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Influence of MJO Activity on the Genesis and Environment of Tropical Cyclones in the Indian Ocean: Climatological Analysis and a Case Study for CINDY2011

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Introduction

Three MJOs developed during CINDY period [Oct.-Nov.-Dec. (OND) in 2011]. MJO is a factor that modulates tropical cyclone genesis (TCG). The present study focuses on large-scale environmental conditions during CINDY period over the Indian Ocean (IO), under which MJO activity was enhanced, in terms of TCG. In order to reveal the characteristics of environmental conditions for TCG in CINDY period, statistical analyses are conducted to demonstrate characteristics of environmental conditions for TCG in years in which MJO activity during OND season is enhanced (MJO active years) and that is suppressed (MJO non-active years). Moreover, the environmental conditions in CINDY period are compared with the mean environmental conditions in La Nina year.

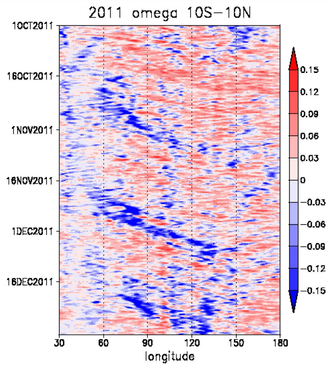


Fig. 1: The longitude-time diagrams of 6-hourly anomalies of vertical velocity for OND in 2011.

Data and Methodology

Data

- JRA/JCDAS dataset
- JTWC best-track dataset
- the TC dataset archived at the Unisys Weather web site
- the Wheeler-Hendon MJO index archived at Australian Government Bureau Meteorology (for definitions of MJO active year and non-active year)
- the Oceanic Nino Index diagnosed by NOAA' s Climate Prediction Center, determined by the anomaly of SST over the tropical central Pacific (i.e., 5S-5N and 170W-120W).

Genesis Potential Index (GPI) of Murakami et al. 2011

$$GPI \equiv \left|10^5 \eta\right|^{\frac{3}{2}} \left(\frac{RH}{50}\right)^3 \left(\frac{V_{pot}}{70}\right)^3 \left(1+0.1V_s\right)^{-2} \left(\frac{-\omega+0.1}{0.1}\right)$$

η:Vorticity (850hPa)	RH : relative humidity (700hPa)	MPI	vertical shear (850and200hPa)	vertical velocity (500hPa)

$$MPI \text{ (Maximum Potential Intensity)} \equiv \sqrt{\frac{C_k}{C_D}\frac{T_S}{T_0}\left(CAPE^* - CAPE^b\right)}$$

T_S : Sea surface temperature
T_0 : mean outflow temperature
C_D : drag coefficient
C_k : exchange coefficient for enthalpy

CAPE* : CAPE computed by lifting a saturated air parcel at the sea level
CAPE^b : CAPE computed by lifting an air parcel with boundary-layer mean quantity

Result of statistical analysis

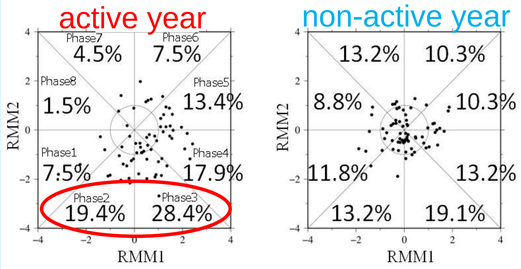


Fig. 2: Black dots indicate the days when TCG occur in the RMM1 and RMM2 space and the percentages denote the number of TCG events for each MJO phase to the total number of TCG events.

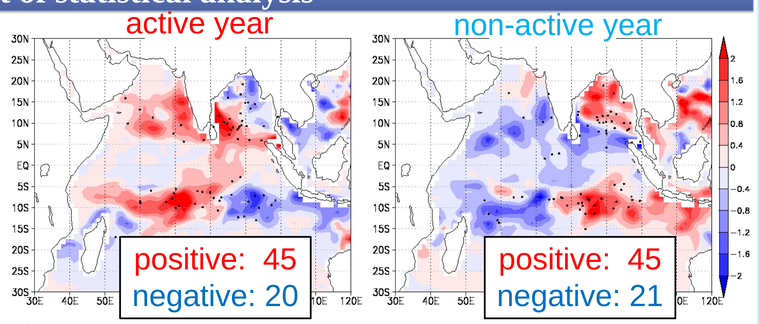
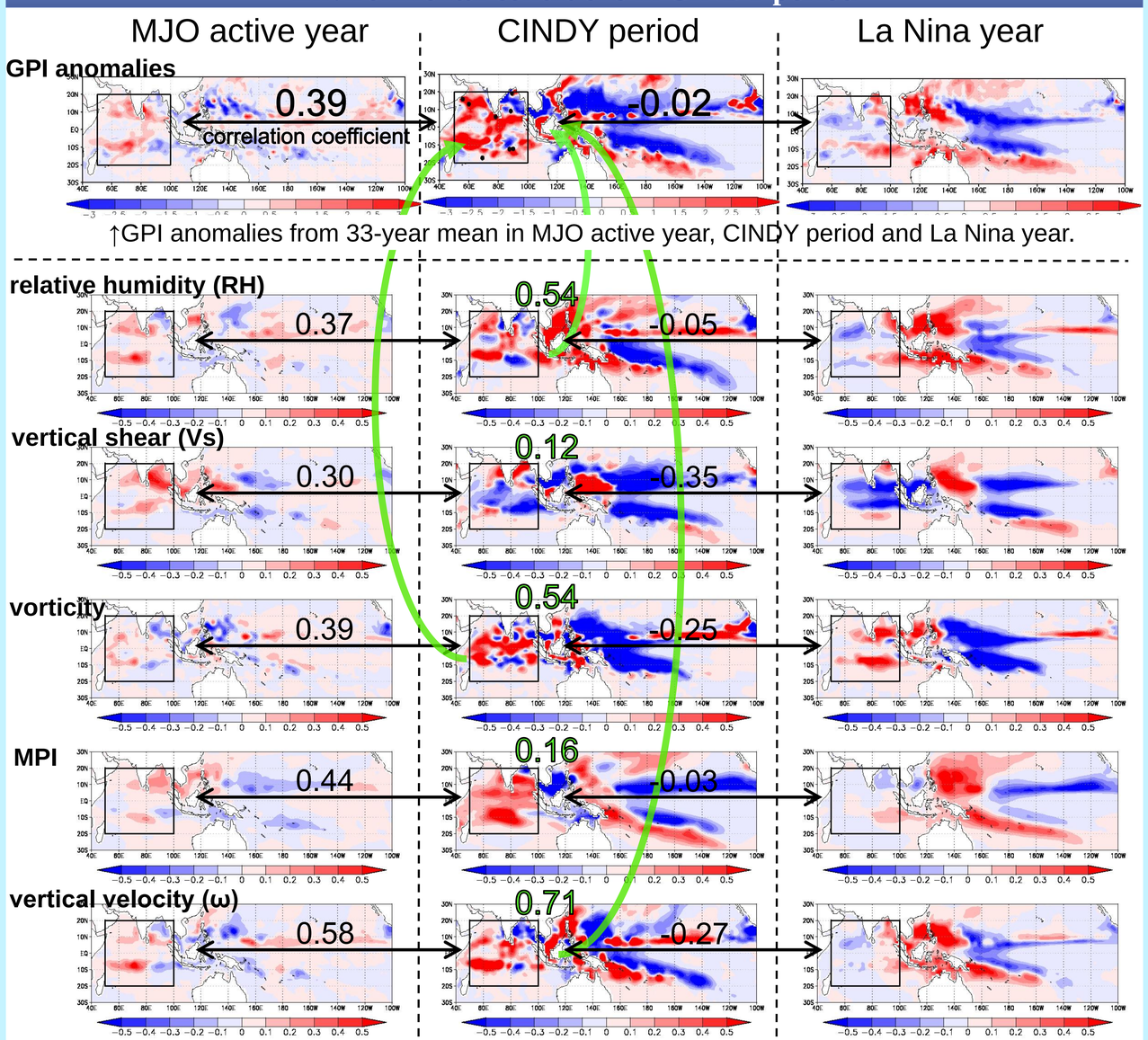


Fig. 3: GPI anomalies (color) and the TCG points (black dots) in the active year and the non-active year. The numbers of "positive (negative)" mean the number of TCG events in areas where GPI anomalies show positive (negative).

- ✓The number of TCG events in the IO is significantly enhanced when the active convective phase of MJO is located in the IO (Fig. 2).
- ✓The spatial distribution of TCG events show difference corresponded to GPI between active and non-active year (Fig. 3).

Environmental conditions in CINDY period



↑GPI anomalies from 33-year mean in MJO active year, CINDY period and La Nina year.

↑Contributions of RH, vorticity and ω to GPI anomalies in MJO active year, CINDY period and La Nina year.

Summary

- ◆GPI and TCG show significant difference between MJO active year and non-active year.
- ◆As for GPI anomalies and contributions of 5 factors to GPI in the IO, CINDY period and MJO active year shows higher correlation than CINDY period and La Nina year.
- ◆In the Pacific Ocean, environmental conditions in CINDY period are similar to La Nina year.
- ◆ Contributions of RH, vorticity and ω show high correlations with GPI anomalies in CINDY period over the IO.
- ◆GPI anomalies in CINDY period show stronger correlation with active year than La Nina year mainly due to contributions of RH, vorticity and ω affected by enhanced MJO activity.