

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



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

# Overview

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- The MJO became more coherent and strengthened at the beginning of March with its enhanced phase over Africa and the western Indian Ocean.
- Dynamical models are in good agreement that the MJO continues to propagate eastward from the Indian to the Pacific Ocean during the next to three weeks.
- Given this predicted MJO evolution, more than a 60 percent chance of tropical cyclone (TC) development is forecast from the Kimberley Coast of Australia east to the Gulf of Carpentaria from March 13 to 19. Elevated chances of TC development continue for the Gulf of Carpentaria and also the Coral Sea through late March.

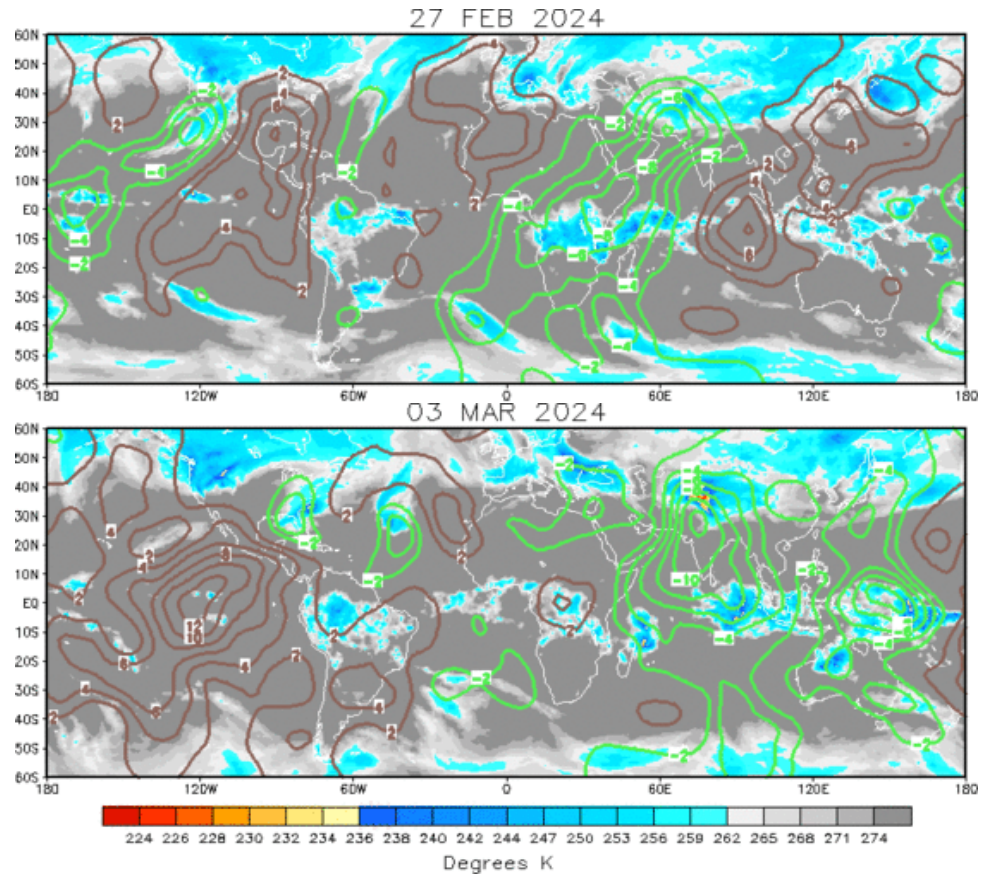
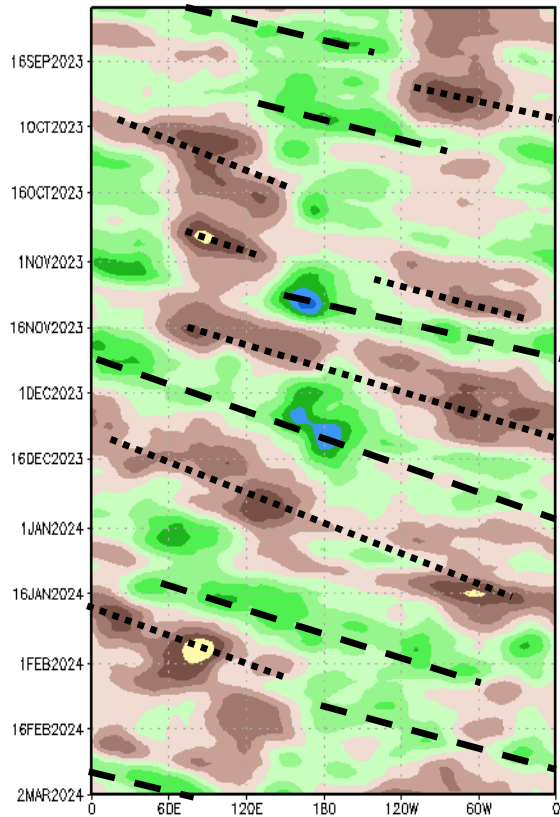
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:  
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

# 200-hPa Velocity Potential Anomalies

**Green shades: Anomalous divergence (favorable for precipitation)**

**Brown shades: Anomalous convergence (unfavorable for precipitation)**

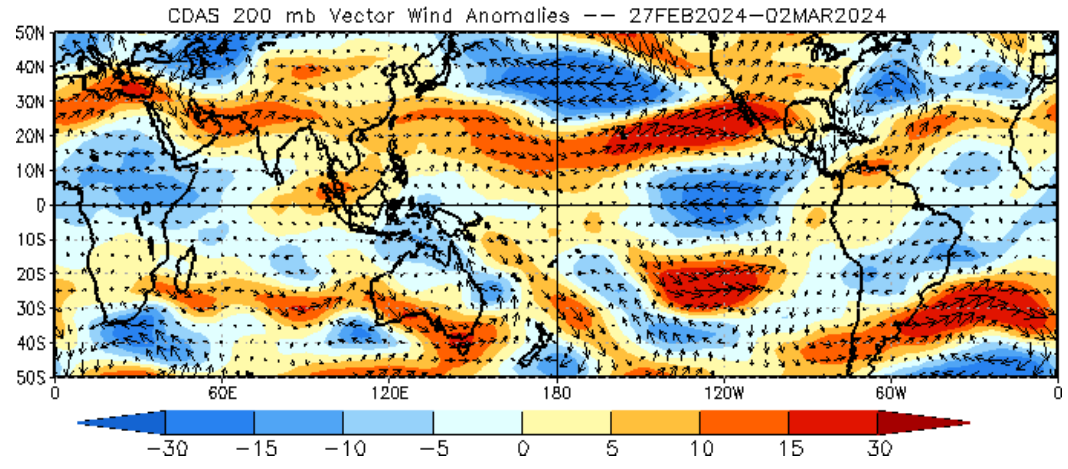
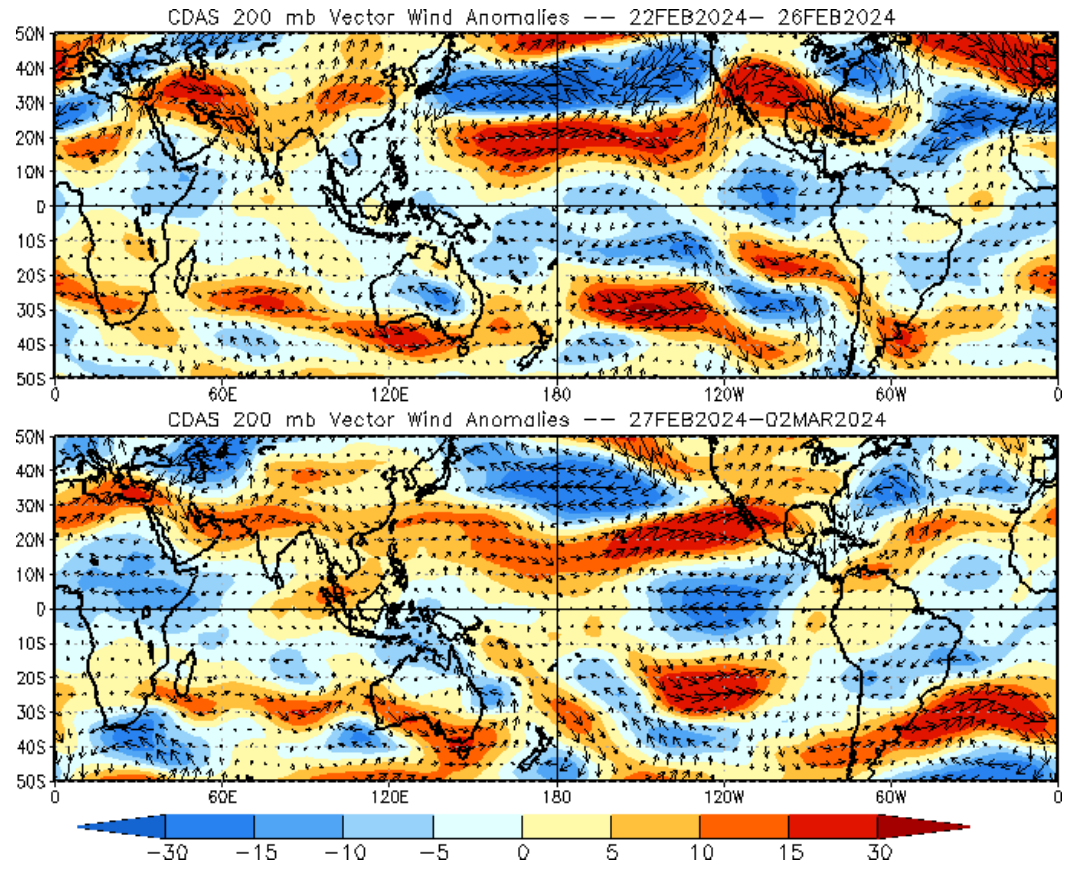
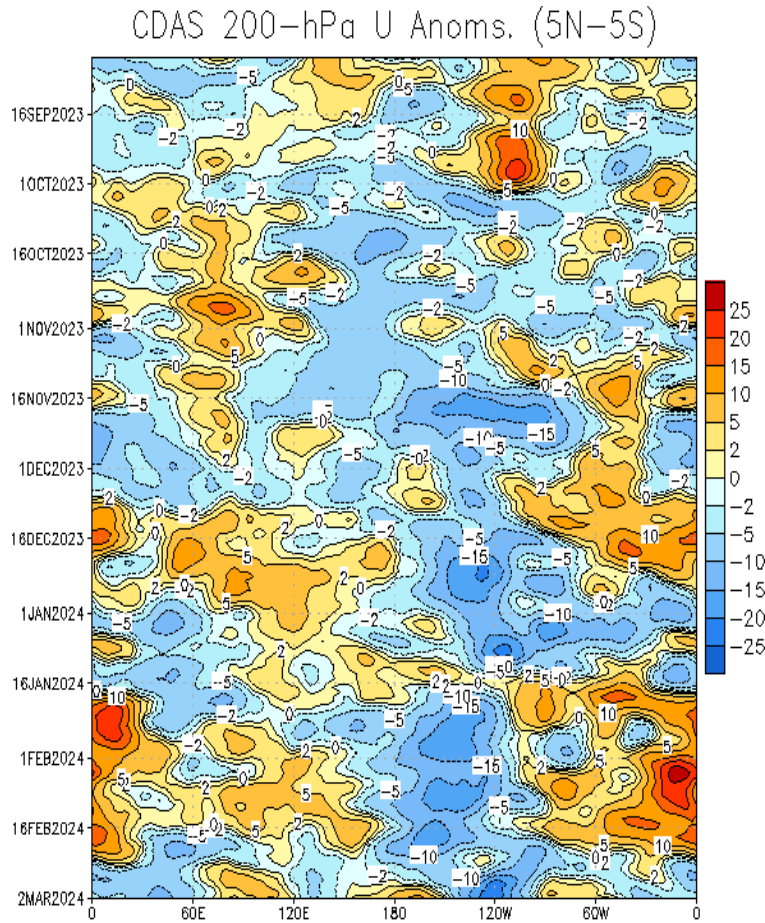
200-hPa Velocity Potential Anomaly: 5N-5S  
5-day Running Mean



- Continued eastward MJO propagation is apparent on the time-lon velocity potential plot.
- The upper-level velocity potential anomaly fields indicate anomalous divergence shifting from Africa to the Indian Ocean from late February to the beginning of March, consistent with the MJO.
- A coherent wave-1 pattern of anomalous upper-level divergence (convergence) over the Indian Ocean (eastern Pacific) recently developed.

# 200-hPa Wind Anomalies

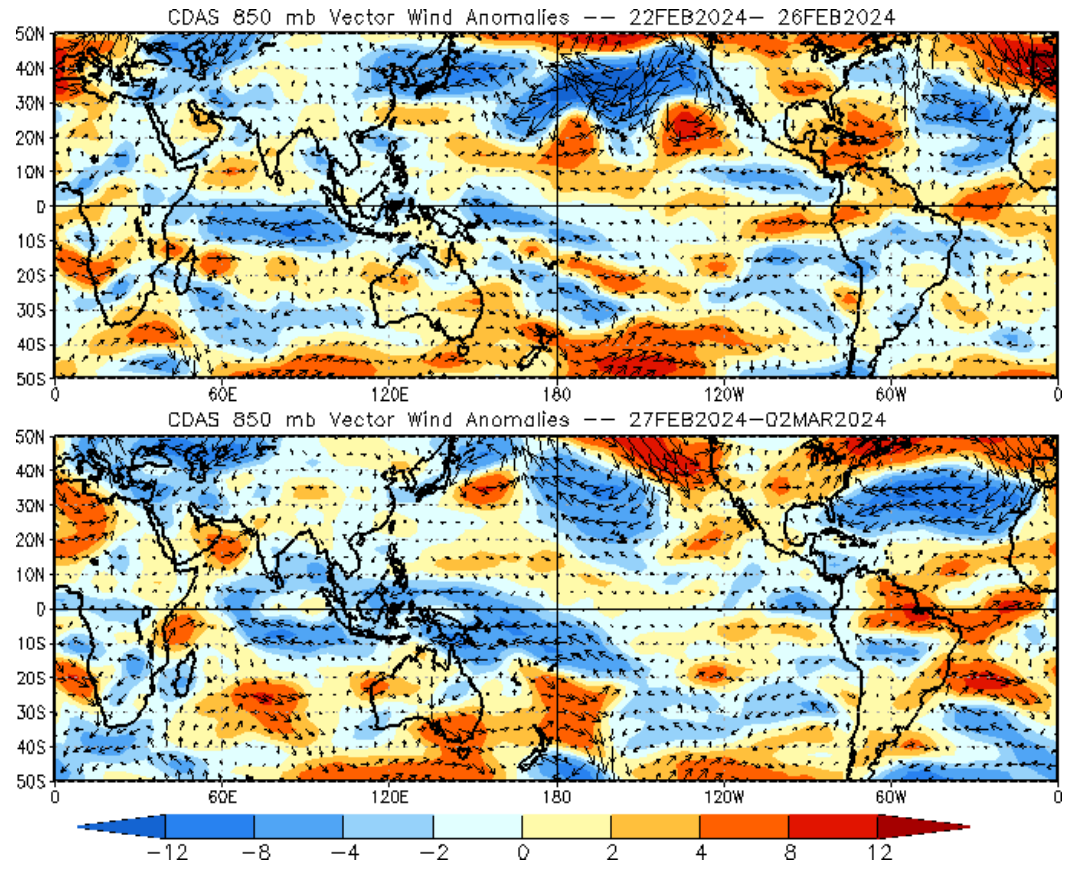
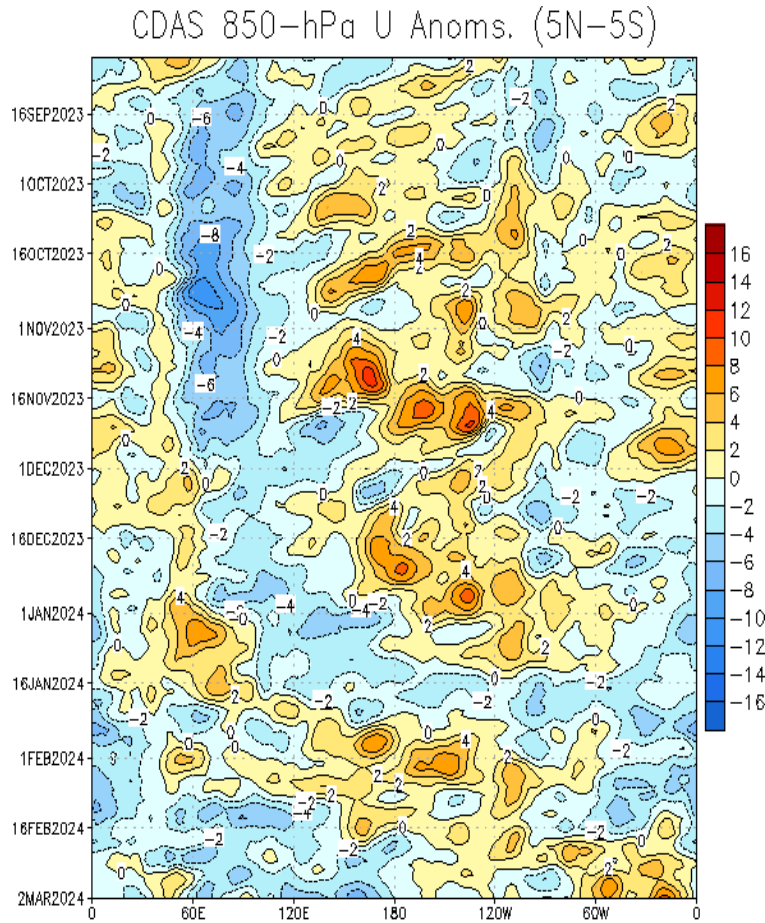
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- A strong subtropical jet is noted across much of the Pacific, associated with continued enhanced moisture advection into the southwestern U.S.
- Anomalous upper-level easterlies have increased across the equatorial eastern Pacific following the departure of the MJO and remaining under the influence of the El Niño base state.

# 850-hPa Wind Anomalies

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

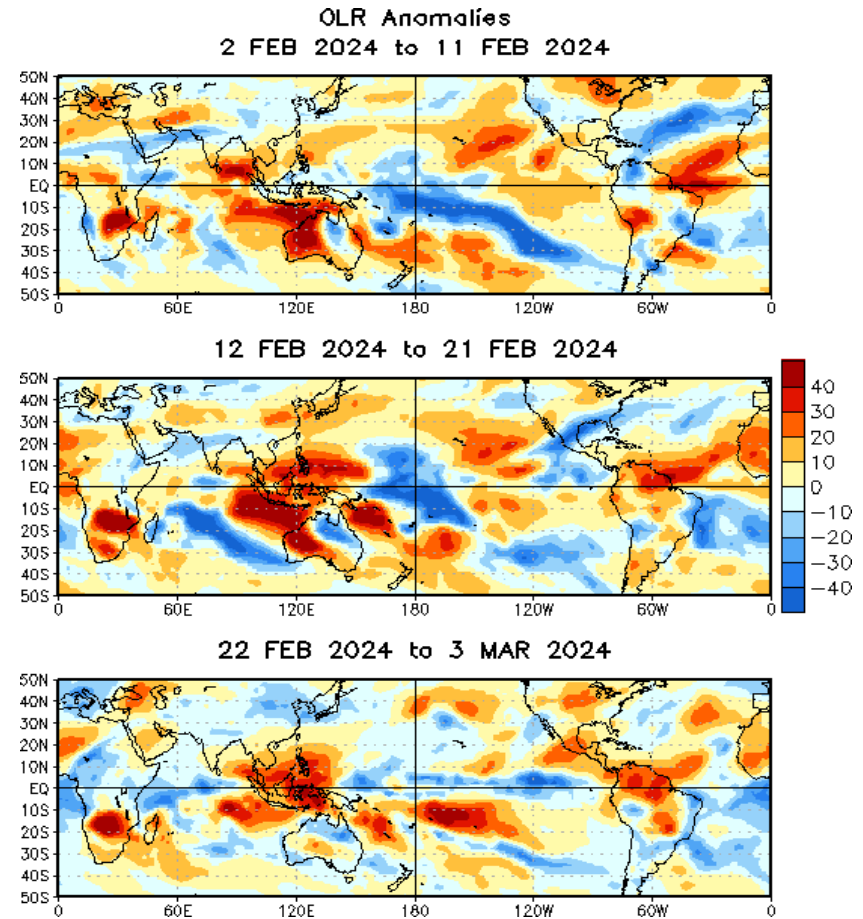
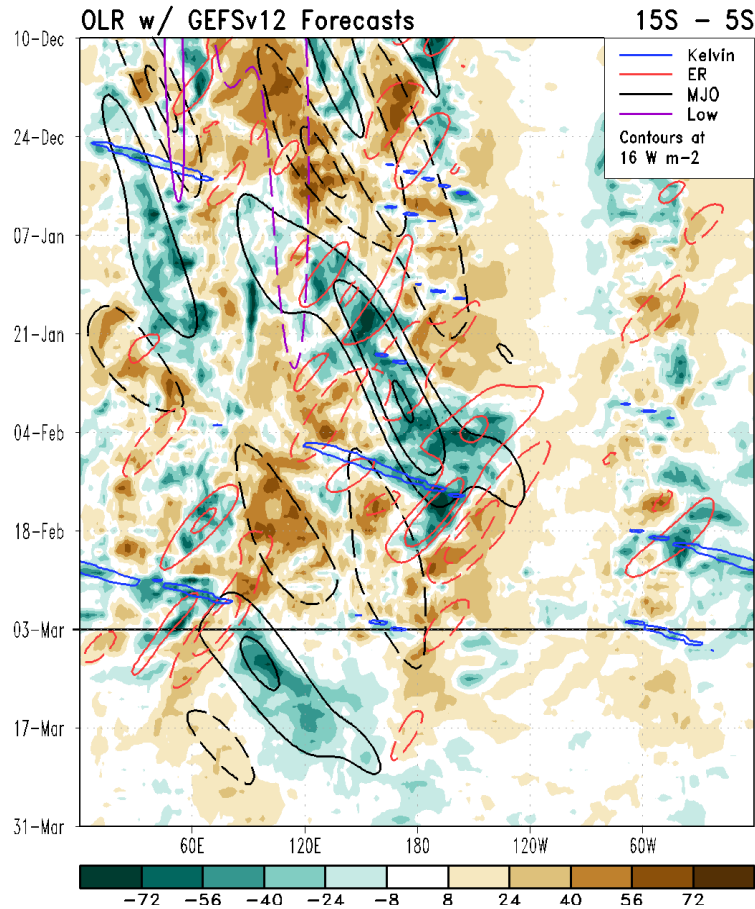


- There has been a clear eastward propagation of anomalous low-level westerlies across the equator tied to the MJO.
- Anomalous low-level easterlies have increased across the equatorial Indian Ocean leading to enhanced convergence across Africa and the western Indian Ocean.

# Outgoing Longwave Radiation (OLR) Anomalies

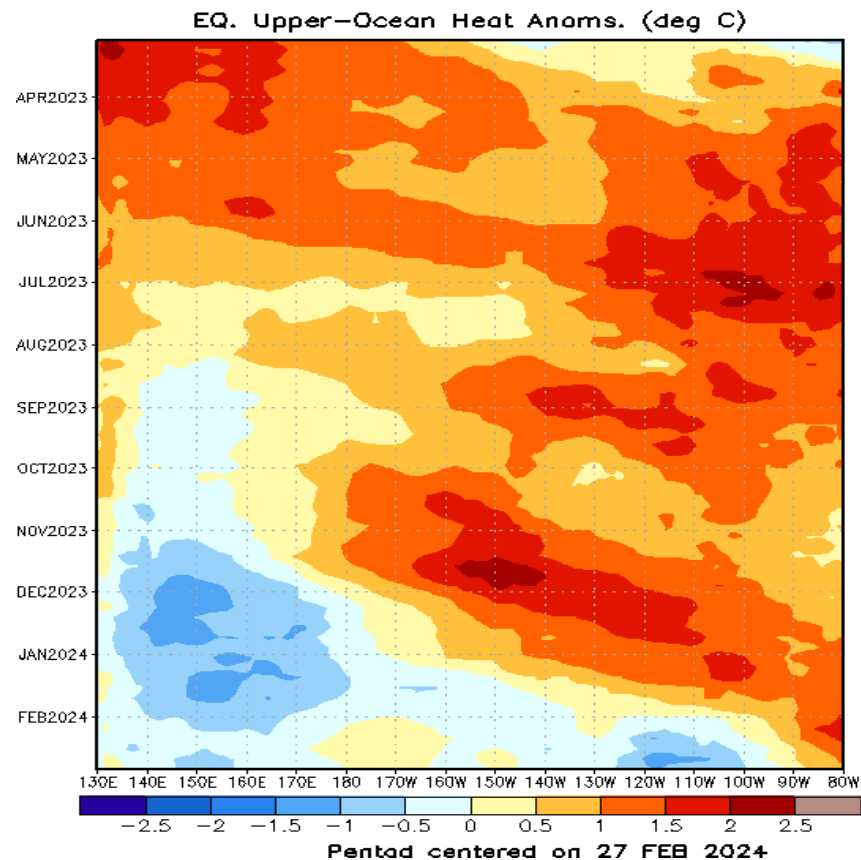
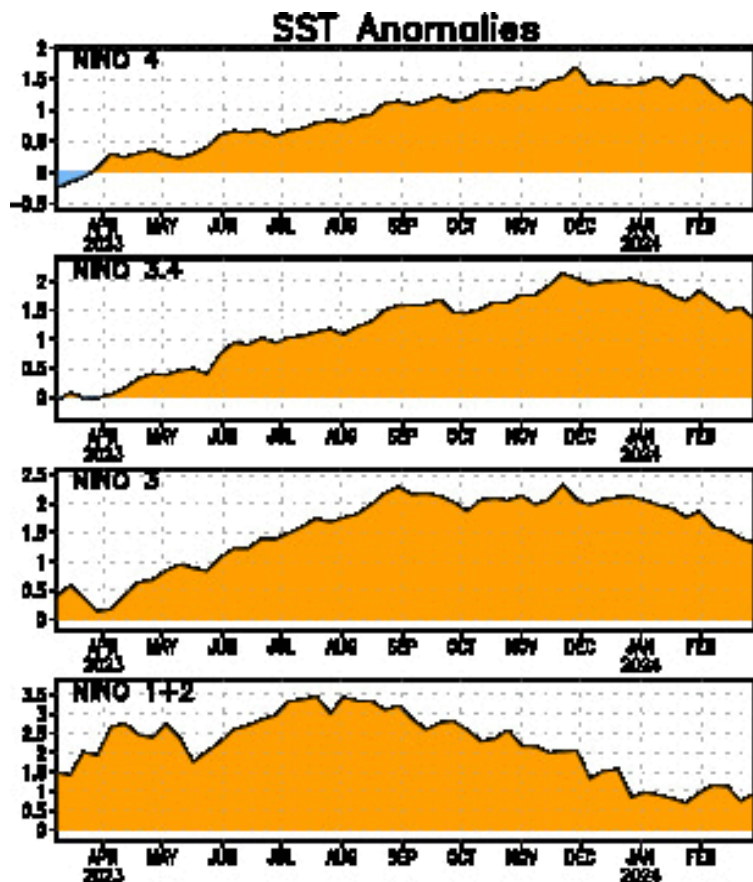
**Green shades:** Anomalous convection (wetness)

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



- MJO signal is coming through the OLR filtering over Indian Ocean, and the GEFS OLR forecasts depict a continued propagation of this enhanced signal to the Western Pacific during early to mid-March.
- The suppressed phase of the MJO led to a weakening of enhanced convection, associated with El Niño, at the Date Line by late February.

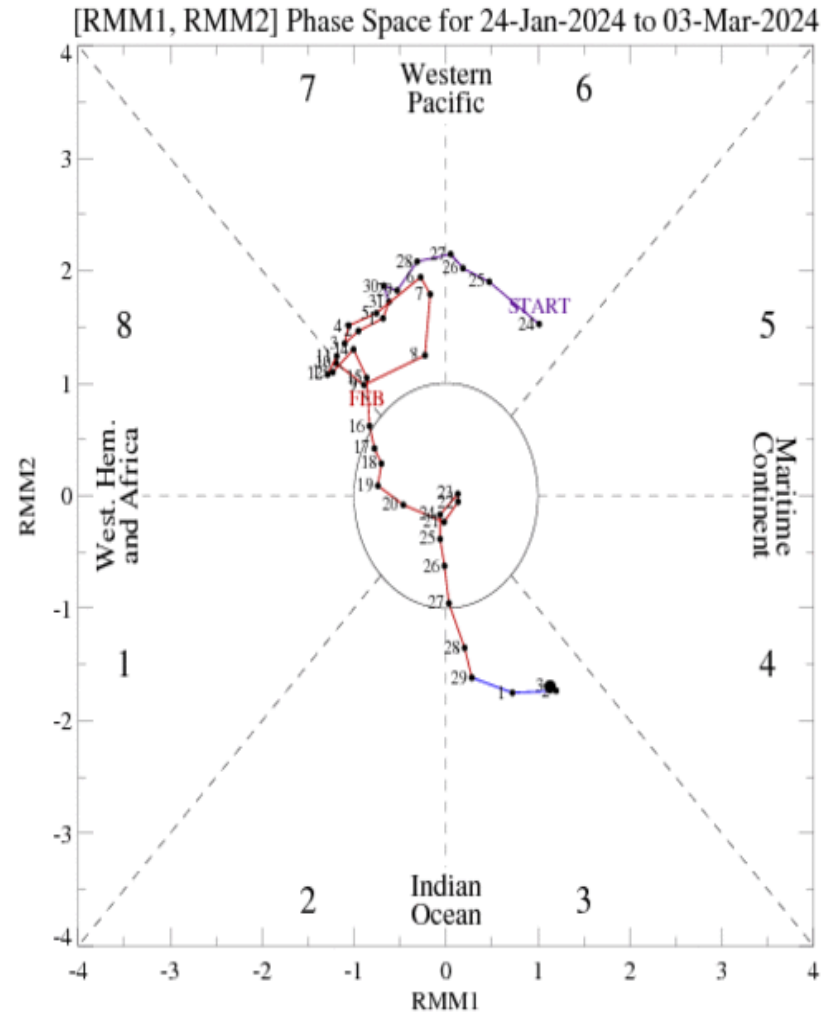
# SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- 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.

# MJO Index: Recent Evolution

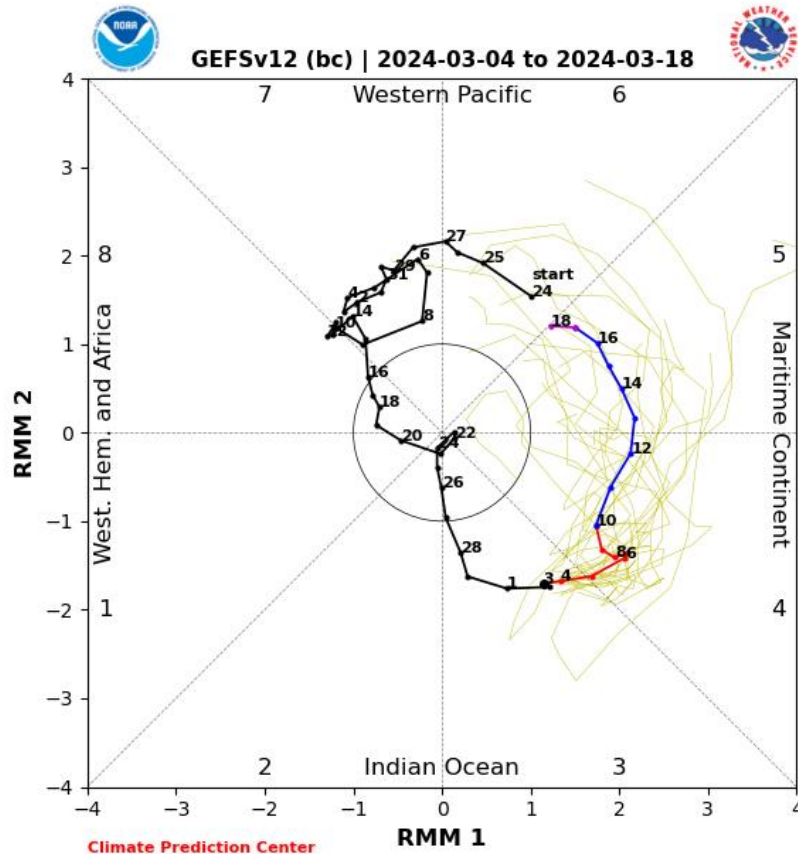
- During the latter half of February, the RMM-based MJO index has returned to the unit circle. However, the removal of the 120-day running mean in the RMM-computation favors a rightward bias, and the velocity potential pattern was more indicative of an active MJO.
- By the beginning of March, the RMM-based MJO index gained amplitude with eastward propagation.



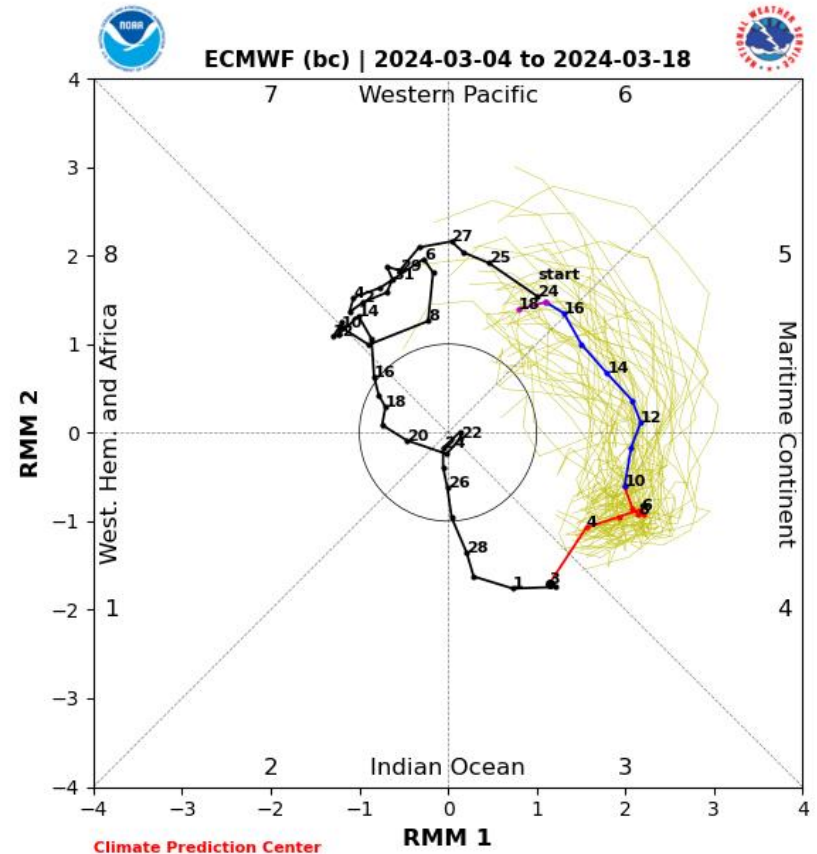
For more information on the RMM index and how to interpret its forecast please see:  
[https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC\\_MJOinformation.pdf](https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf)



# MJO Index: Forecast Evolution



**GEFS Forecast**



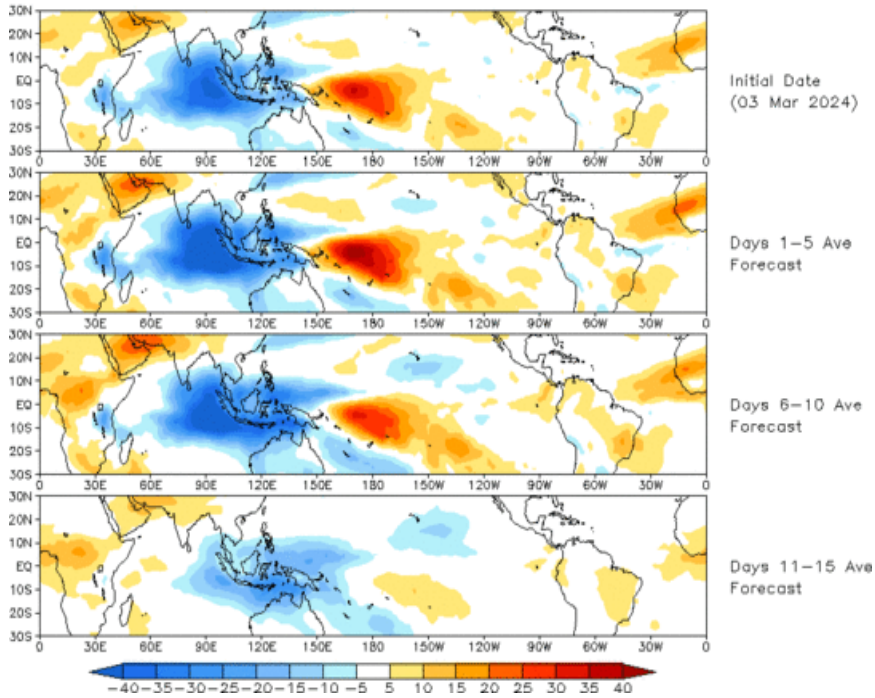
**ECMWF Forecast**

- Both the GEFS and ECMWF RMM-based forecasts indicate a continued eastward propagation of the MJO over the Maritime Continent to the West Pacific during the next 2 weeks.
- A removal of the 120-day running mean in RMM computation may be resulting in a rightward shift in the RMM-based forecasts, suggesting that the current forecast may be slightly over-amplifying the MJO signal.

# MJO: GEFS Forecast Evolution

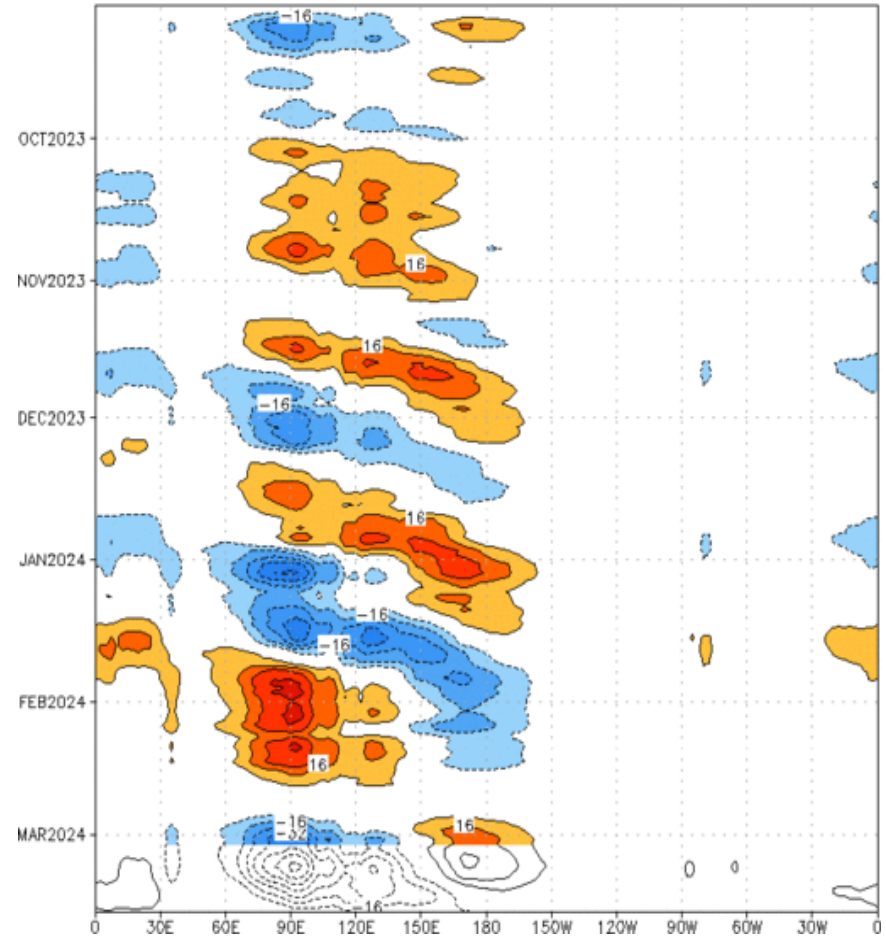
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

Prediction of MJO-related anomalies using GEFS operational forecast  
Initial date: 03 Mar 2024  
OLR



- The GEFS RMM-based tool depicts negative OLR anomalies (enhanced convection) shifting east from the Indian Ocean to the Maritime Continent and West Pacific.

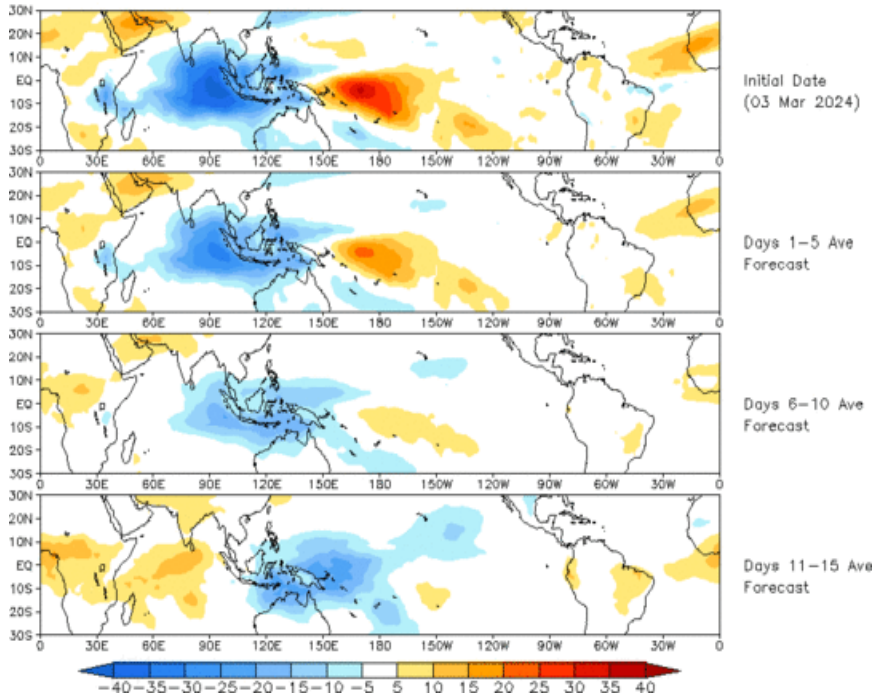
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2  
OLR [7.5°S,7.5°N] (cont:4Wm<sup>-2</sup>) Period:02-Sep-2023 to 03-Mar-2024  
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days



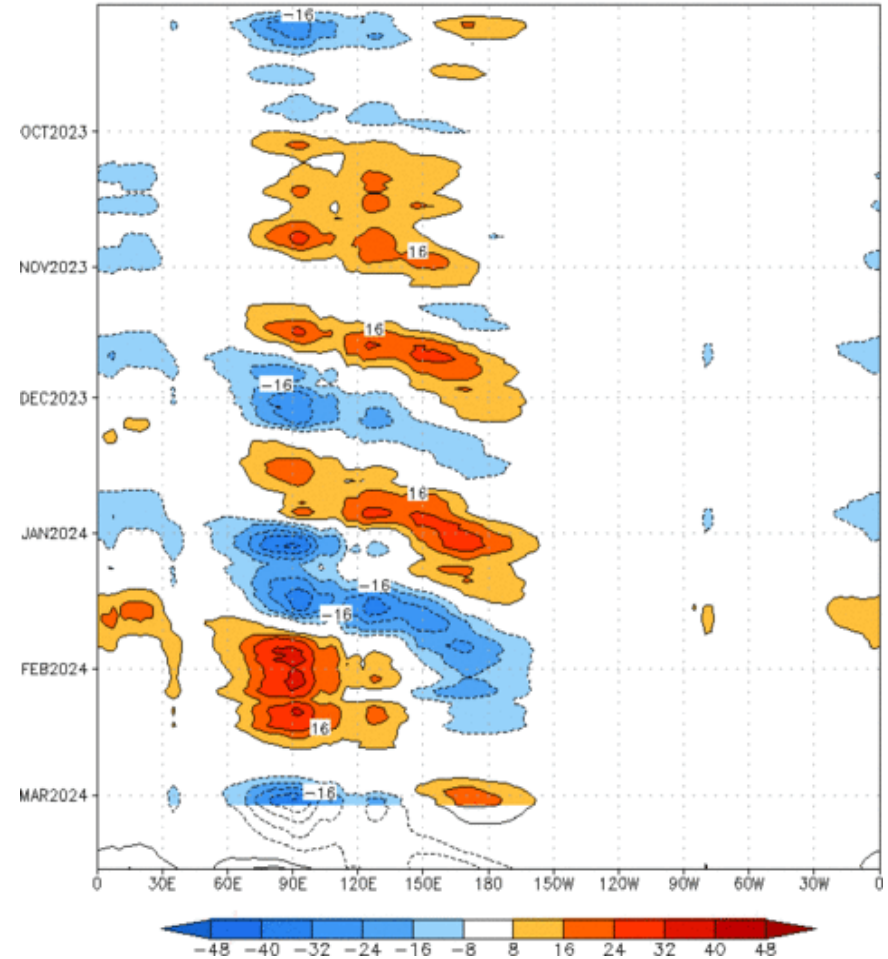
# MJO: Constructed Analog Forecast Evolution

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 (03 Mar 2024)



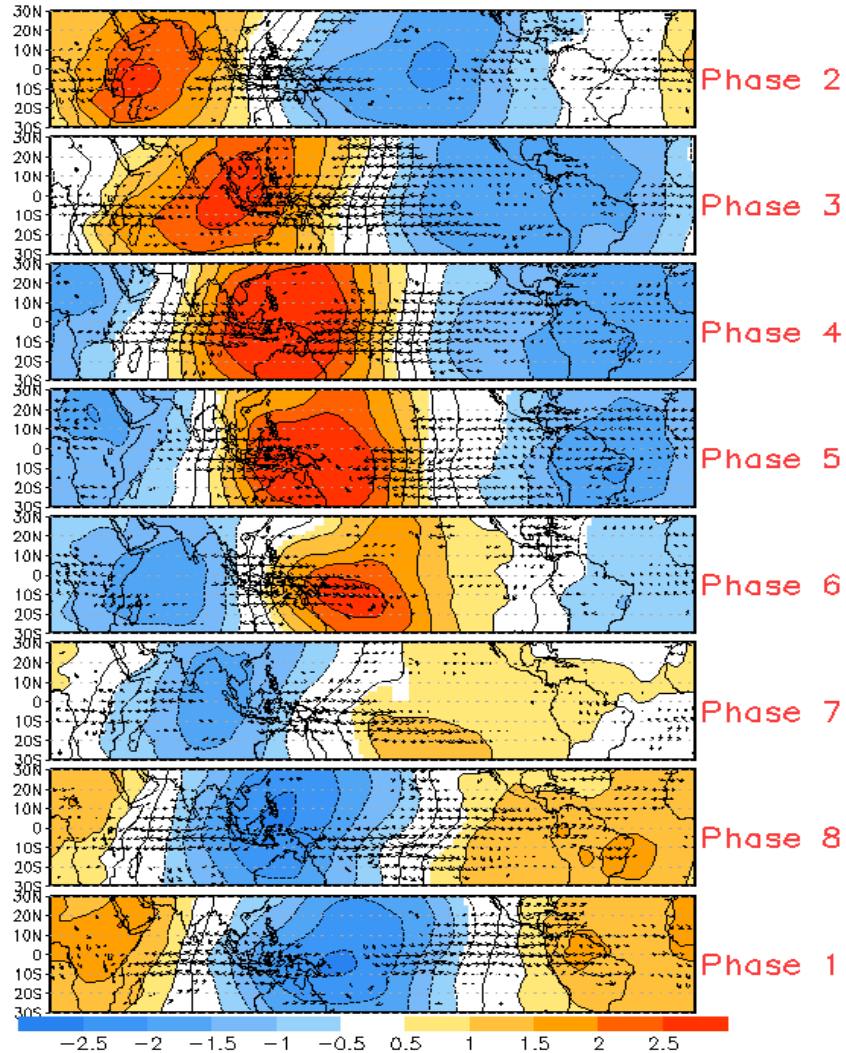
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm<sup>-2</sup>) Period:02-Sep-2023 to 03-Mar-2024  
The unfilled contours are CA forecast reconstructed anomaly for 15 days



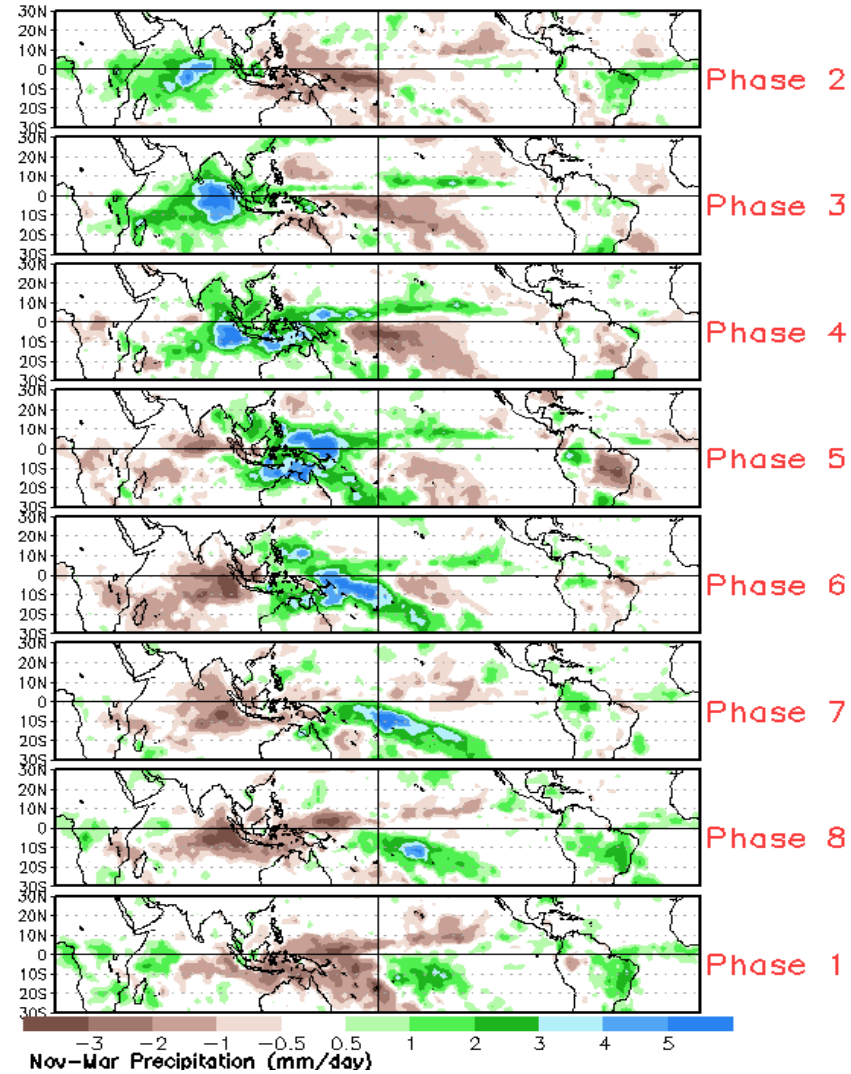
- The constructed analog tool depicts a faster progression of the MJO compared to the GEFS, with negative OLR anomalies (enhanced convection) reaching the central Pacific during week-2, and a transition to positive OLR anomalies (suppressed convection) over the Indian Ocean.

# MJO: Tropical Composite Maps by RMM Phase

## 850-hPa Velocity Potential and Wind Anomalies



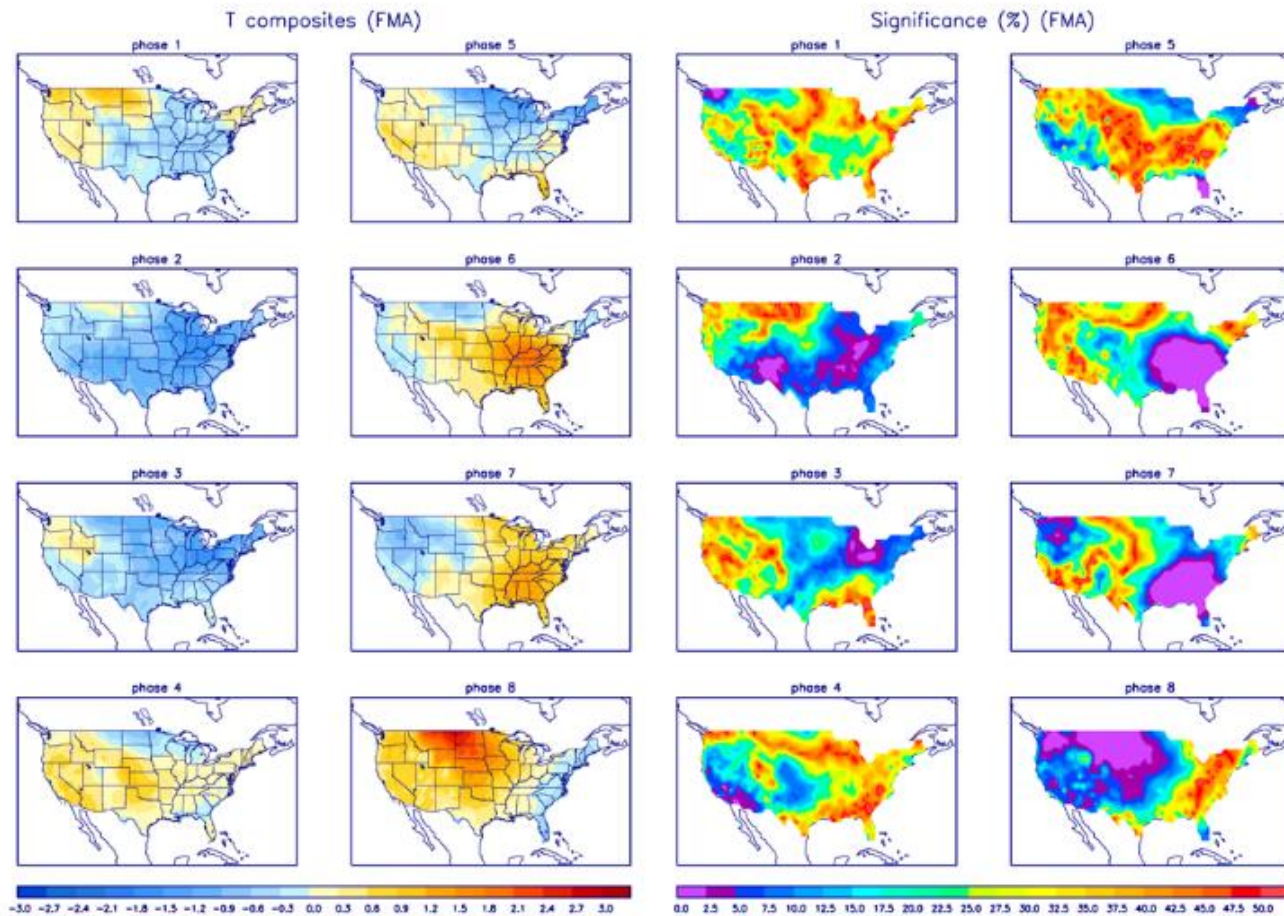
## Precipitation Anomalies



# 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.

