Convective Developments in the Madden-Julian Oscillation with Equatorial Rossby Wave in the Equatorial Indian Ocean

Chiharu Takahashi（JAMSTEC/IORGC)

Introduction

- A baroclinic mode of the combined westward equatorial Rossby wave (ER) and eastward Kelvin structure is prominent for the MJO (Masunaga et. al, 2006)
- In equatorial Indian ocean (IO), where is the onset region of MJO, the occurrence variance of convection maximum

associated with an ER Is largest in the southern fall to winter .

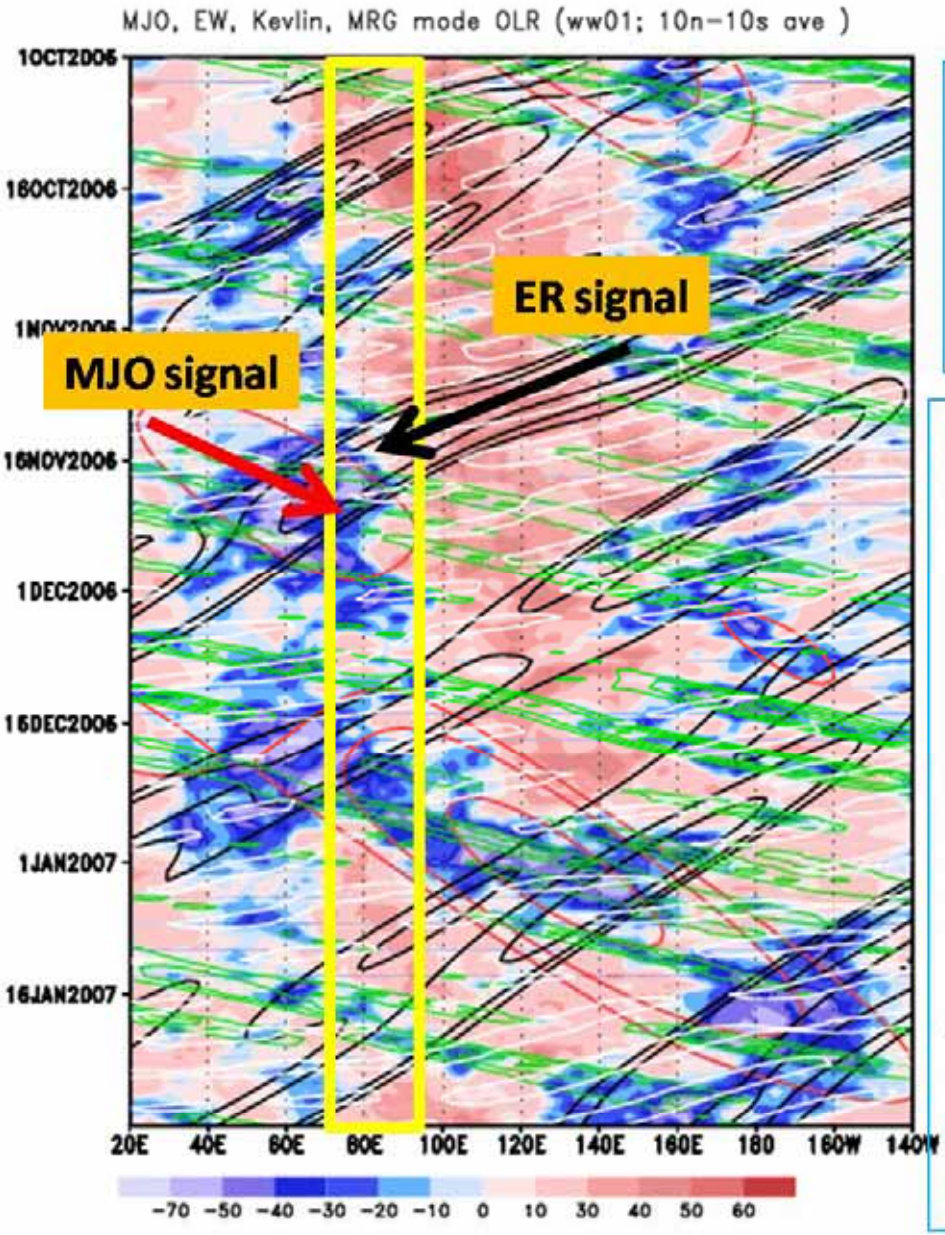
→ What is the mechanism of convective development ?

What is the role of equatorial wave to the environmental change ?

Objective

To investigate the differences in the convective development of MJO in association with the westward propagation of ER
In equatorial Indian ocean (IO).

Data and Analytical method



Data

- JRA/JCDAS (1.25deg)
- OLR
- NOAA OISST

→1985-2007

Analytical method

①OLR-MJO filter

（wave number: 1-5, period : 30-120days）

n=1 ER filter

（Wheeler and Weickmann (2001)）

②Equatorial Indian Ocean（70-90E,7.5N-7.5S)

MJO negative anomaly <-10 (W/m^2)

ER negative anomaly < -8 (W/m^2) —ER event

positive anomaly > 5 (W/m^2) —no ER event

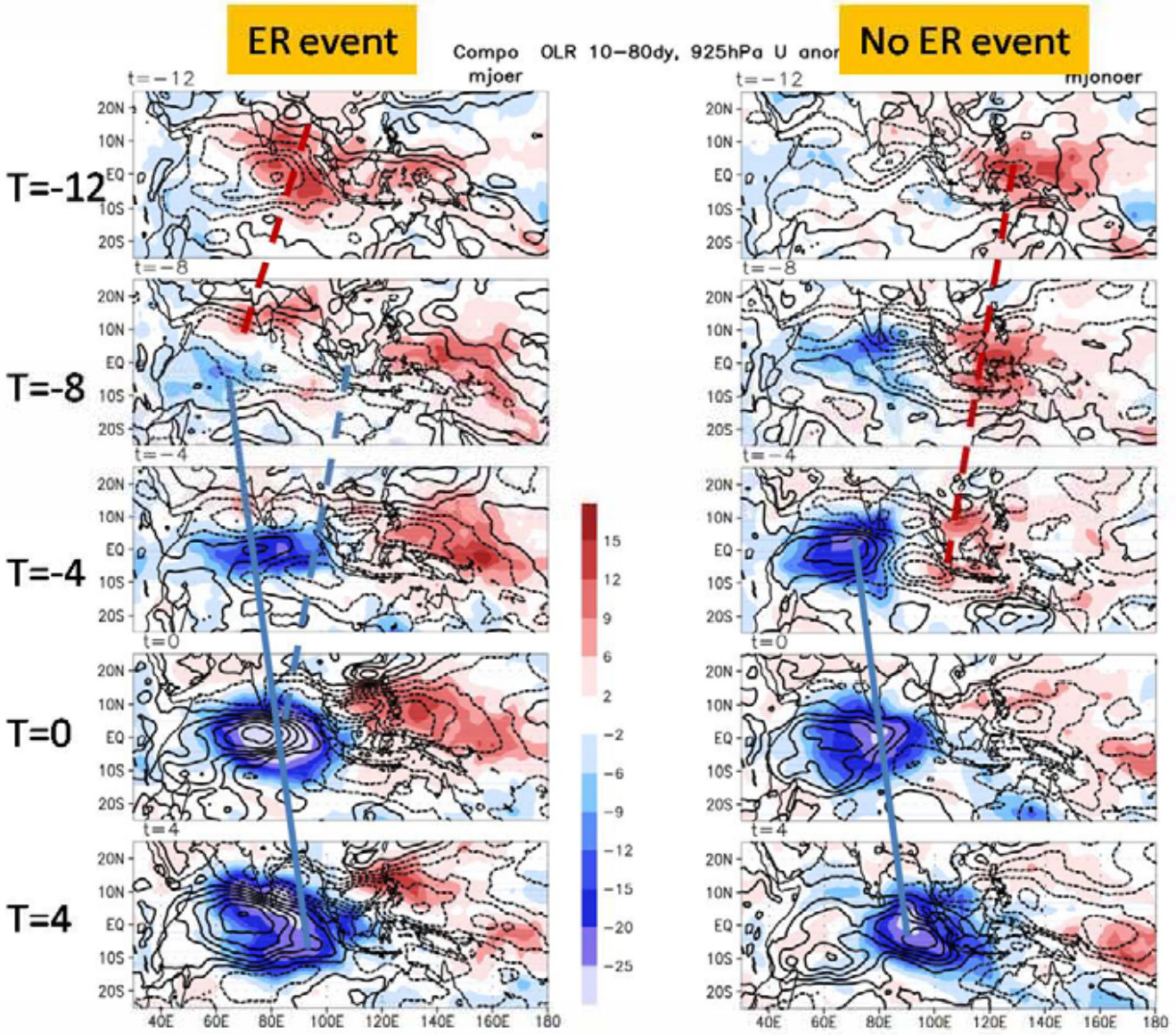
Area-meaned OLR is minimum day

→ each case is composited as Lag=0

＊all MJO（110 cases）

—ER envent（48cases）, no ER event（46cases）

Convection and Zonal wind anomalies



Suppressed convective anomaly

Active convective anomaly

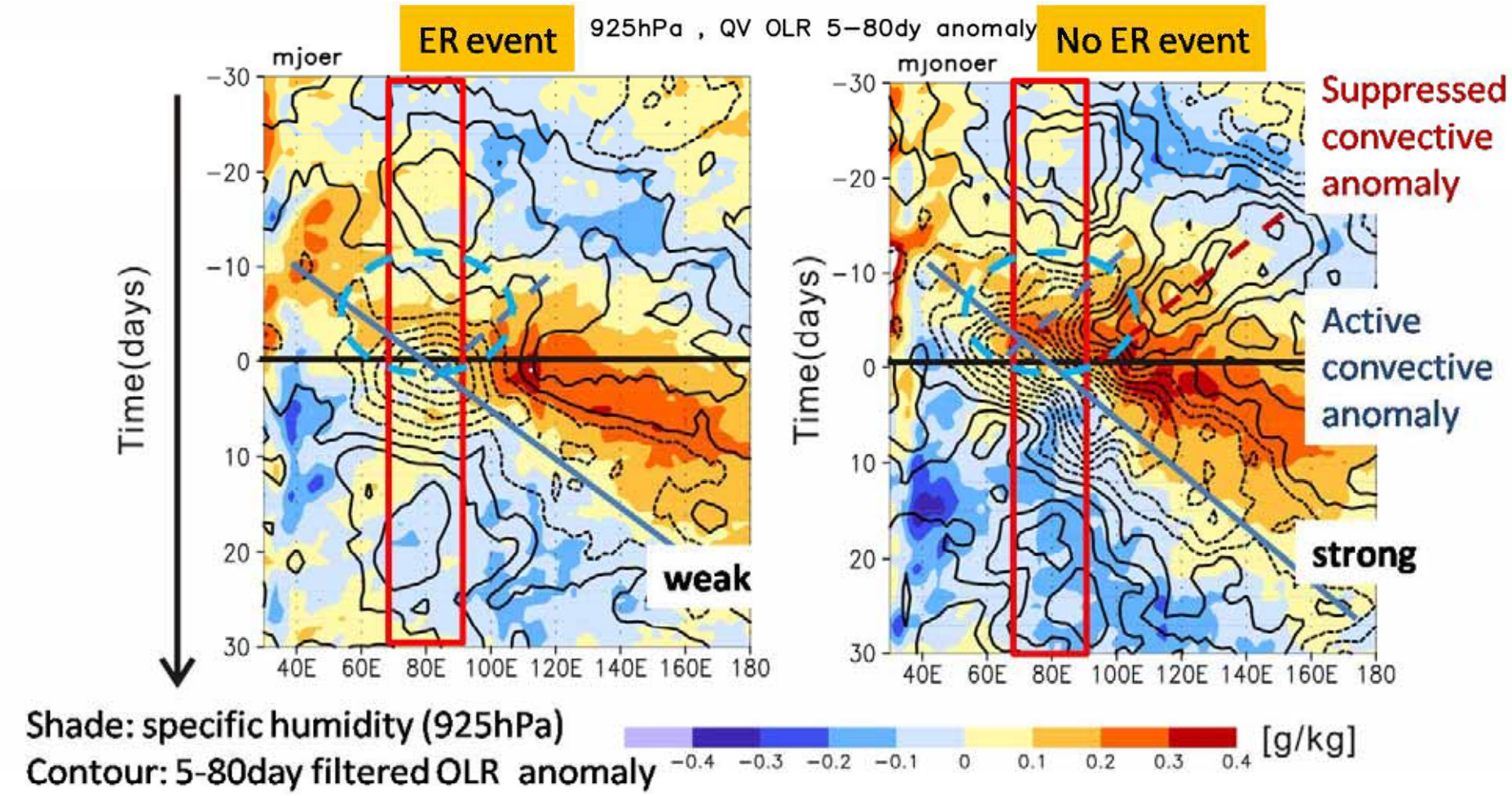
- Westward propagating **active anomaly** intersect s eastward active anomaly

- Westward propagating **suppressed anomaly** intersects eastward active anomaly

Shade: 10-80day filtered OLR anomaly

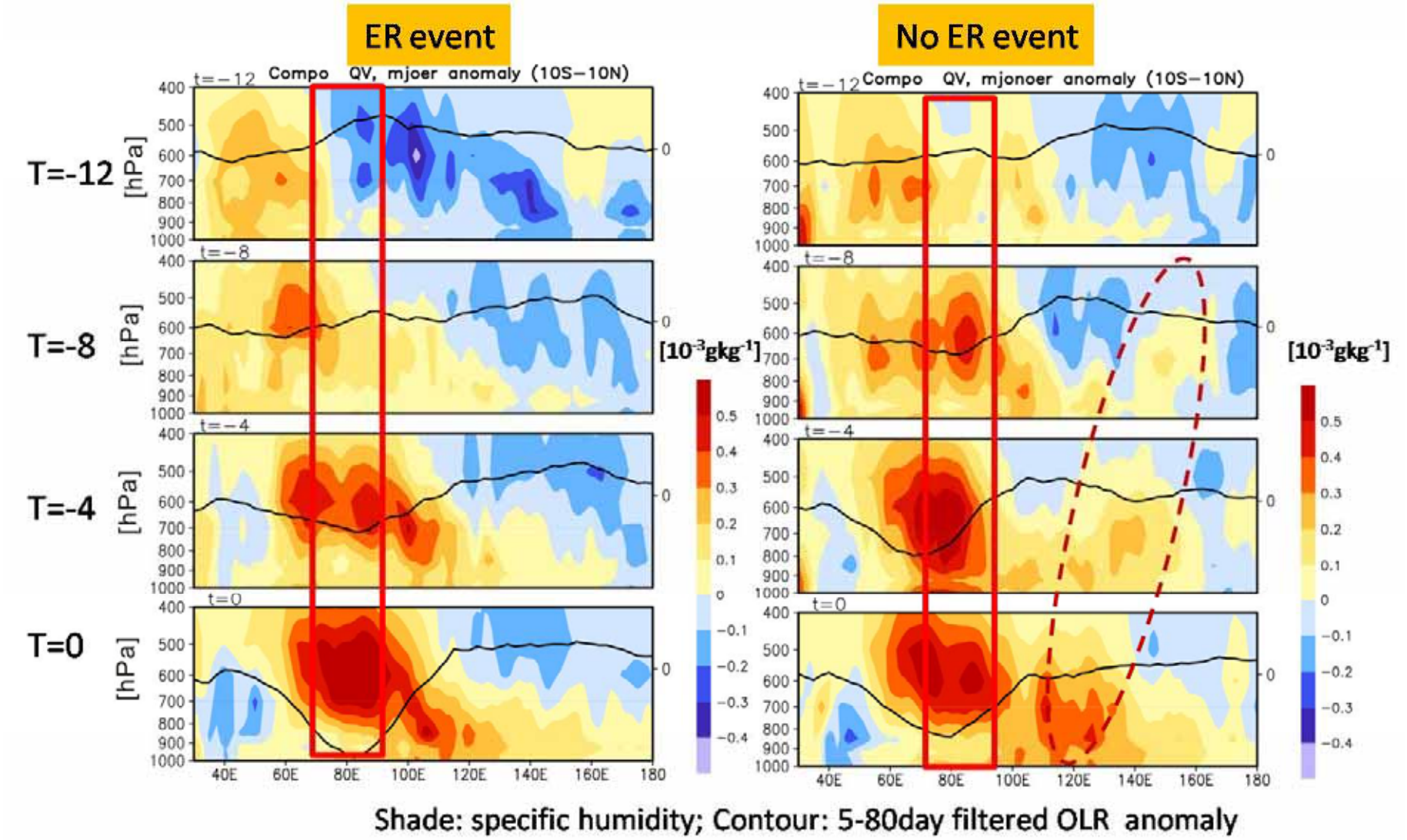
Contour: Zonal wind (925hPa) anomaly

Moisture variation (low-level)



- The anomalies of the low-level moisture precede the eastward propagating active convective anomalies in both events.
- The ER event shows convective developments in smaller positive moisture anomaly than those of no ER event in IO.
- Eastward propagation of MJO signal is stronger in no ER event than ER event.

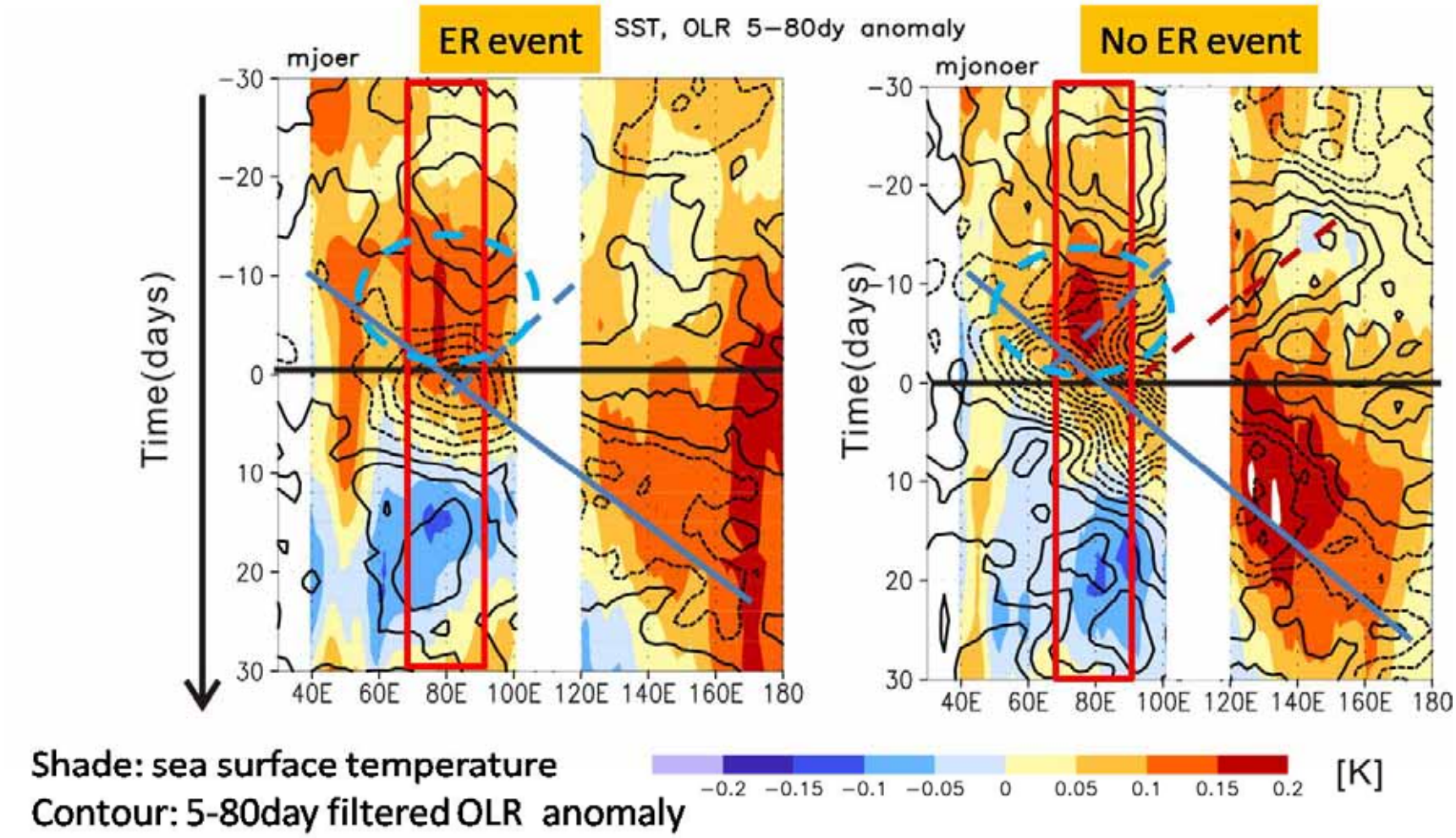
Moisture variation (vertical structure)



Shade: specific humidity; Contour: 5-80day filtered OLR anomaly

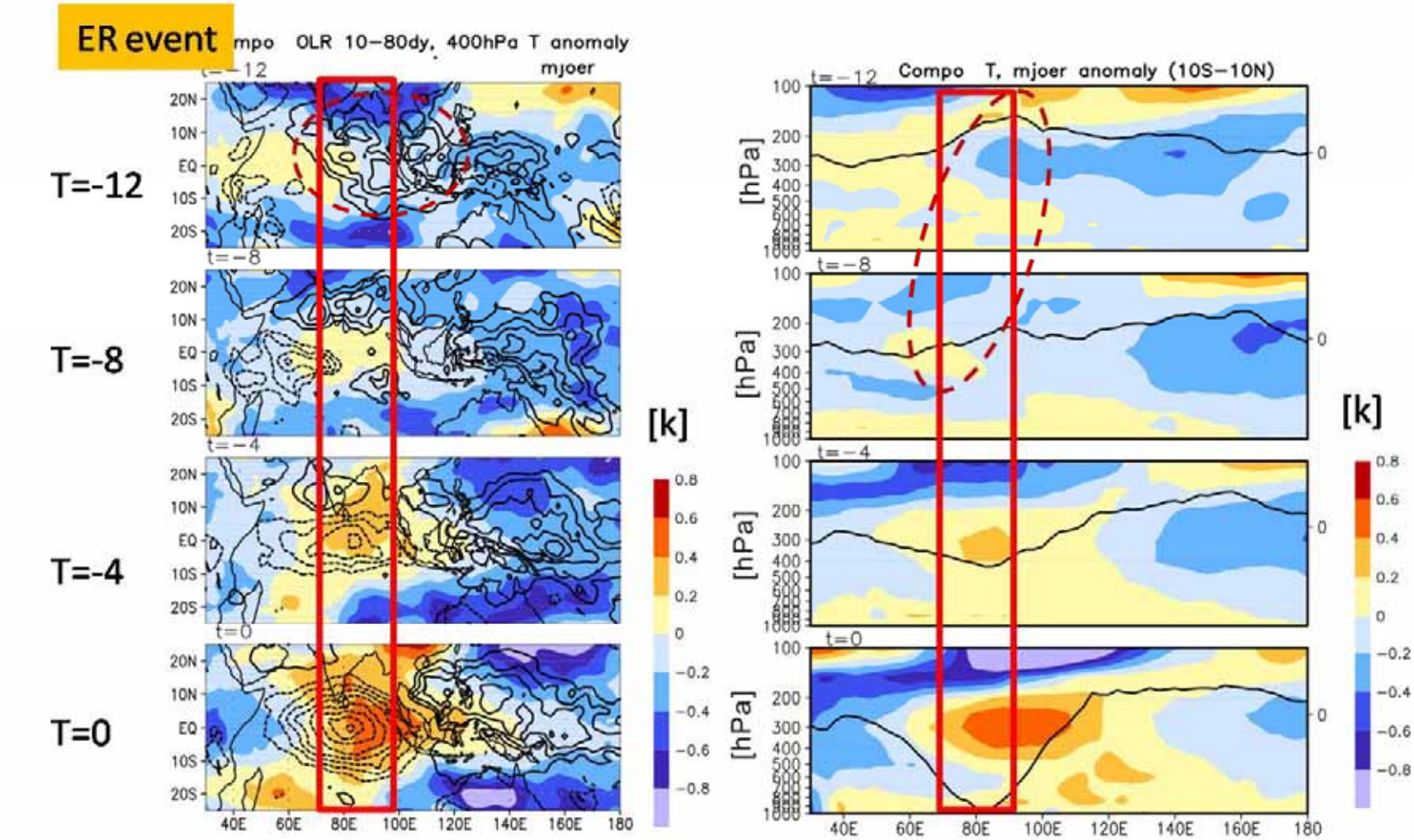
Moisture anomalies appears to propagate westward and eastward ,
and that intersects in no ER event , but not ER event.
This anomaly corresponds to the westward suppressed convection .

SST variation



The ER event shows convective developments in colder SST anomaly than that of no ER event.

Thermodynamical variation (horizontal and vertical structure)

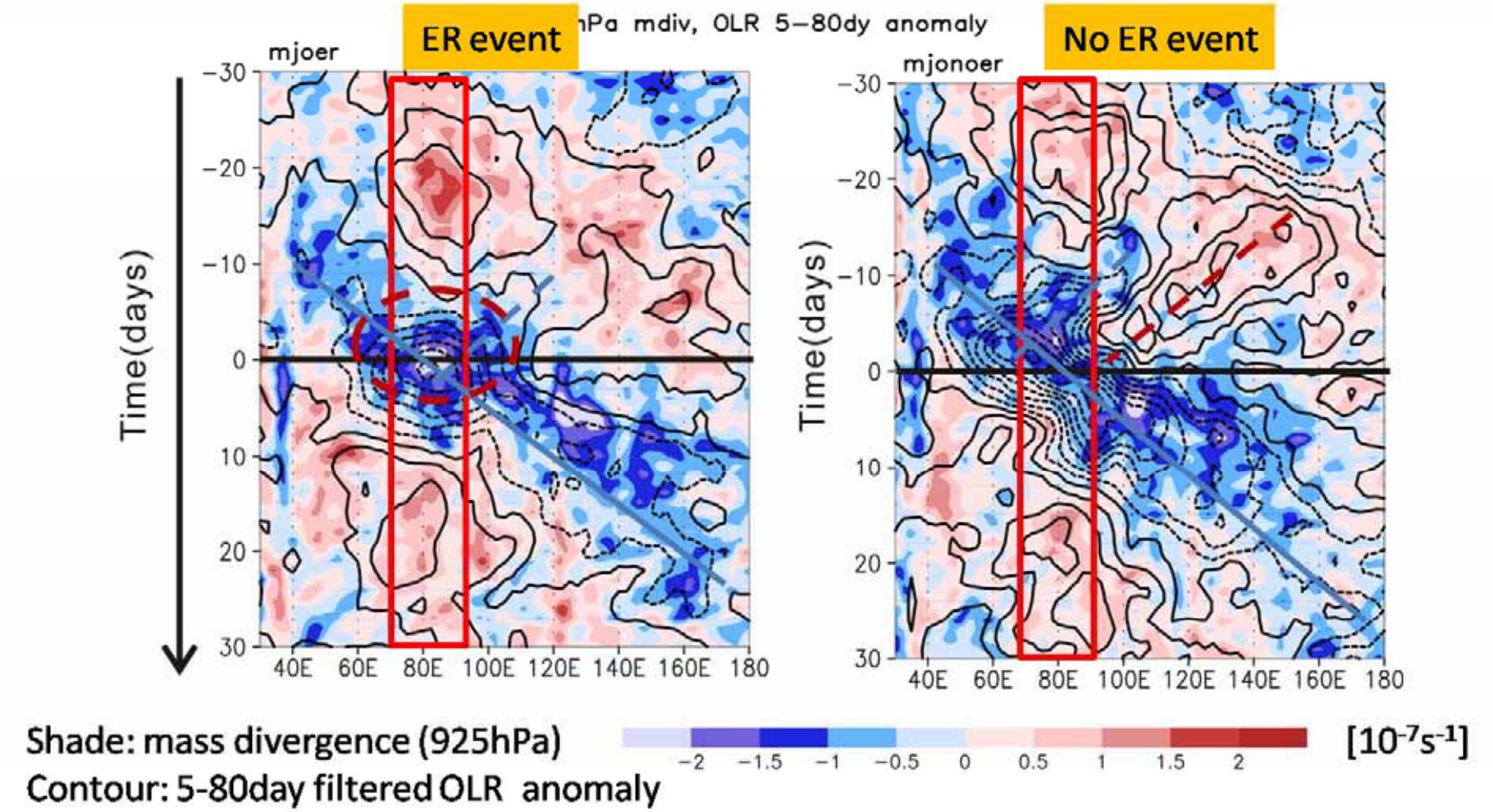


Shade: Tempareture (400hPa); Contour: 10-80day filtered OLR anomaly

Suppressed convective anomalies with the low-level anticyclonic circulations appear north and south of the equator during convective developing phase.

These are accompanied by the cold temperature anomaly in the mid-troposphere.

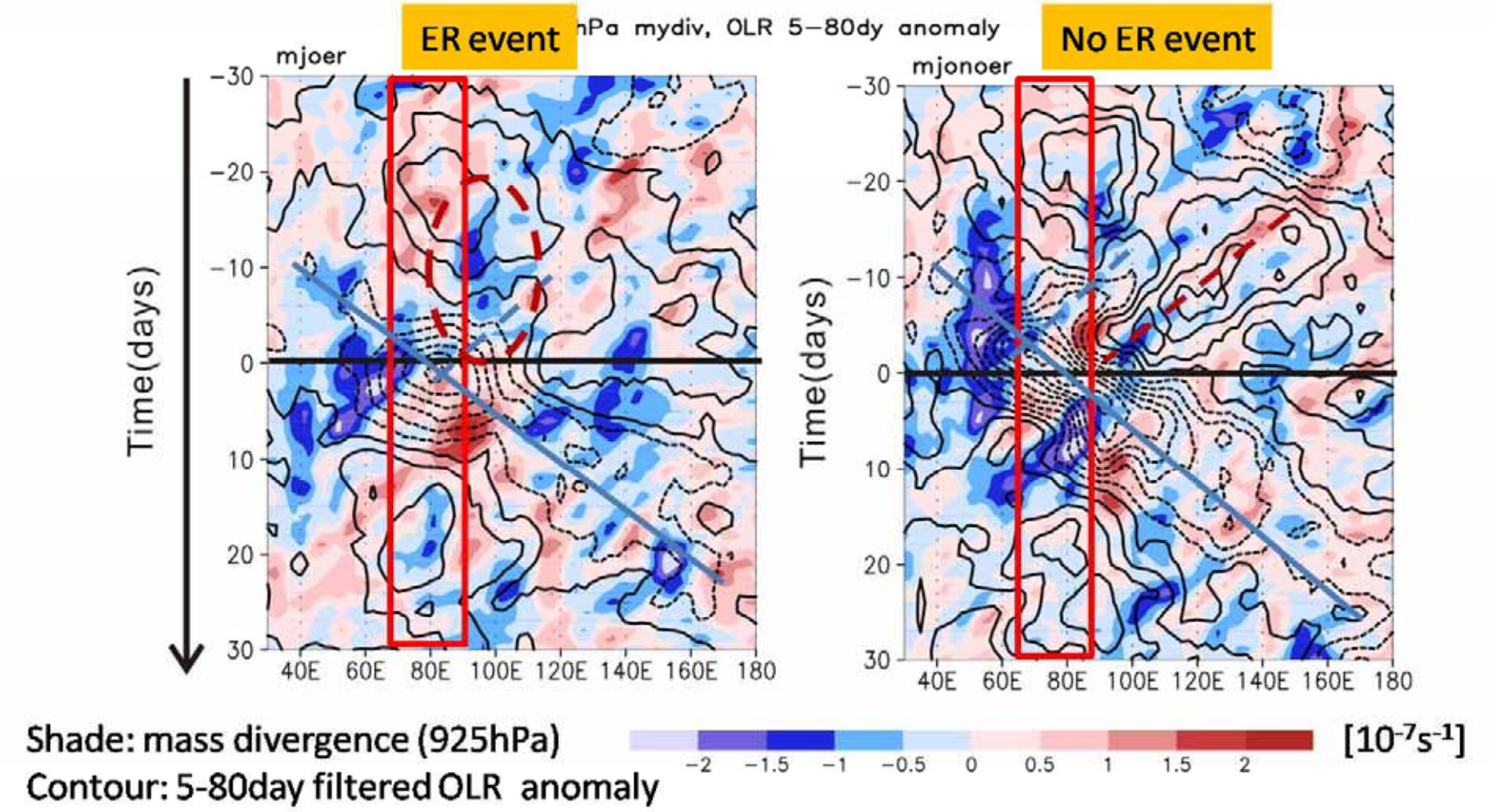
Mass divergence variation (low-level)



The convection with ER event can develop in smaller low-level convergence than no ER event over the west IO (west of 80E).

After that, high moisture and convergence anomalies more rapidly increased by the coming ER event

Mass divergence variation : Meridional component (low-level)

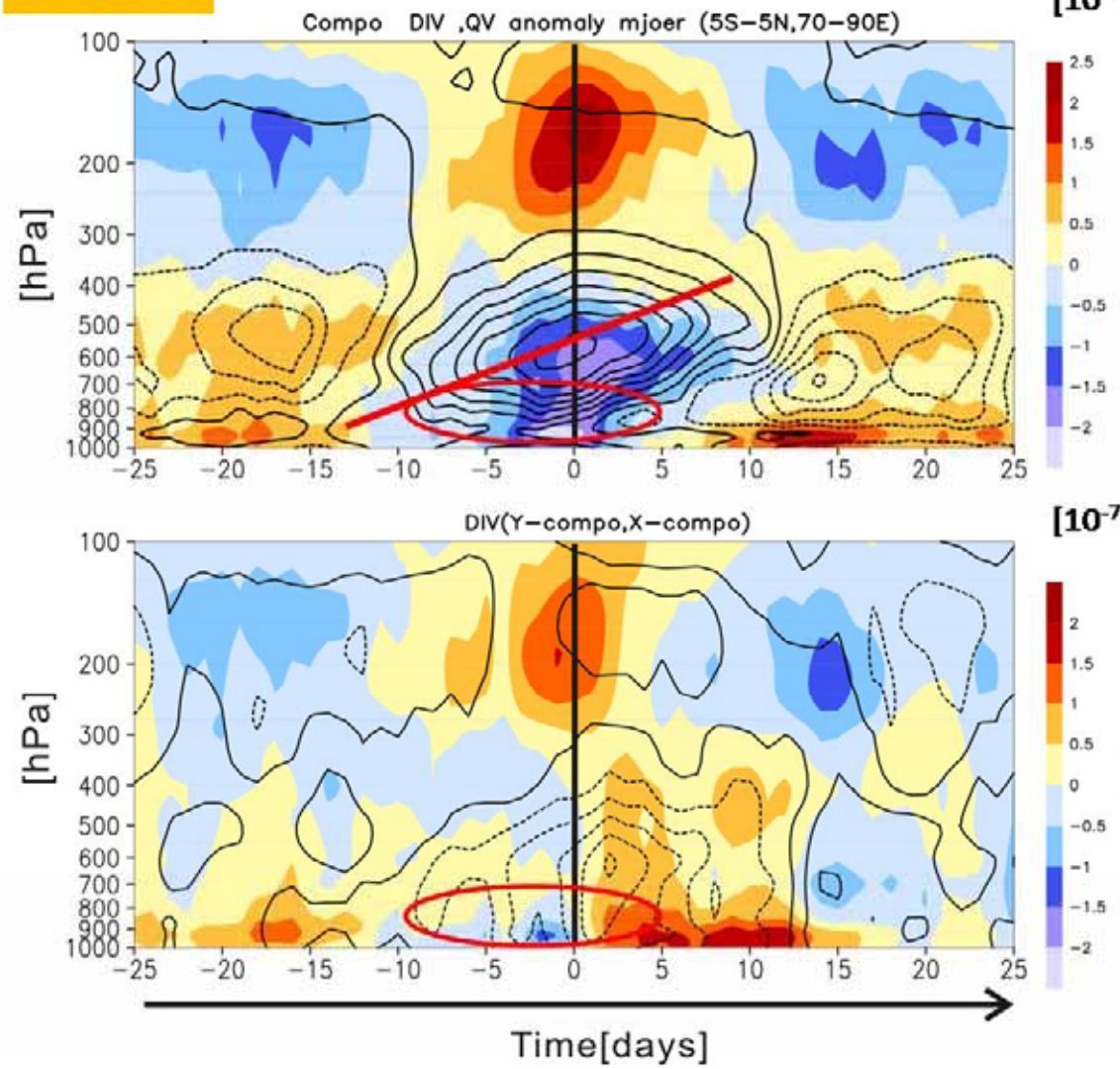


The ER event show that the enhancement of the friction-induced meridional convergence over the east IO (east of 90E) 10 days and then zonal convergence 5 days ahead of convection peak, respectively.

→ larger moisture convergence at the low-level than no ER event.

Mass divergence variation (vertical structure)

ER event



Shade: mass divergence
contour: specific humidity

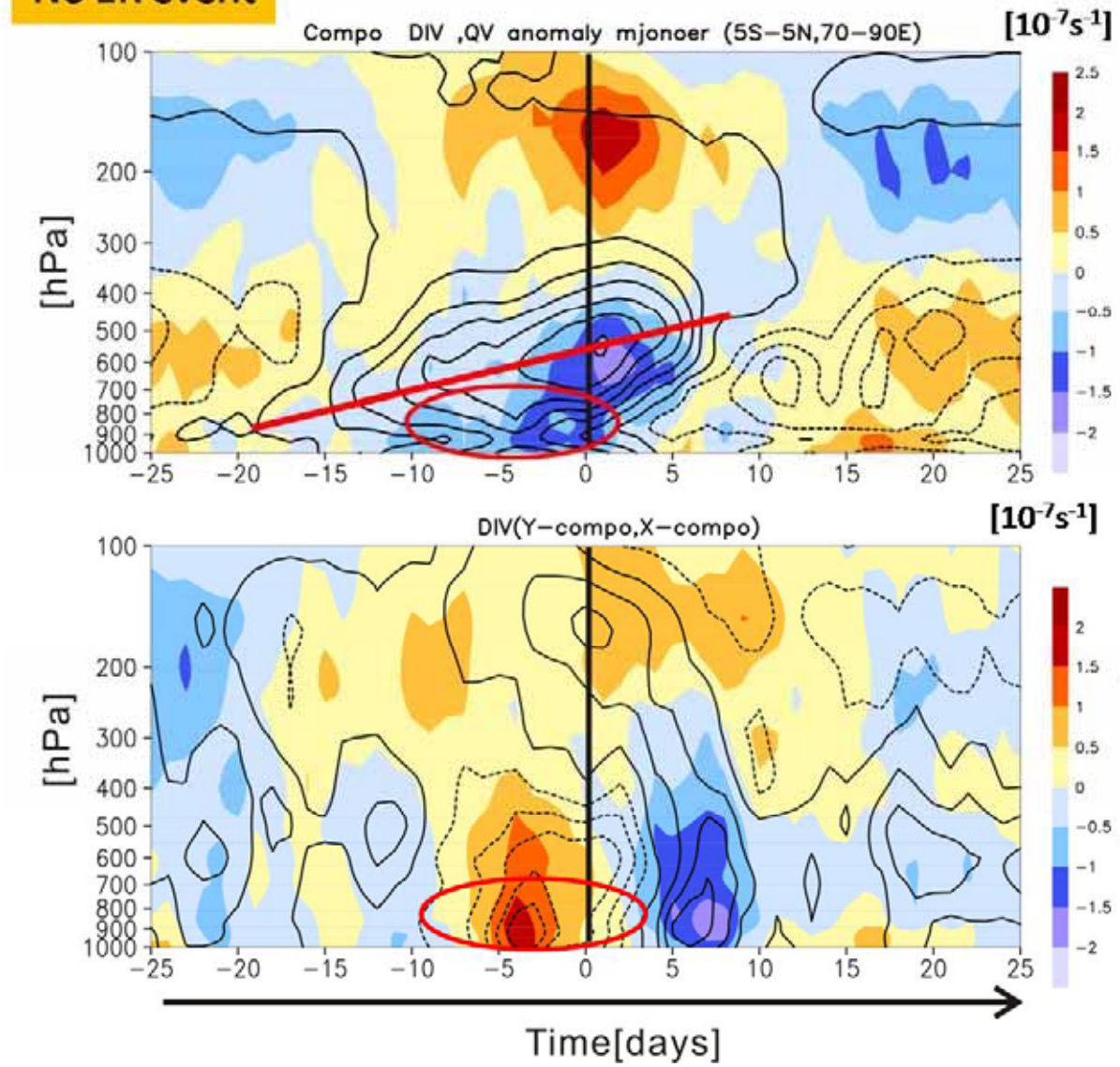
Shade: meridional divergence
contour: zonal divergence

Friction-induced meridional and zonal convergence both contribute to all convergence.

High moisture and convergence anomalies rapidly increased from the low to middle atmosphere over the middle IO (70-90E) by the coming ER event

Mass divergence variation (vertical structure)

No ER event



Shade: mass divergence
contour: specific humidity

Shade: meridional divergence
contour: zonal divergence

The zonal moisture convergence largely contributes to the total low-level convergence.
This is thought of the formation by Kelvin wave.

Summary

An observational study of differences in the convective onset and development of MJO in association with the westward propagation of an ER is conducted by the composite analysis using 22yr data.

- About 45% cases of the MJO initiated with the coming of ER event over IO.

- The ER event shows convective developments in smaller positive moisture anomaly and colder SST anomaly than those of no ER event.

- The ER event show that the enhancement of the friction-induced meridional convergence over the east IO, 10 days and then zonal convergence 5 days ahead of convection peak, respectively.
→The larger moisture convergence at the low-level than no ER event.

- These suppressed convective regions in ER event are accompanied by the cold temperature anomaly in the mid-troposphere
→ the condition of convective instability and intensify the low-level convergence over the high SST of IO, resulting in fast-development of convection.