# Modulation of MJO propagation speed by the fluctuation of large-scale background zonal circulation


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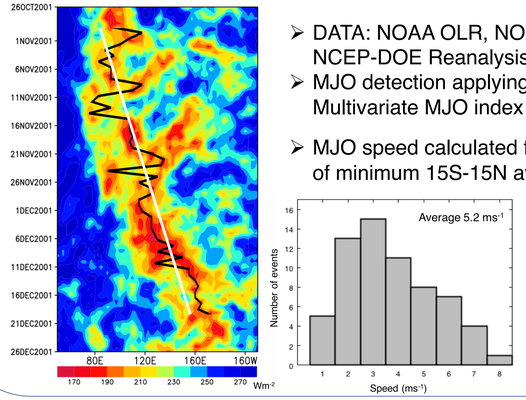
## 1. Introduction & Motivation

Eastward progression of convectively active region is a distinguishing characteristic of the MJO. However, understanding on the mechanisms of their eastward progression and what determines their propagation speeds is still limited. Taking this into consideration, this study investigated how the boreal winter MJO propagation speed is modulated by the background environment.

## 2. Method: Calculating speed of eastward movement of the MJO

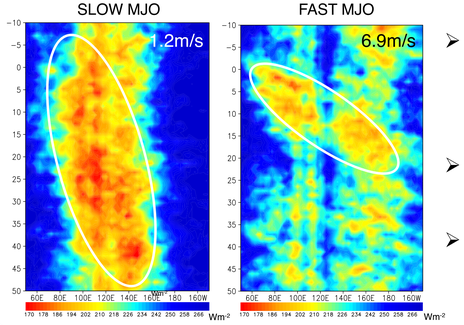






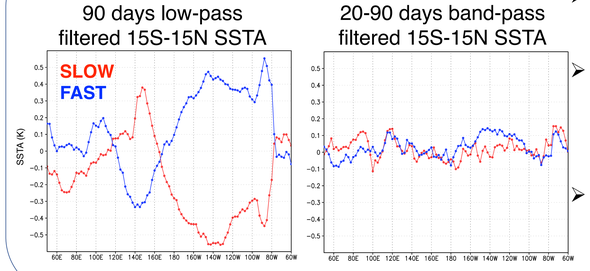
- DATA: NOAA OLR, NOAA OISST V2, NCEP-DOE Reanalysis II
- MJO detection applying Realtime-Multivariate MJO index Wheeler and Hendon 2004 Suematsu and Miura 2018
- MJO speed calculated from daily tracking of minimum 15S-15N averaged OLR
- 64 events were tracked between Nov. – Apr. 2012-2016
- Average MJO speed 5.2 ms$^{-1}$

## 3. Comparing Slow and Fast MJO



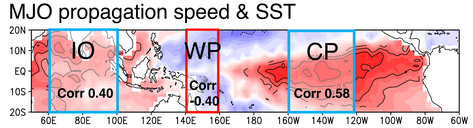

- 6 slowest and 6 fastest events are compared to elucidate differences between slow MJO and fast MJO events
- Average speed of slow MJO and fast MJO was 1.2 ms$^{-1}$ and 6.9 ms$^{-1}$ respectively
- Slow MJO is characterized by stronger signal of low OLR than the fast MJO

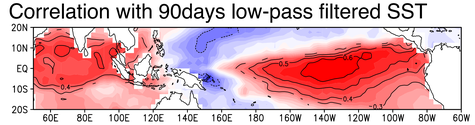
## 4. Comparing SST during Slow and Fast MJO

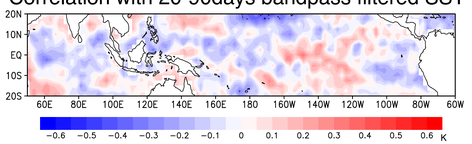


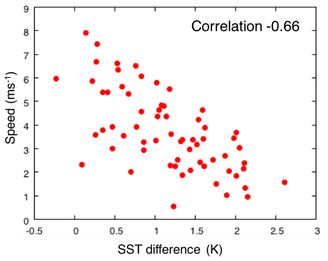

- Slow and fast MJO occurred under contrasting background SSTA
- Background SSTA increased and decreased towards western Pacific for the slow and fast MJO respectively.
- SSTA difference was insignificant for the intraseasonal SSTA variability

## 5. Correlation between MJO speed and SST distribution



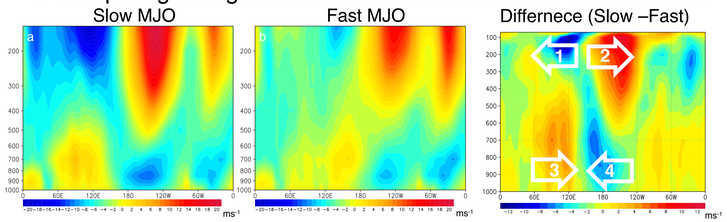



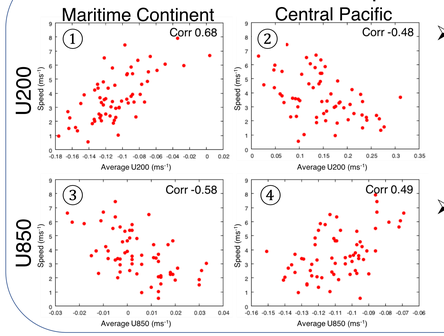

- MJO speed tends to be slower when SST distribution is characterized by warm SST over WP and cool SST over IO and CP
- Such relationship only holds for the low-frequency (i.e. background ) SST variability, and is not seen for the SST variability at intraseasonal range
- Correlation is stronger for index for positive SST gradient toward WP than for SST over any of the ocean basins alone

## 6. Comparing background circulation between Slow and Fast MJO




- Slow MJO is associated with stronger background (90-days low pass filtered zonal wind) circulation compared with the Fast MJO

## 7. Correlation between MJO speed and background circulation




- Correlation of upper (200hPa) and lower (850 hPa) level background (90 days low-pass filtered) zonal wind with the MJO speed shows that slower MJO is associated with stronger background zonal circulation
- Such relationship was not present in the variability of the zonal winds in the intraseasonal frequency (20-90 days) range (not shown)

## 8. Summarizing points

- MJO is slower when there is larger positive zonal SST gradient towards the WP
- Eastward progression of the MJO is slower with stronger background westerlies over the convective region of the MJO. i.e. MJO is *not* Doppler Shifted.
- MJO appears to be a part of the large-scale zonal circulation induced by the zonal SST gradient over the tropics

## References


Suematsu, T. and H. Miura, 2018: Zonal SST Difference as a Potential Environmental Factor Supporting the Longevity of the Madden–Julian Oscillation. Journal of Climate

Suematsu, T. and H. Miura: Changes in the eastward progression speed of the MJO with the fluctuation of the large-scale zonal circulation, *in preparation*