

# **Madden-Julian Oscillation:** Recent Evolution, Current Status and Predictions



**Update prepared by the Climate Prediction Center  
NWS / NCEP / CPC  
11 March 2024**

# Overview

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- A robust MJO event continues to unfold, with the enhanced convective phase now crossing the Maritime Continent.
- Widespread enhanced convection overspread the eastern Indian Ocean and western Maritime Continent, which is a departure from the weakening long-term ENSO base state.
- Dynamical models are in good agreement with tight ensemble clustering that strong MJO activity continues to propagate eastward from the Maritime Continent to the Pacific and Western Hemisphere over the next two weeks. The forecasted phase speed is faster than recent observations.
- The MJO is likely to contribute to enhanced chances for additional tropical cyclone formations during Week-2 near Australia and over the Coral Sea, with favorable regions extending eastward to the South Pacific during Week-3.
- Although tropical-extratropical teleconnections begin to wane during the Boreal spring months, the MJO can help influence a pattern change over North America, with increased troughing over the central and eastern CONUS possible during Week-3.

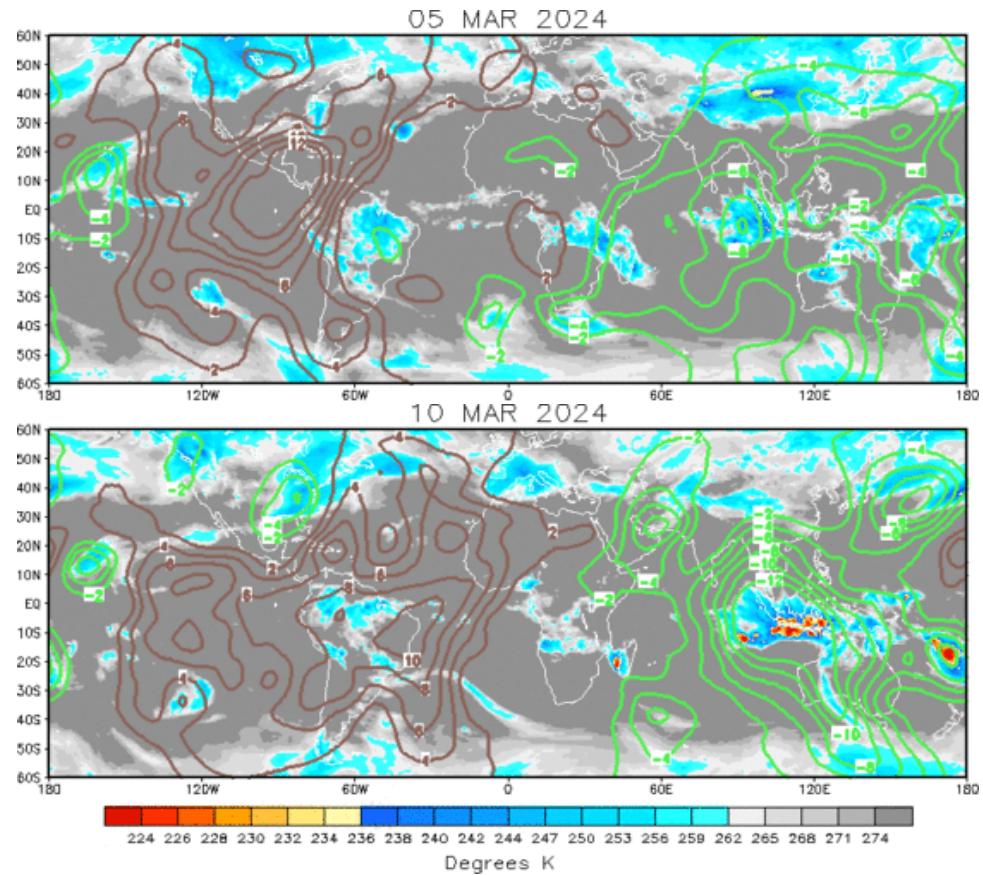
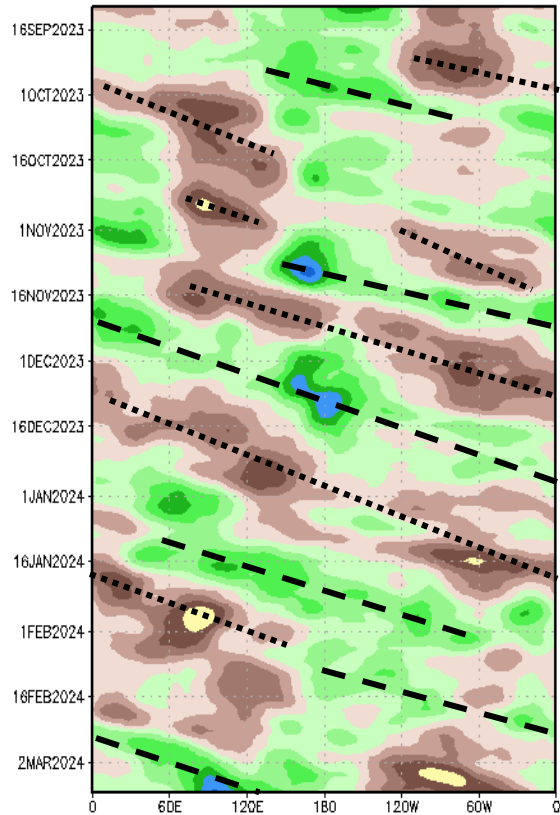
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:  
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

# 200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

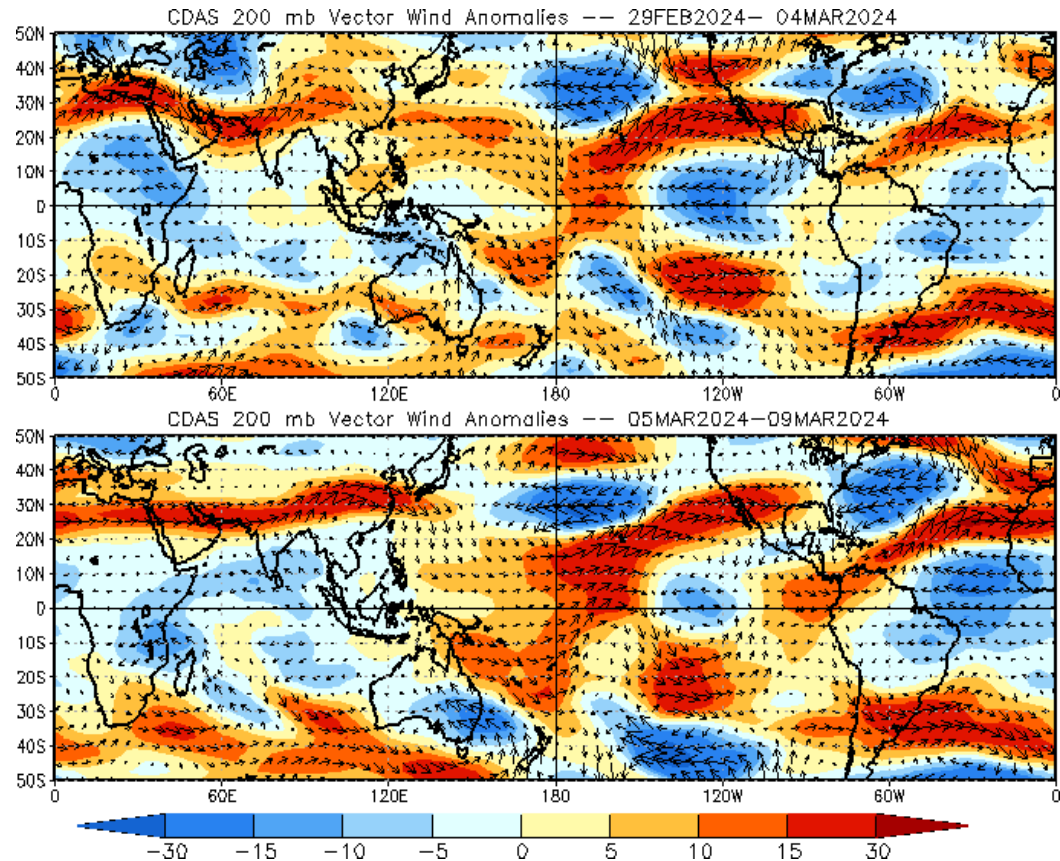
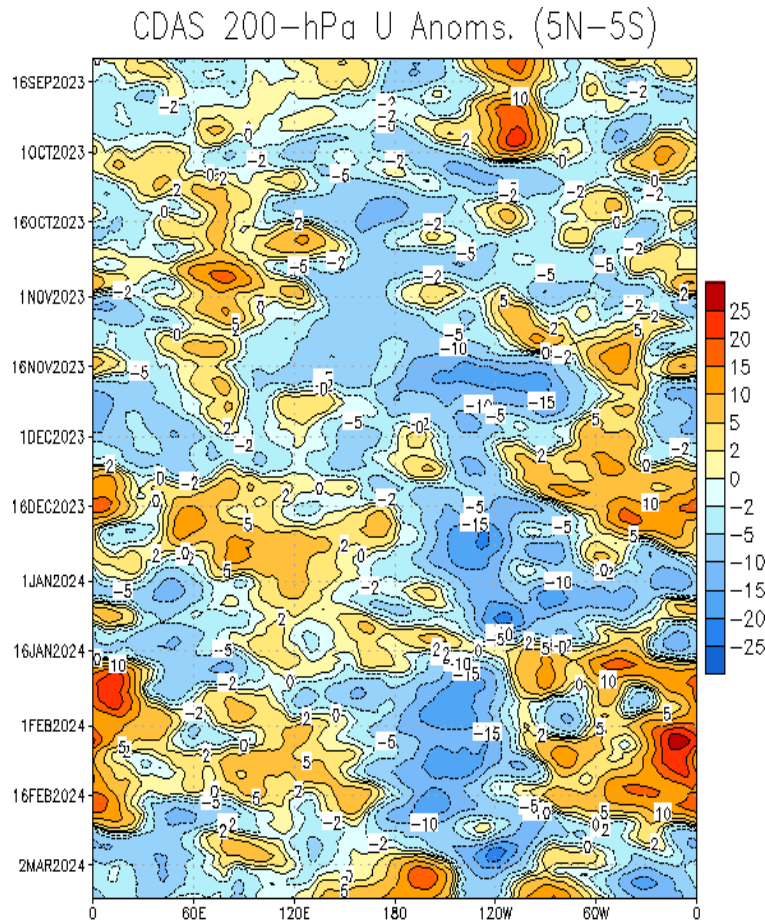
200-hPa Velocity Potential Anomaly: 5N-5S  
5-day Running Mean



- Recent MJO propagation is apparent in the time-longitude field, with the enhanced phase propagating across the Indian Ocean and Maritime Continent.
- Enhanced convection near the Date Line appears tied to the low frequency base state and Rossby wave activity.
- Constructive interference among these features may help maintain a high amplitude event.

# 200-hPa Wind Anomalies

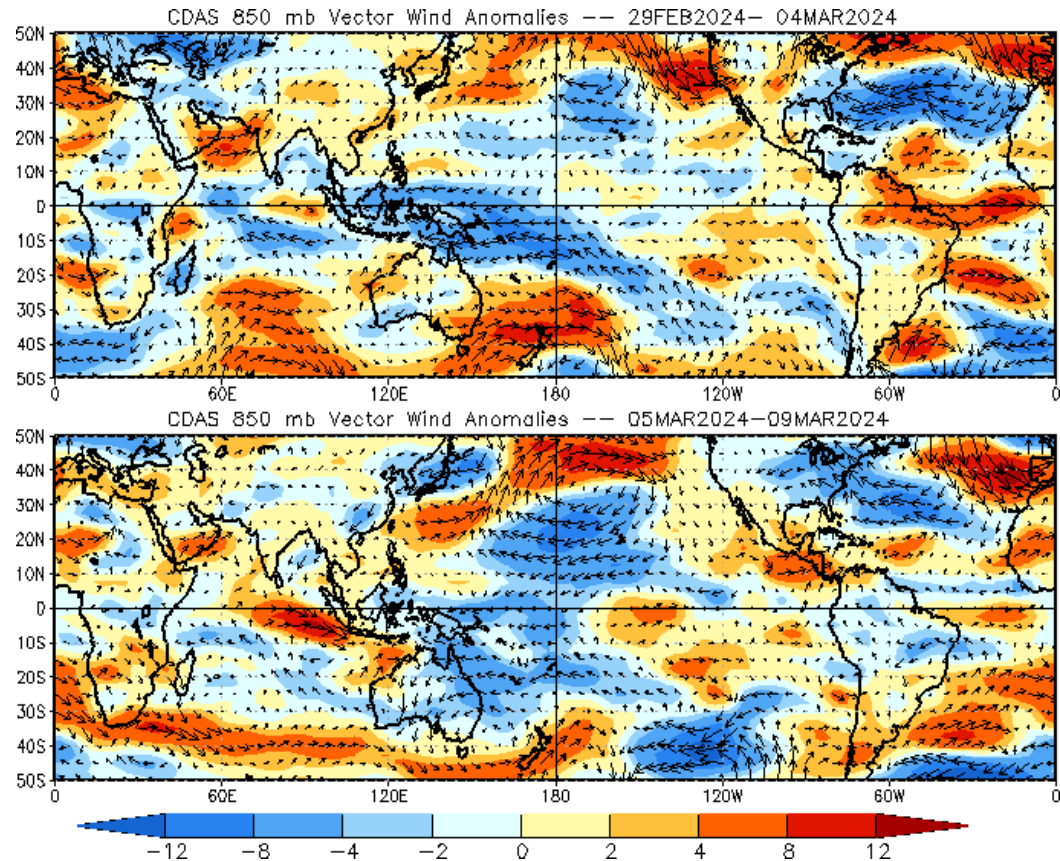
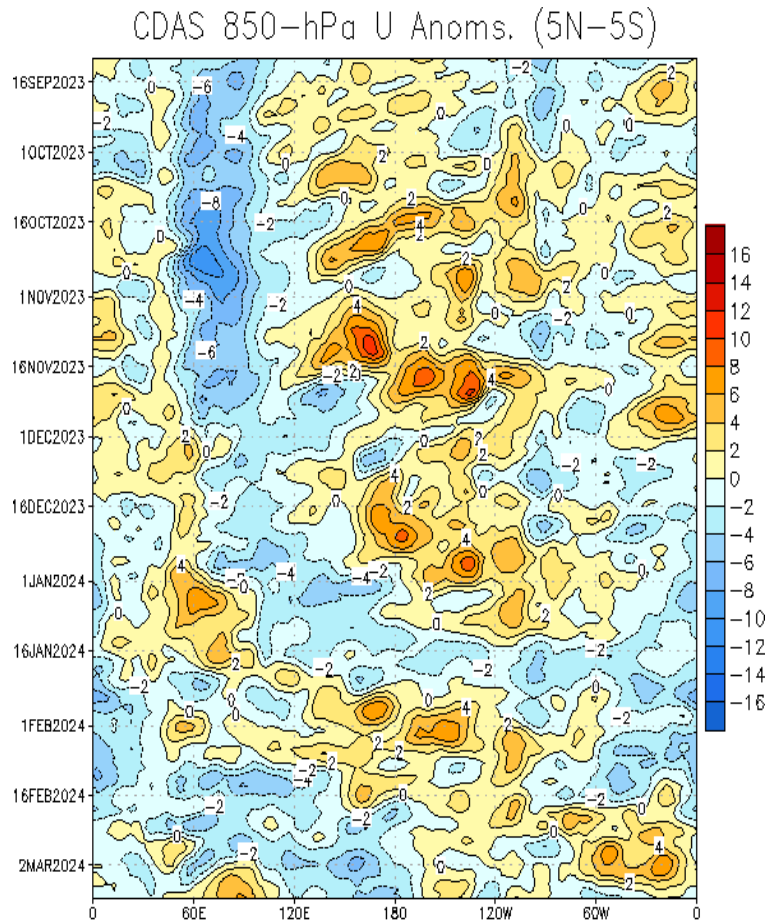
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- An atmospheric response to ongoing El Niño conditions persists, with a strong southerly jet extending from the Pacific across the southern tier of the CONUS, and upper-level easterly anomalies along the equatorial East Pacific.
- Easterly (westerly) anomalies across the Indian Ocean (West Pacific) appear tied to MJO activity, with constructive interference from Rossby wave activity over the west-central Pacific.

# 850-hPa Wind Anomalies

Shading denotes the zonal wind anomaly. **Blue shades: Anomalous easterlies.** **Red shades: Anomalous westerlies.**

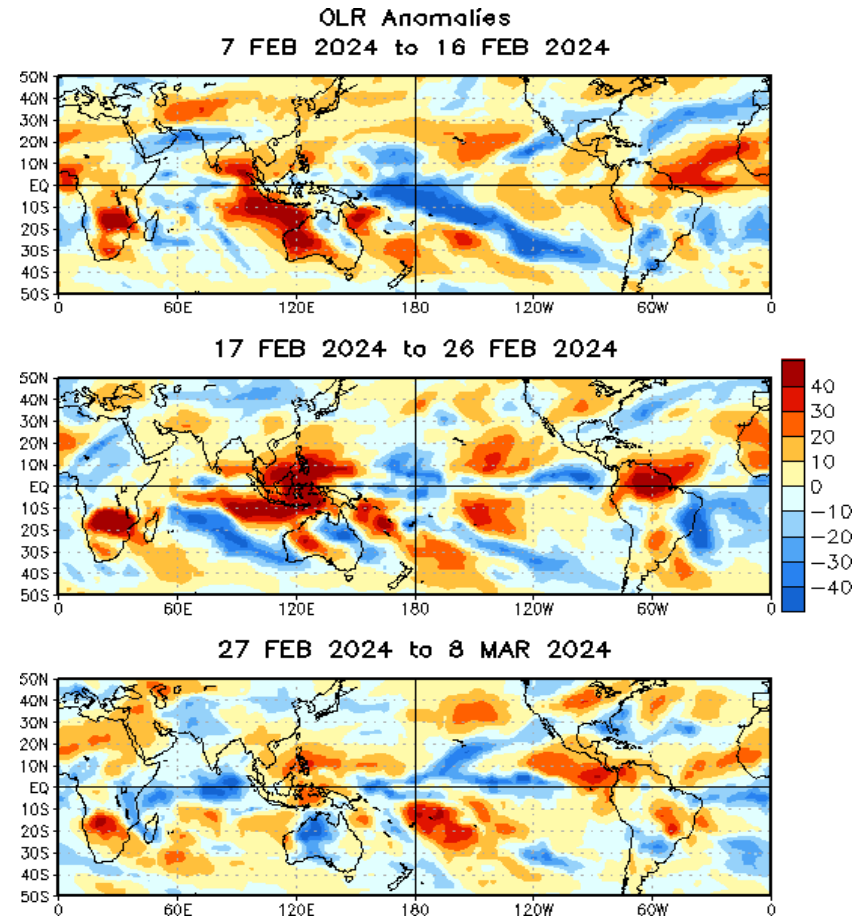
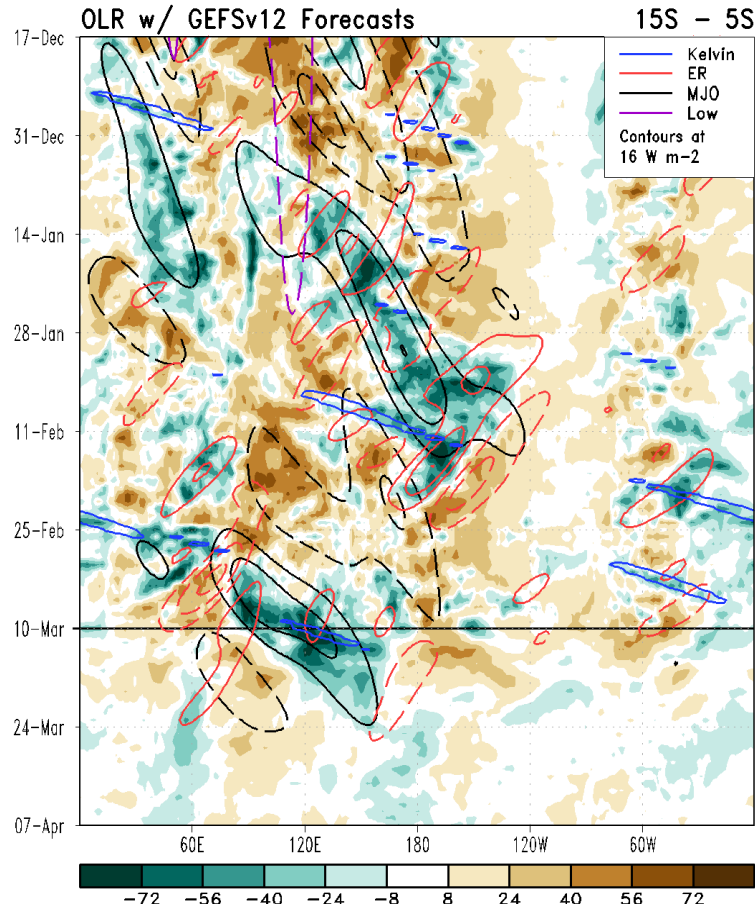


- Strong westerly anomalies over the eastern Indian Ocean appear tied to both MJO and tropical cyclone activity.
- Easterly anomalies propagated eastward just past the Date Line, while trade winds remain fairly disrupted over the East Pacific.
- Strong ridging over the north-central Pacific appears to be influencing the tropical pattern over the west-central Pacific.

# Outgoing Longwave Radiation (OLR) Anomalies

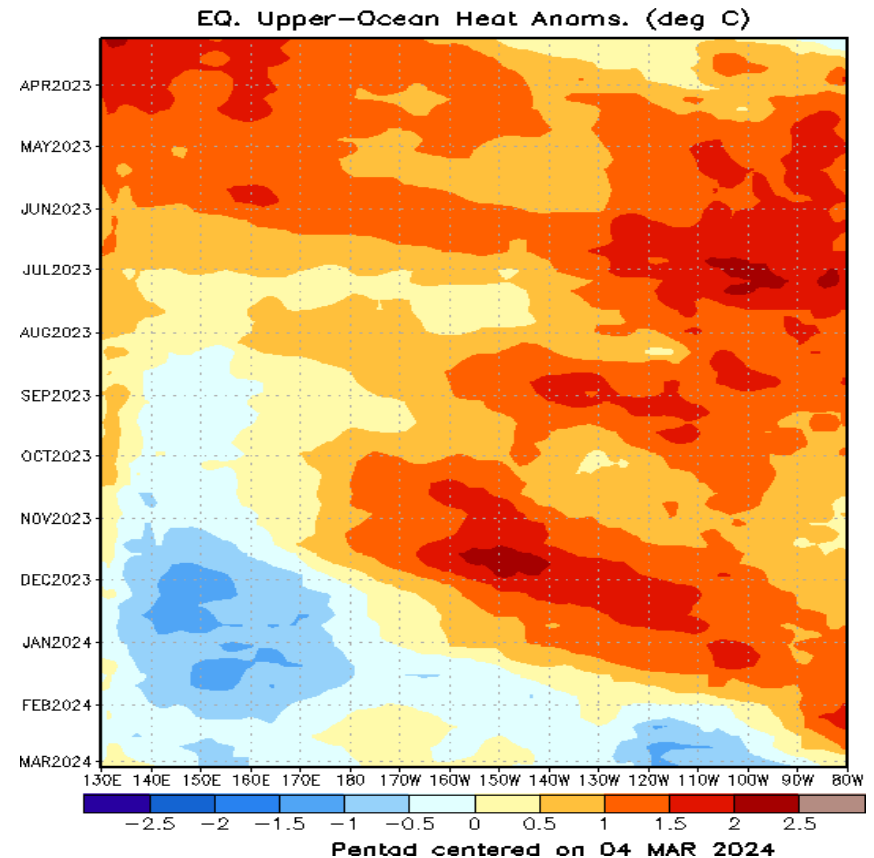
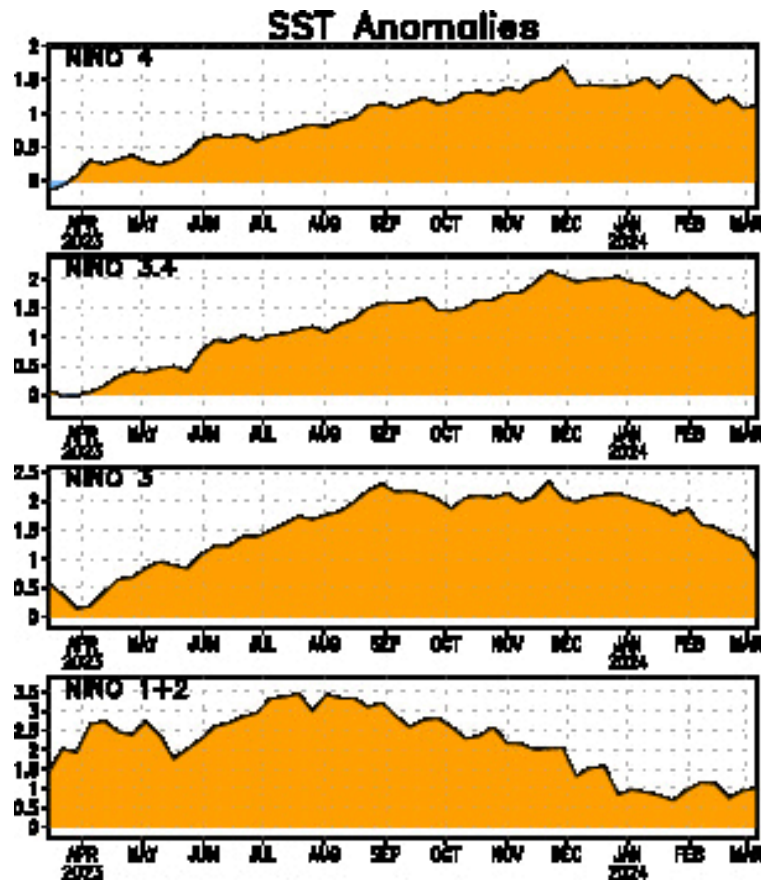
**Green shades:** Anomalous convection (wetness)

**Brown shades:** Anomalous subsidence (dryness)



- The MJO signal is well represented in the objective filtering, with the enhanced phase crossing the Maritime Continent.
- Suppressed convection overspread the far eastern Pacific and western South America.
- GEFS forecasts depict the MJO activity reaching the Pacific over the next two weeks.

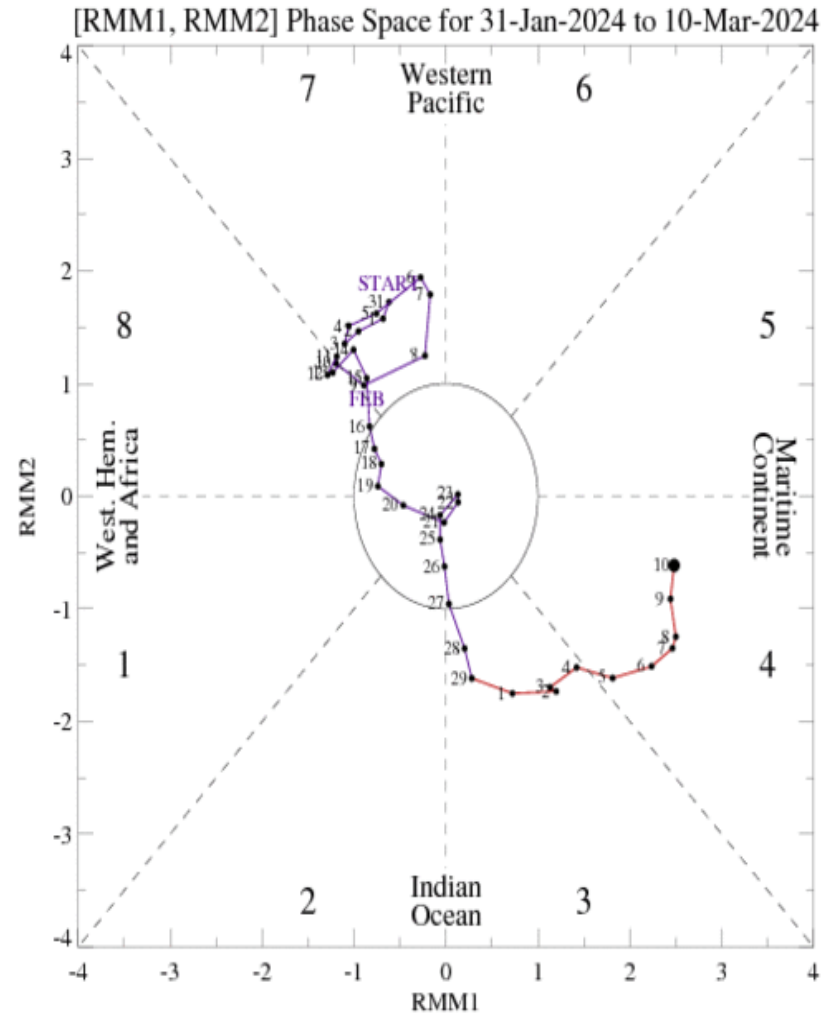
# SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- There has been a notable downward trend in SST anomalies in all NINO regions during the past two months suggestive of a weakening El Niño.
- Since early February, subsurface anomalies have flipped sign over the central and eastern equatorial Pacific due to upwelling generated in part by MJO activity.

# MJO Index: Recent Evolution

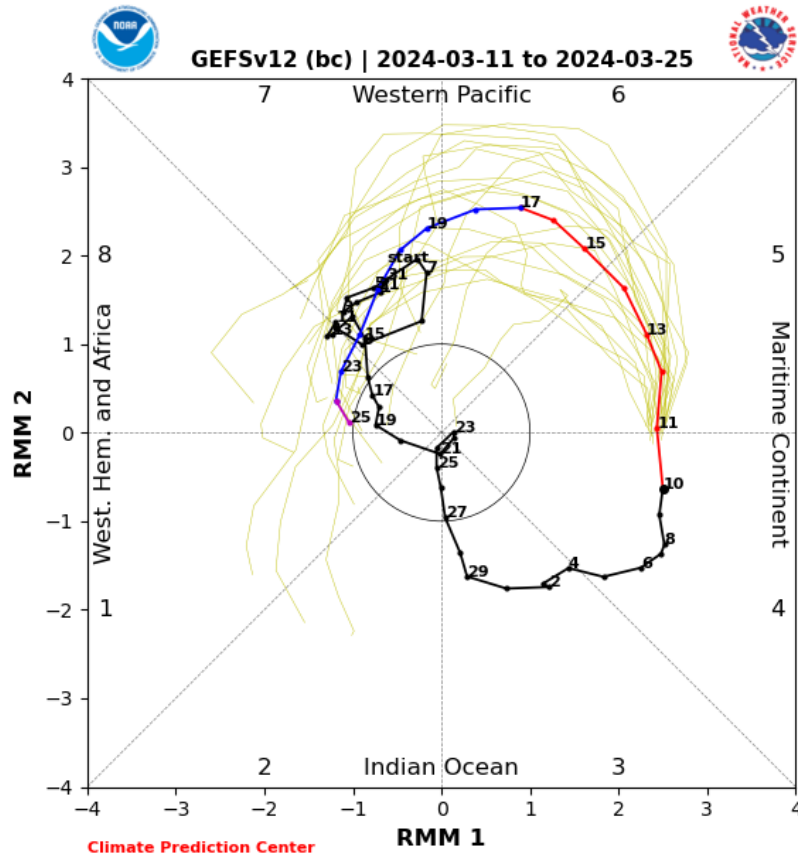
- The RMM-based MJO index reflects strong MJO activity, with clearly established eastward propagation from the Indian Ocean to the Maritime Continent at high amplitude.
- Some of the high amplitude may be due to ongoing weakening of the low frequency ENSO base state, which is still reflected in the 120-day period mean that is removed in this analysis.



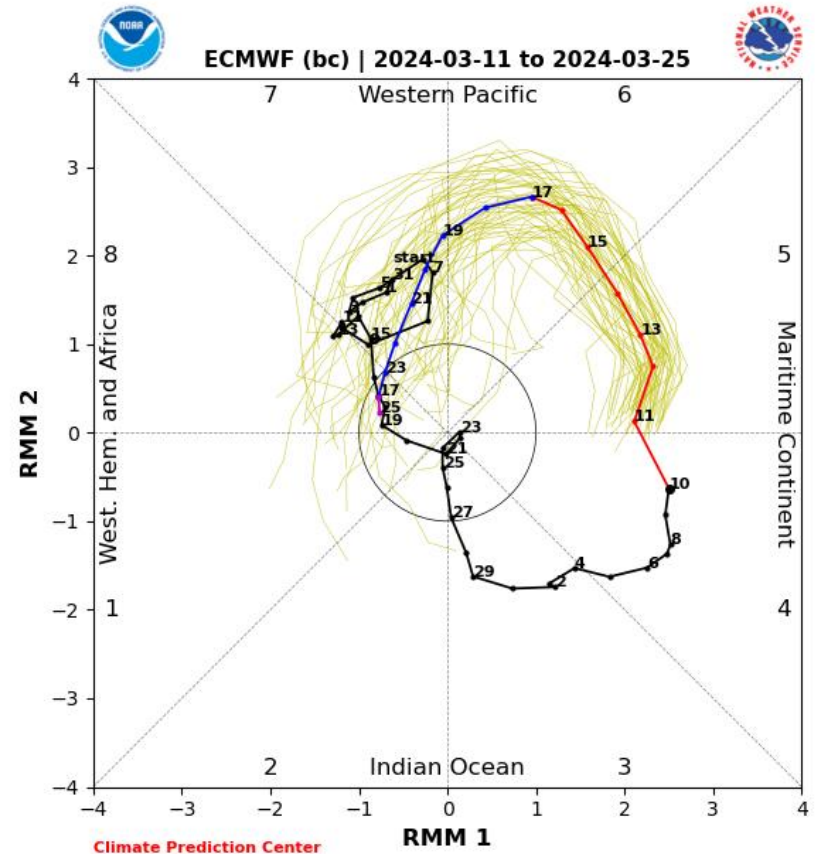
For more information on the RMM index and how to interpret its forecast please see:  
[https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC\\_MJOinformation.pdf](https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf)



# MJO Index: Forecast Evolution



**GEFS Forecast**



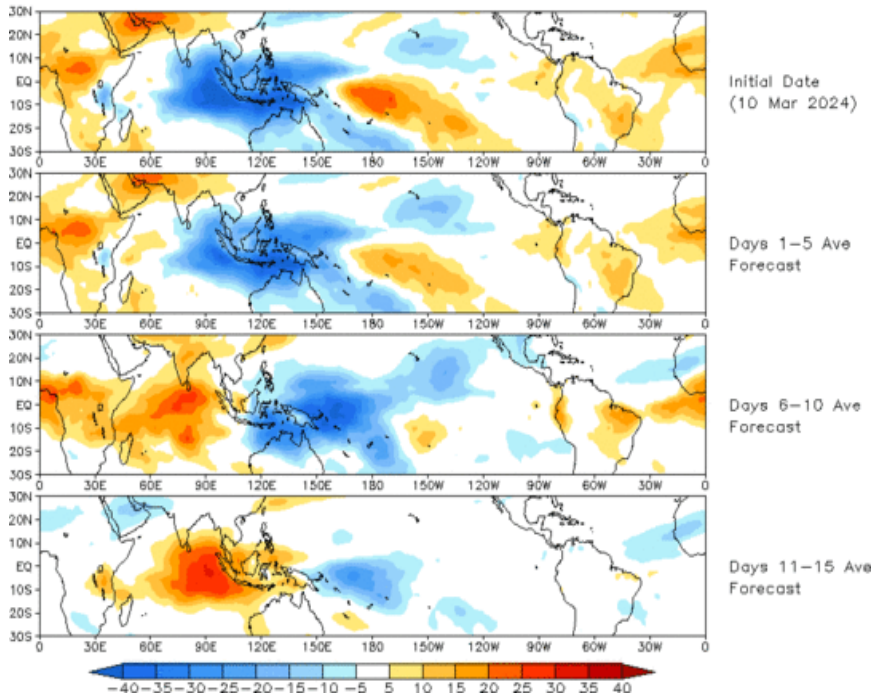
**ECMWF Forecast**

- The GEFS and ECMWF forecasts are remarkably consistent, and their respective ensemble members are tightly clustered, depicting continued MJO evolution with the enhanced phase crossing the Pacific and reaching the Western Hemisphere by the end of Week-2.
- The MJO phase speed increases rapidly during Week-1, with the signal quickly reaching the West Pacific before a resumption of a slower evolution.
- Longer range model forecasts have greater spread, but are not inconsistent with continued MJO activity.

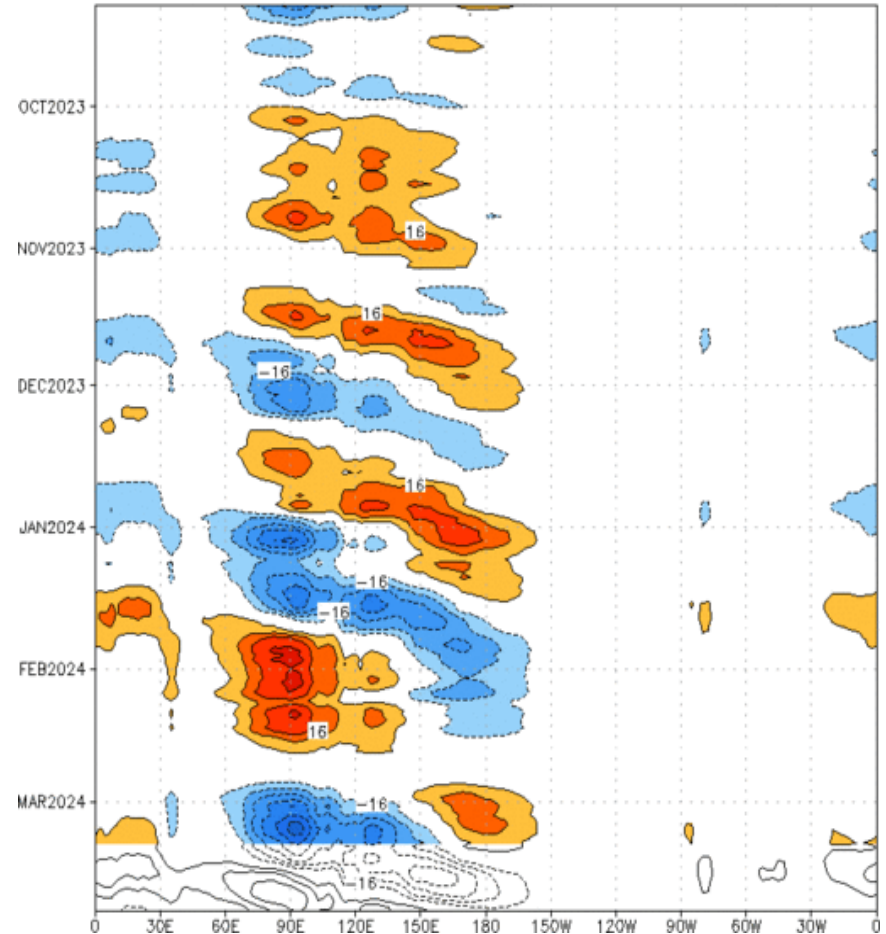
# MJO: GEFS Forecast Evolution

Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

Prediction of MJO-related anomalies using GEFS operational forecast  
Initial date: 10 Mar 2024  
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2  
OLR [7.5°S,7.5°N] (cint:4Wm<sup>-2</sup>) Period:09-Sep-2023 to 10-Mar-2024  
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

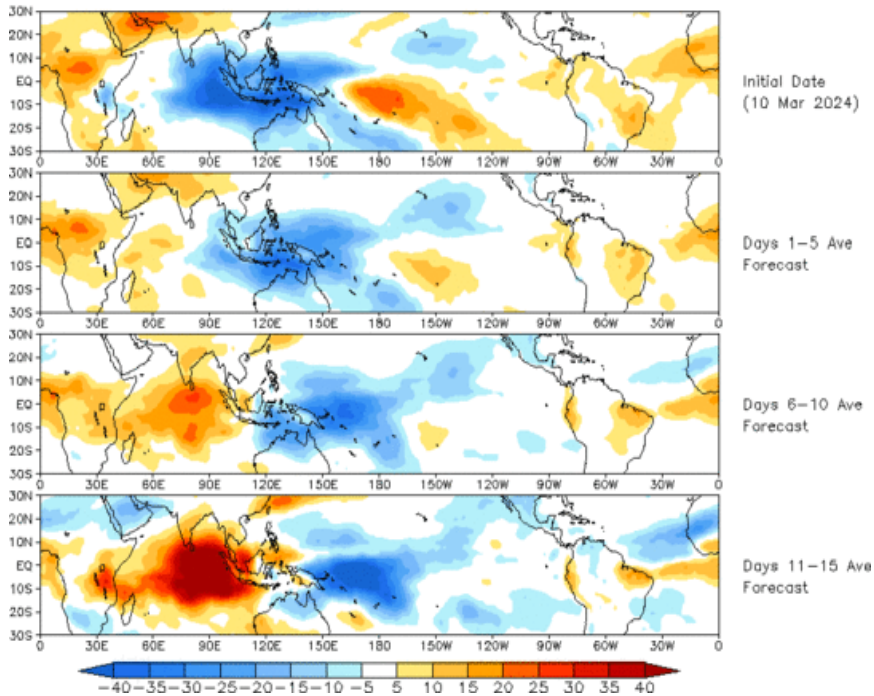


- The GEFS RMM-based tool shows a rapid evolution of the OLR pattern from an active Maritime Continent to an active West Pacific.
- The anomaly field remains quite robust through most of the forecast period, with some slight weakening by the end of Week-2.

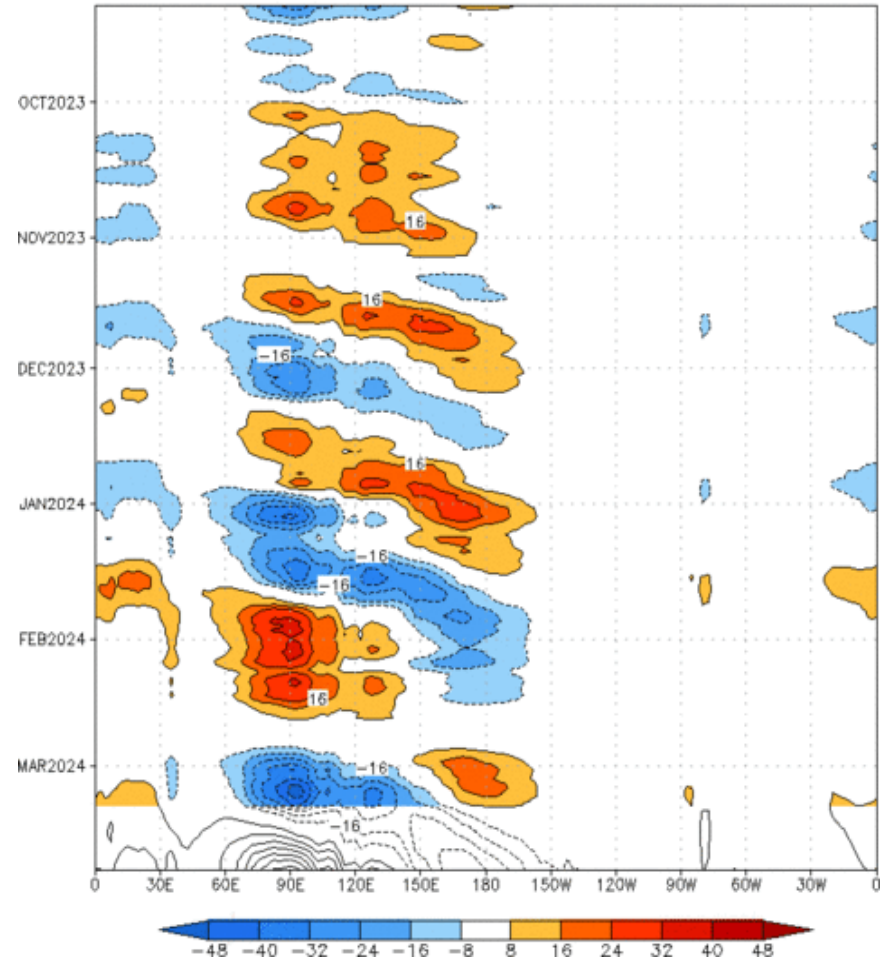
# MJO: Constructed Analog Forecast Evolution

Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

OLR prediction of MJO-related anomalies using CA model reconstruction by RMM1 & RMM2 (10 Mar 2024)



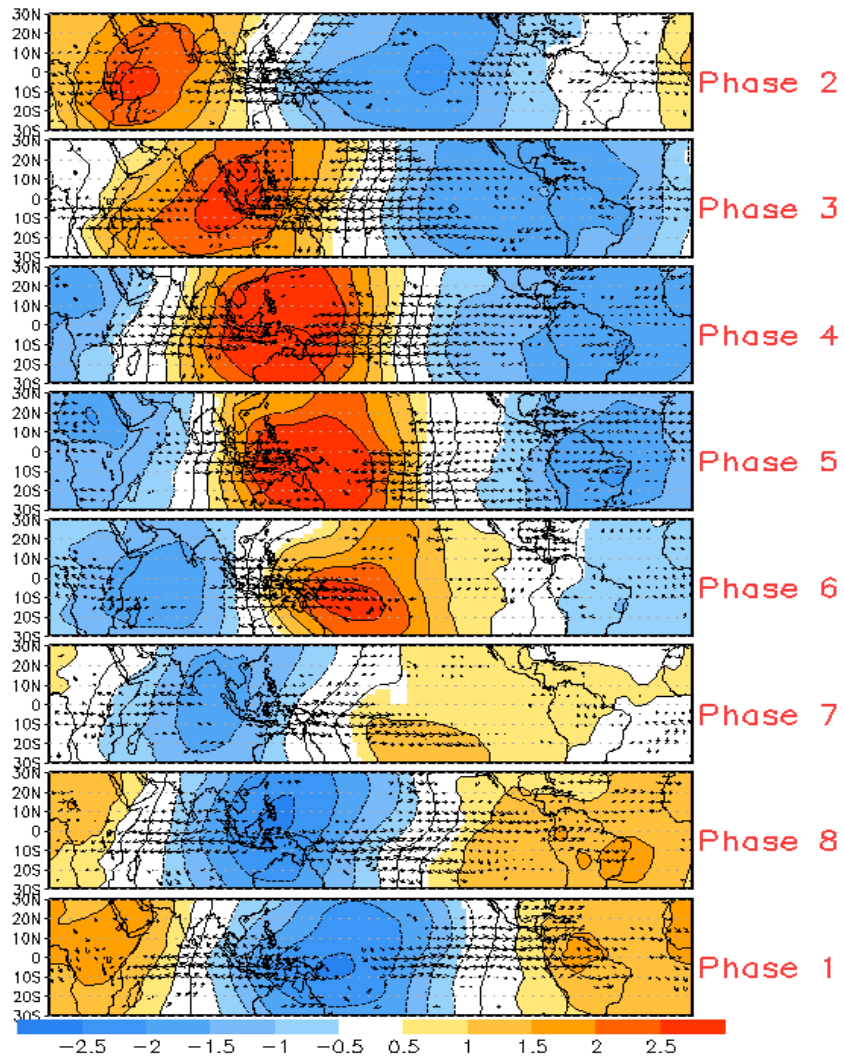
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm<sup>-2</sup>) Period:09-Sep-2023 to 10-Mar-2024  
The unfilled contours are CA forecast reconstructed anomaly for 15 days



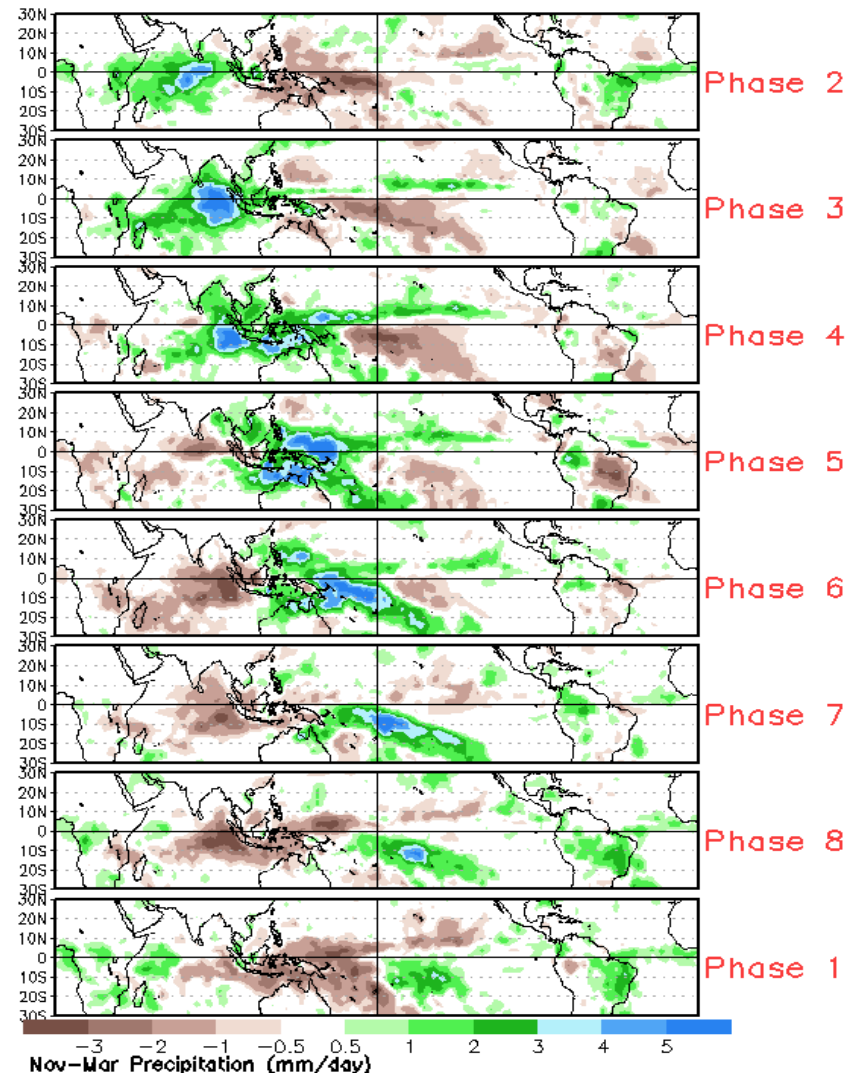
- The constructed analog tool depicts an even stronger and slightly slower MJO evolution compared to the GEFS.

# MJO: Tropical Composite Maps by RMM Phase

## 850-hPa Velocity Potential and Wind Anomalies



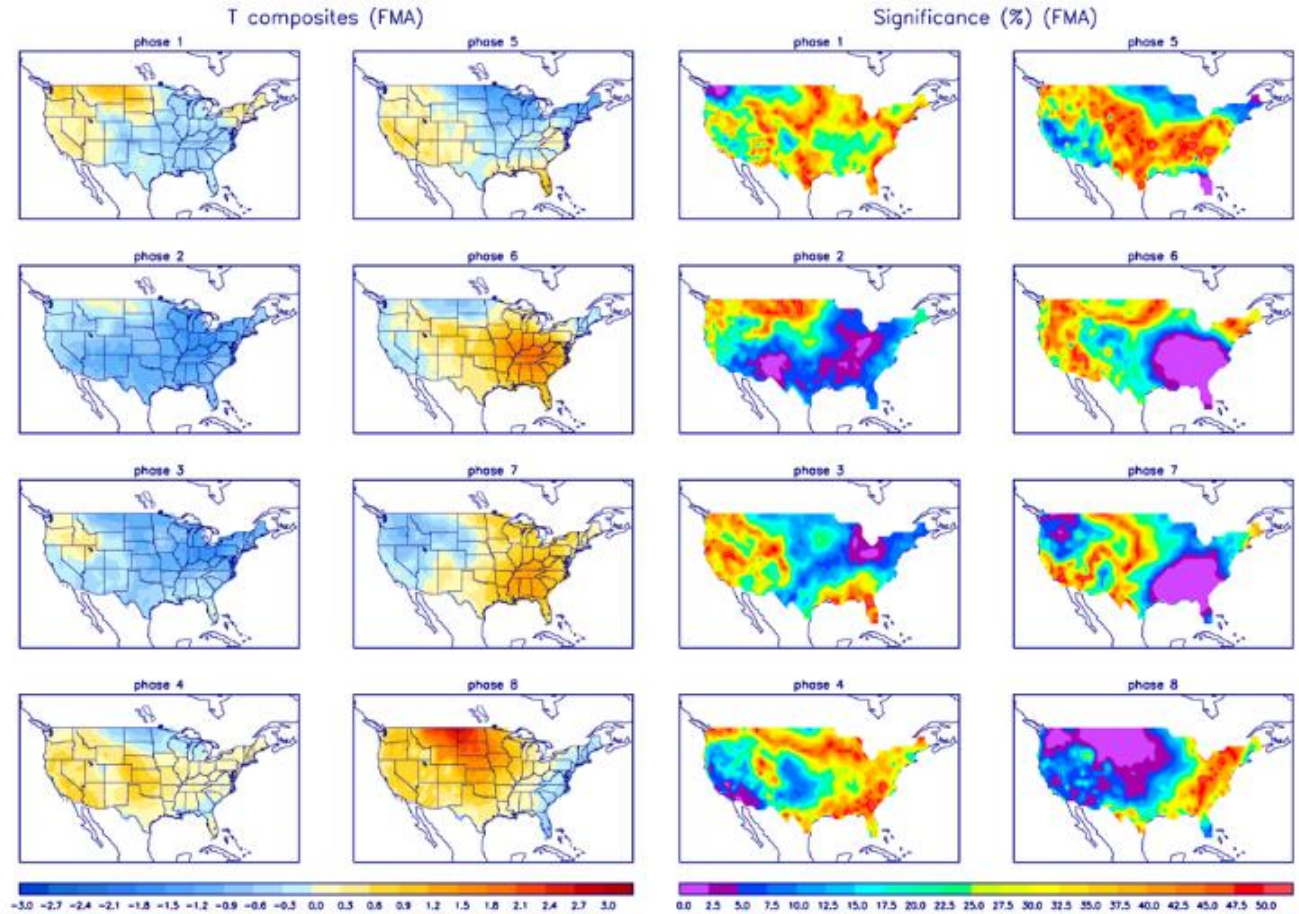
## Precipitation Anomalies



# MJO: CONUS Composite Maps by RMM Phase - Temperature

Left hand side plots show temperature anomalies by MJO phase for MJO events that have occurred over the three month period in the historical record. Blue (red) shades show negative (positive) anomalies respectively.

Right hand side plots show a measure of significance for the left hand side anomalies. Purple shades indicate areas in which the anomalies are significant at the 95% or better confidence level.



# MJO: CONUS Composite Maps by RMM Phase - Precipitation

Left hand side plots show precipitation anomalies by MJO phase for MJO events that have occurred over the three month period in the historical record. Brown (green) shades show negative (positive) anomalies respectively.

Right hand side plots show a measure of significance for the left hand side anomalies. Purple shades indicate areas in which the anomalies are significant at the 95% or better confidence level.

