# Madden-Julian Oscillation Over Malay Peninsula

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## Introduction

- Madden-Julian Oscillation (MJO) as the dominant weather pattern in intraseasonal time scale in the equatorial tropics (Maden & Julian 1972) was expected to be manifested in the weather pattern over Malay Peninsula, since the land-mass is located along the MJO propagation trajectory (Wang & Rui 1990).
- Topography in western maritime continent (Northern Sumatra, Malay Peninsula and Borneo) was suggested to modify the detailed structure during eastward propagation of MJO (Wu & Hsu 2009). Such modification would imply inhomogeneous spatial weather pattern in smaller scale (Kemball-Cook & Weare 2001, Kiladis et al 2005).
- Study on MJO manifestation within local weather structure over Malay Peninsula are presented in this poster.

## Local Multivariate MJO (LMM) Index

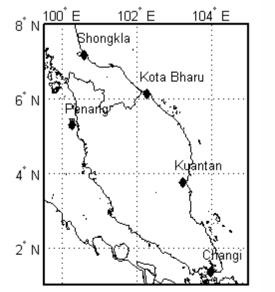



Fig.1. Location of radiosonde launches in Malay Peninsula. The radiosonde parameters are : zonal (U) and meridional (V) wind at 850 and 250 mb, temperature (T) at 500 mb, specific humidty (SH) at 850 and 500 mb, temperature difference (dT) between 250 and 850 mb, windshear between 500 and 850 mb.

- Weather signals in intraseasonal time scale were extracted using Extended - Empirical Orthogonal Function (EEOF) method from filtered daily radiosonde observation (1981-2000) at 5 locations (Fig.1).
- Correlation was computed between the 1st two Principal Components (PC) with the projection of Real-time Multivariate MJO index (RMM, Wheeler & Hendon, 2004) onto its angular phases (Fig.2).

$$A_\theta(t) = RMM_1(t)\cos\theta + RMM_2(t)\sin\theta$$

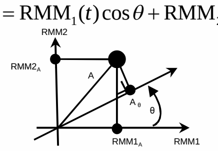


Fig.2. Method of RMM projection into different phase ($\theta$).

- The maximum correlation of the two PC scores along the RMM projection have similar scores and the corresponding PCs are ortho-gonal (Fig.3.P & Q).
- Time window (M) of 17 days was chosen for the EEOF (Fig.3.R). This is when both max.corr.scores start to get saturated at ~0.6
- Thus, the 1st two PCs can act as an index and labeled as Local Multivariate MJO (LMM) (Fig.3. S).

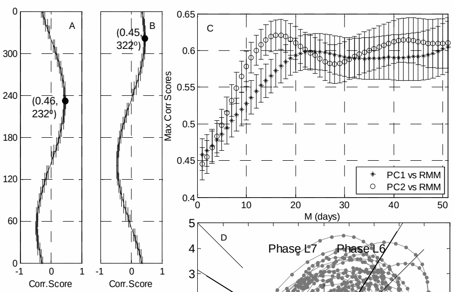
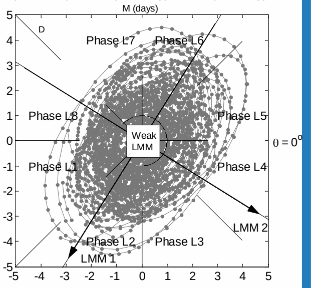


Fig.3. Correlation scores with uncer-tainty limits at 95% confidence level of the 1st PC (A) & 2nd PC (B) with the projected RMM in all phases (M=0 days). Panel C is the maximum correlation scores (uncertainty limits at 95% confi-dence level) along the extended M (days).



Panel D is the biplot of 1st two PCs (M=17 days) labeled as LMM1 & 2. The phases of LMM are aligned with the phases of RMM.

- Further confirmation of LMM as the index for the local manifestation of MJO can be seen from the composite of Outgoing Longwave Radiation (OLR) (Fig.4), which are comparable with the result shown by RMM (Wheeler & Hendon 2004).

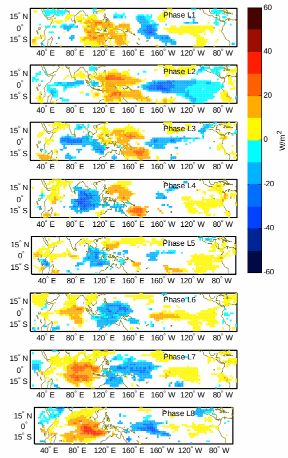


Fig.4. Composite of OLR anomaly (W/m²) in 8 phases of LMM at DJF period (1981-2000).

## Atmospheric Structure of Local MJO

- The atmospheric structure of MJO over Malay Peninsula can be describe from the LMM PCs and the maxima or minima of the composites of other parameters : geo-potential height (H), lifting condensation level (LCL), con-vective inhibition (CINS), surface pressure (SFP), OLR and rainfall, plotted in LMM modified phase-space (Fig.5)
- The baroclinic structure (U, H, SH & SFP) associated with MJO that shown by Fig.5 is consistent with the previous reports (Madden & Juilan 1972, Kemball-Cook & Weare 2001).

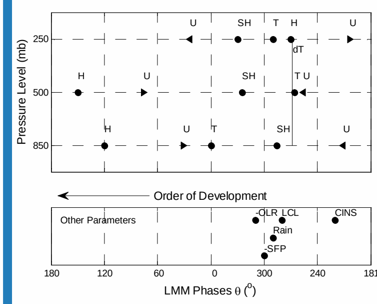


Fig.5. Time-phase evolution of the vertical structure of the atmosphere over Malay Peninsula region in a complete MJO cycle. The circular markers (•) denote the maxima of T, H, SH, Rainfall, LCL (in mb) and CINS, and the minima of OLR and SFP. dT represented by a vertical line from 850mb to 250mb denote T250 minus T850. The direction of the zonal wind (U) extrema is given by the direction of the triangular marker.

- The vertical structure of temperature (Fig.5) is con-sistent with Medan station (East-Coast Sumatra) but not in other region as reported by Kiladis et al (2005).
- We found that the atmosphere is the most stable just before the peak in MJO convection indicated by the highest rain-fall and the lowest OLR. The near-coincidence of the high-est LCL (in mb) and the greatest 850mb humidity when the atmosphere is destabilizing (i.e. dT decre-asing from the maximum) seems important for achieving the peak in MJO convection.

## Local Rainfall Predictability by MJO Indices

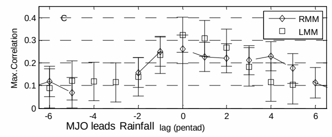


Fig.6. Maximum correlation scores of both MJO indices with rainfall on each time lag (uncertainty limits at 95% conf.level). Only non-zero correlation scores at 95% conf.level are plotted.

- LMM index shows non-zero correlation with the local rainfall 3 to 4 pentads ahead of time but RMM index does not (at the 95% confidence level).

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A paper on these findings has been submitted to Atmospheric Chemistry and Physics (ACP) for publication.