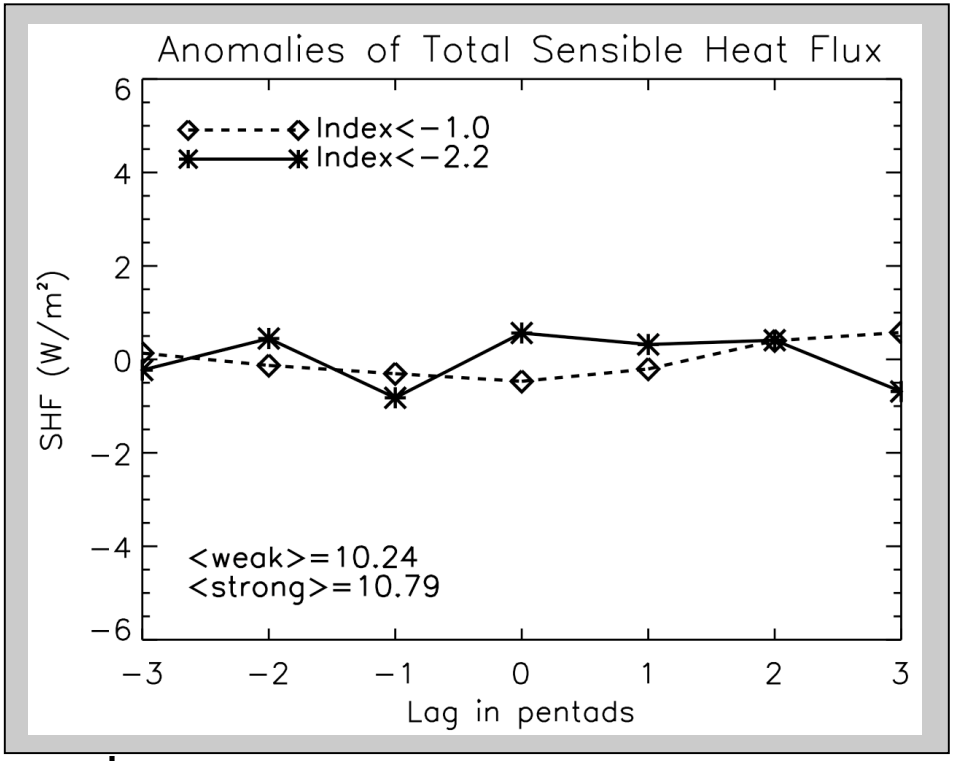
Composite Surface Heat Flux Anomalies in Tropics (1989 - 2000)

Latent Heat Flux Anomalies



- Maximum of total Latent Heat Flux anomalies at lag 2
- Latent heat fluxes lag the convection
- Hint showing a weakness of the WISHE theory

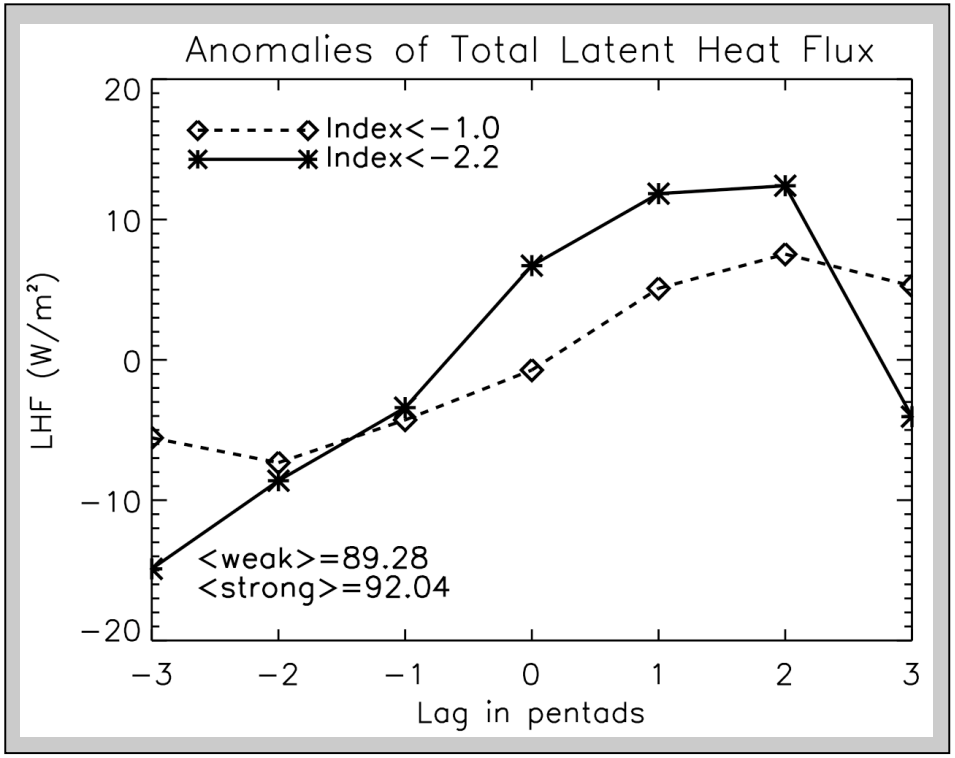
Sensible Heat Flux Anomalies



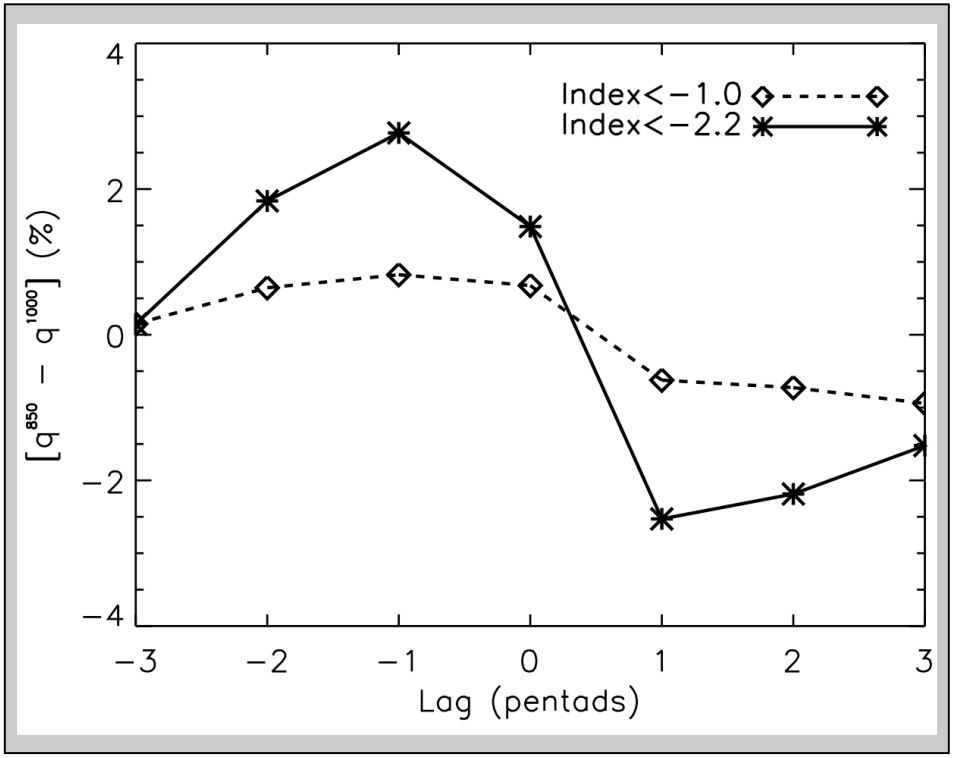
- Fluctuate around zero
- Not dependent with the MJO signal and the MJO phase

Composite Latent Heat Flux Anomalies in Tropics

Latent Heat Flux Anomalies



Near Surface-Air Specific Humidity Anomaly Difference



Moistening/Drying of the lower troposphere

↓

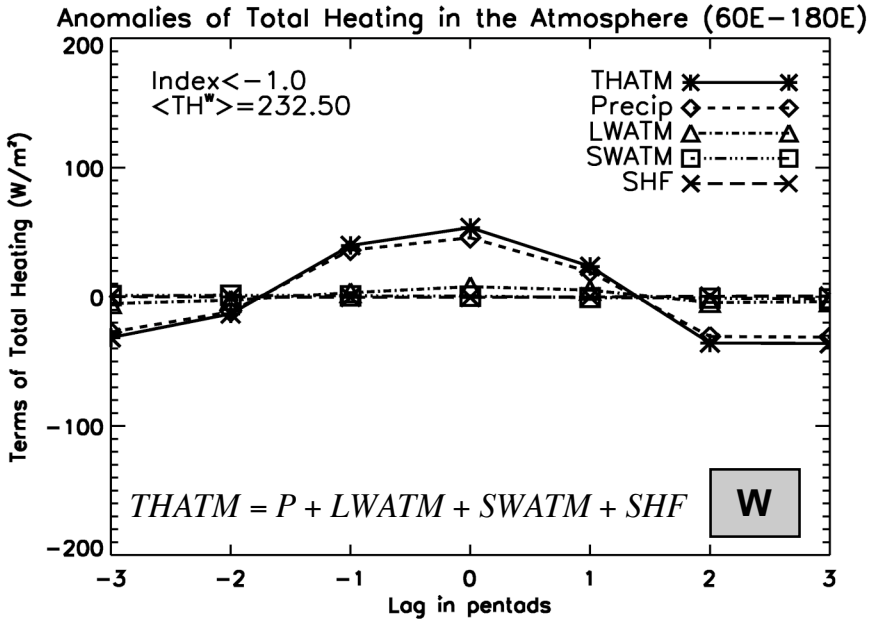
Negative/Positive latent heat flux anomalies

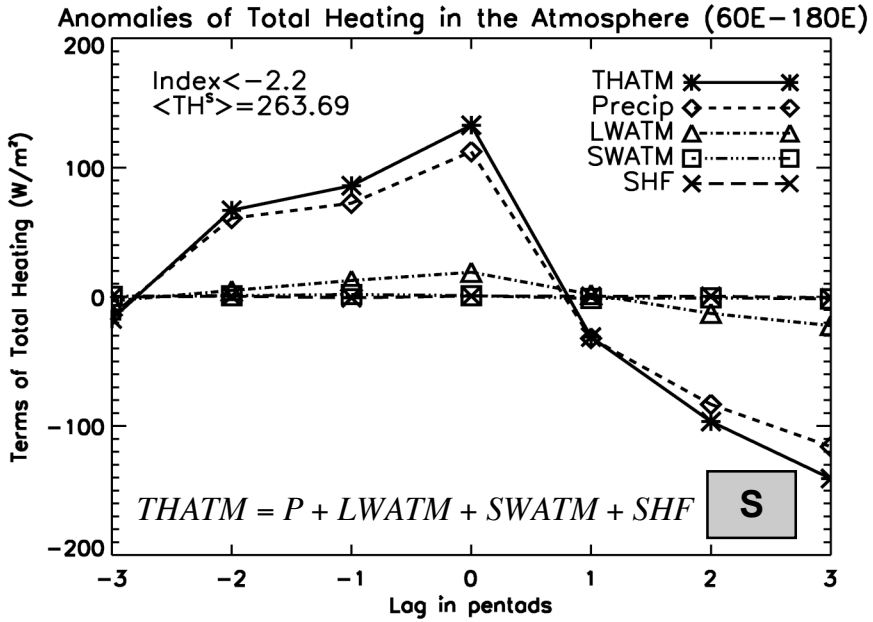
↓

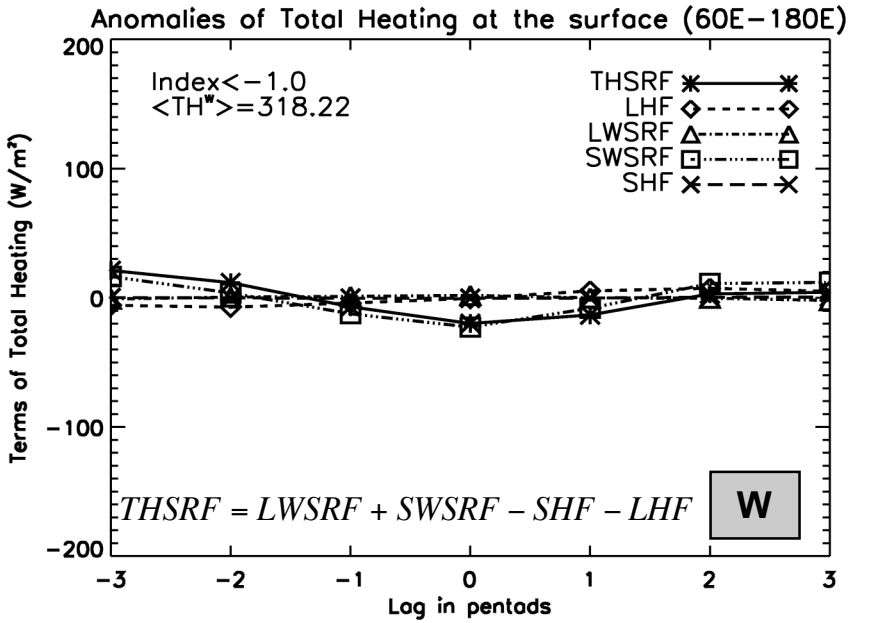
Latent heat fluxes reacts to humidity

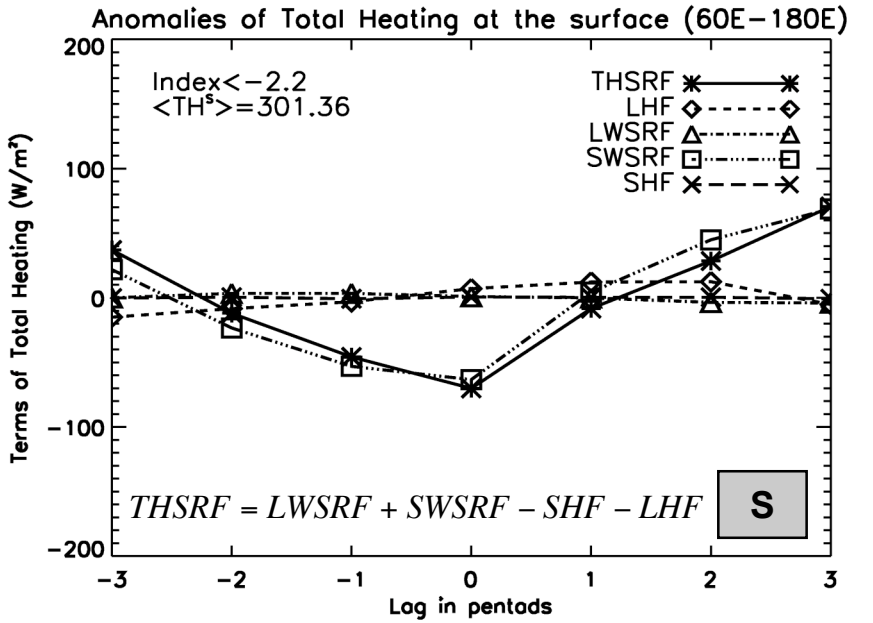
LHF are not driving the MJO cycle

Variation of Energy Transfer associated with the MJO









Tests for Models

Test Amplitude & Phase of atmospheric diabatic heating terms

- Most of precipitation come from WS1
- Temporal asymmetry of total precipitation anomalies
- Surface latent heat fluxes lag convection
- Total heating in the atmosphere mainly due to precipitation
- Passive response at the surface, which is directly linked to cloud net anomalies

Verify behavior in Observations

Things to do …

- **Finer Time Resolution (daily lags)**
- **Link between weak and strong MJO events**
- **Vertical structures**
- **Convective Tracking life cycle**