

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



**Update prepared by the Climate Prediction Center**  
**NWS / NCEP / CPC**  
**22 January 2024**

# Overview

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- Following a period of competing interference with other modes of tropical variability, the MJO became more coherent as it propagated eastward over the Maritime Continent and into the Western Pacific.
- Good agreement exists in the dynamical models looking ahead, which initially favor a high amplitude MJO signal over the Western Pacific that weakens and slows after the week-1 period.
- Enhanced convection associated with MJO activity is expected to provide favorable conditions for Tropical Cyclone (TC) development over the South Pacific Ocean, while a lingering potential for TC activity for the western Indian Ocean remains despite an unfavorable position of the MJO.
- The extratropical response with wintertime Maritime Continent and West Pacific MJO events typically leads to the development of warmer than normal temperatures over the central and eastern U.S. Strong subtropical westerly flow is forecast both near the surface and aloft, potentially leading to an atmospheric river event to affect the West Coast of the U.S. during the week-2 period.

A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:

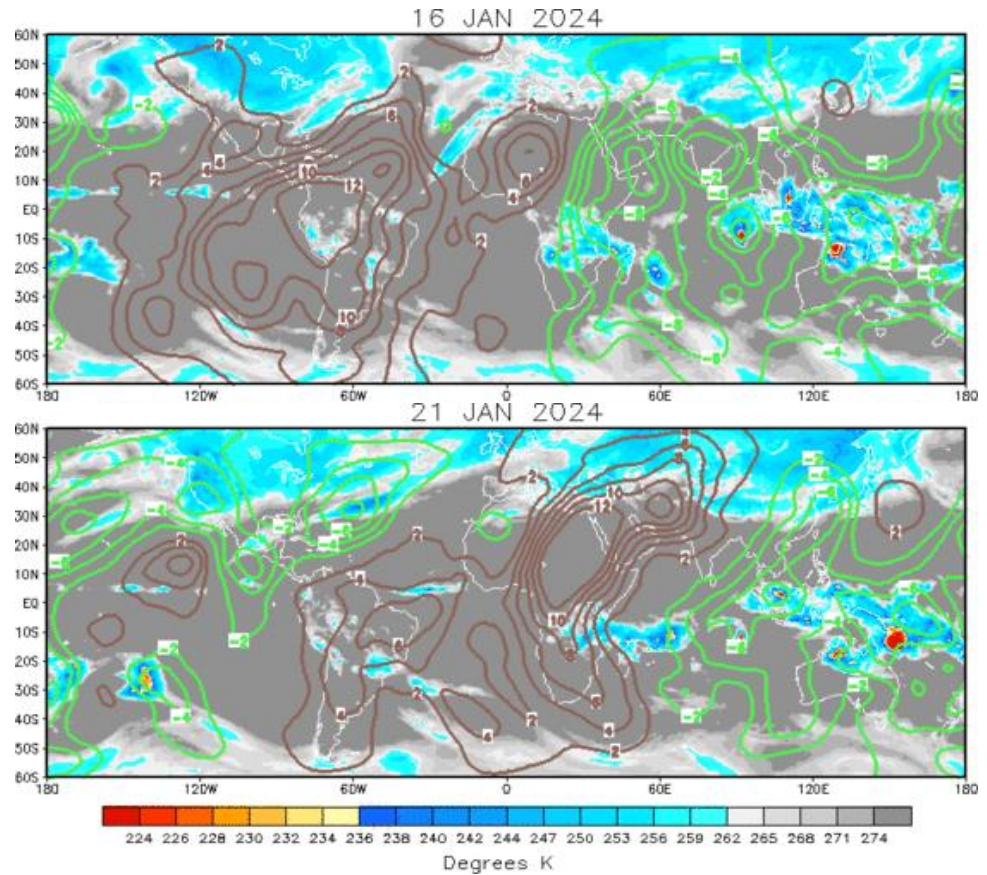
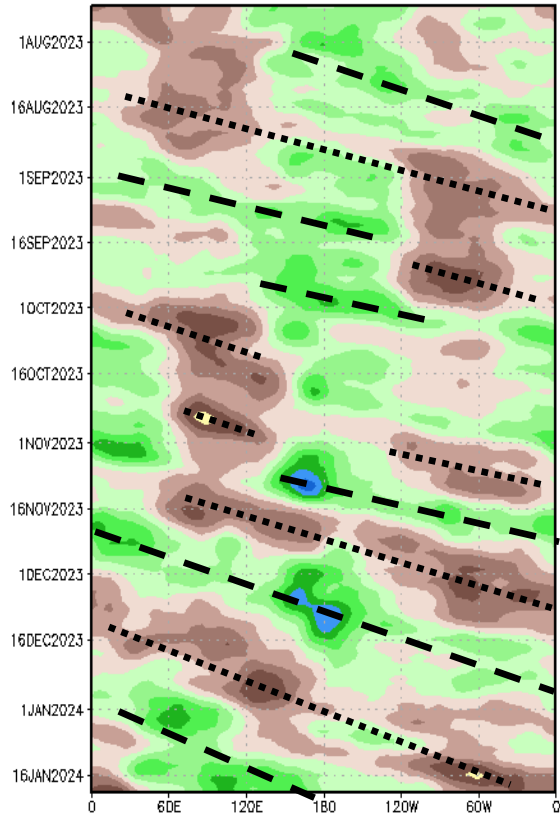
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

# 200-hPa Velocity Potential Anomalies

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

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

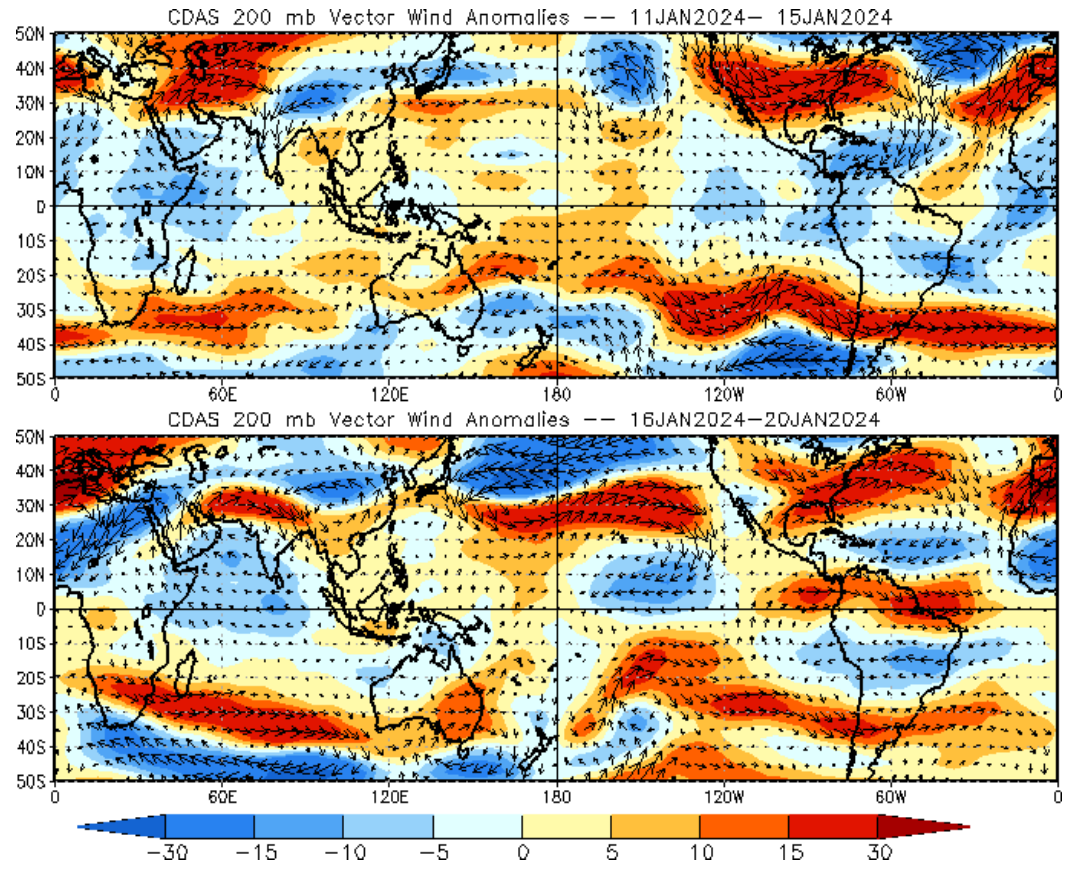
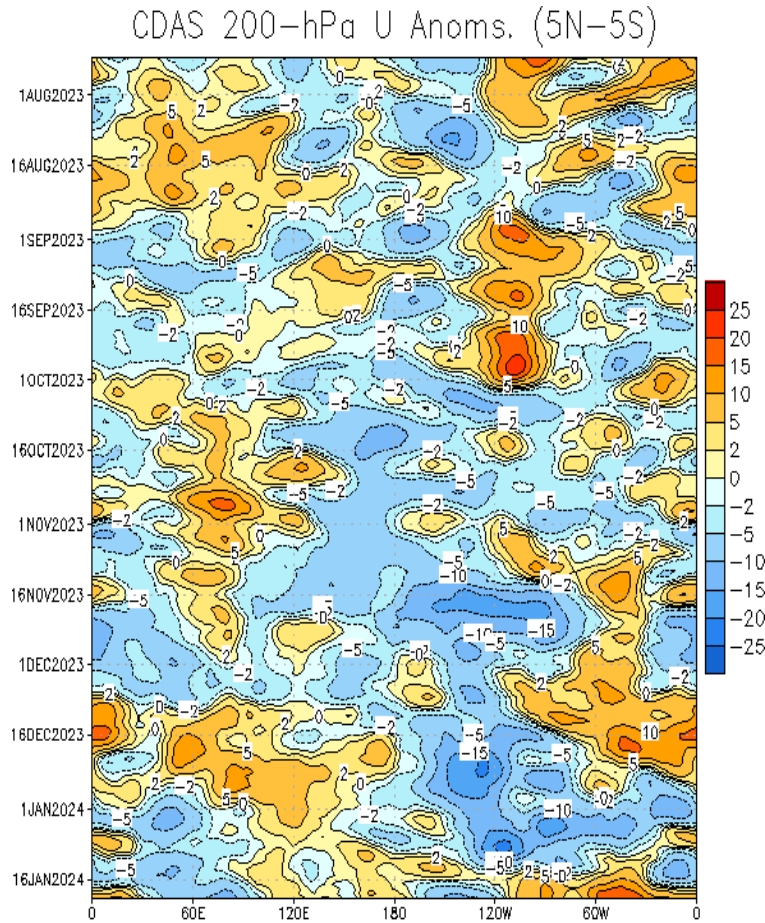
200-hPa Velocity Potential Anomaly: 5N-5S  
5-day Running Mean



- Robust MJO activity is evident in the Hovmoller plot since mid-November. There was a brief period of incoherence right around the New Year, but wave-1 symmetry has become well-established since.
- Recent observations show a very well-defined wave-1 pattern in mid-January, which has become slightly less symmetric but still evident, with the enhanced convective envelope moving into the Western Pacific.

# 200-hPa Wind Anomalies

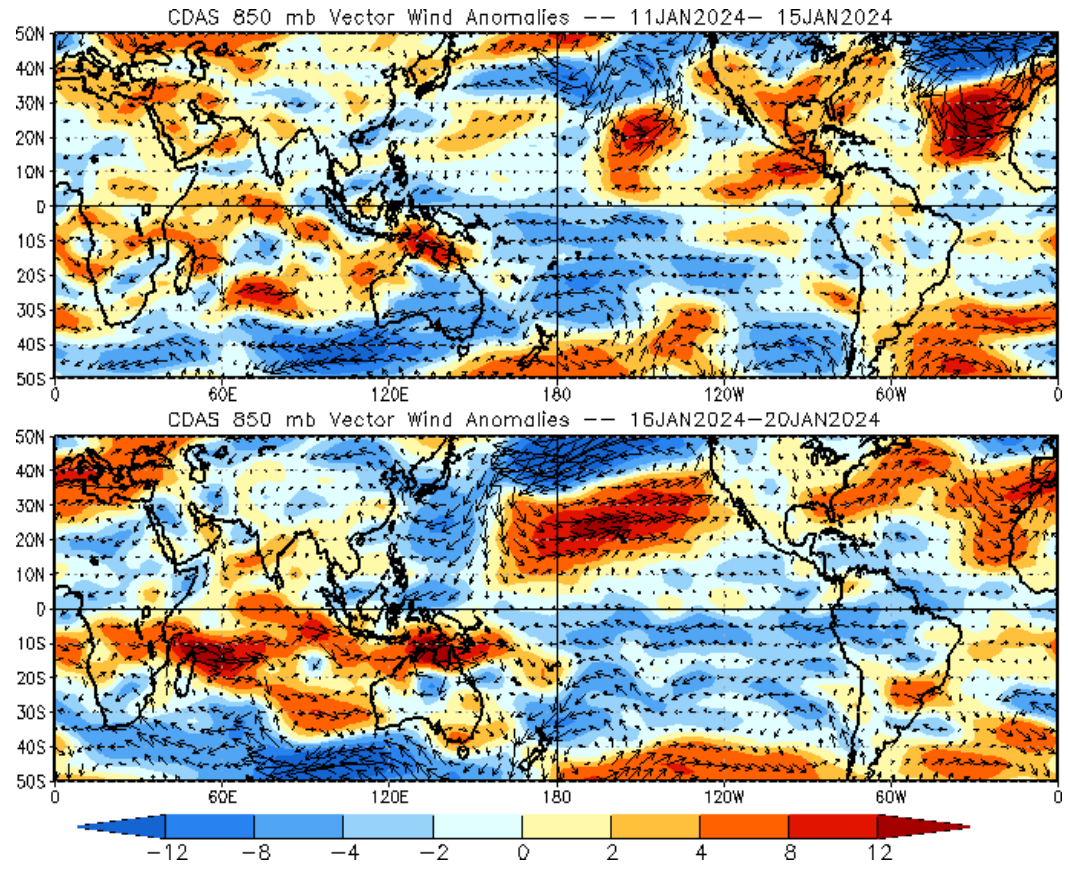
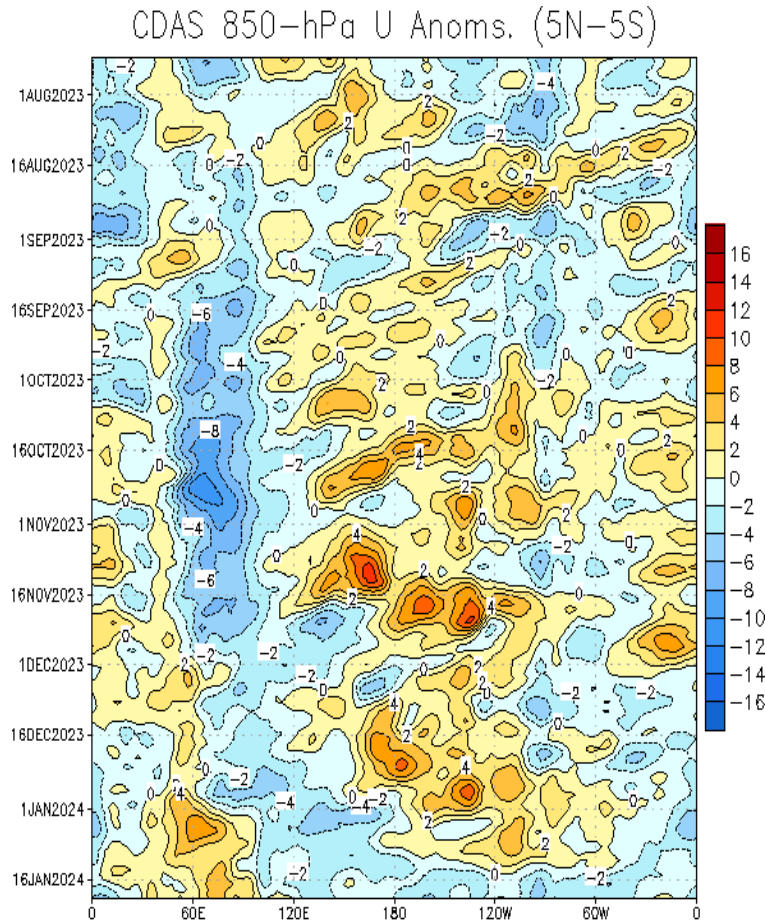
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- The westerly phase of the MJO shifted eastward into the Eastern Pacific, easing destructive interference with persistently strong easterlies tied to the atmospheric response of El Niño.
- Enhanced easterlies overspread the equatorial Indian Ocean, consistent with ongoing MJO activity.
- An enhanced jet has emerged recently over the subtropical Pacific, potentially setting up a large moisture flux into the California coast.

# 850-hPa Wind Anomalies

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

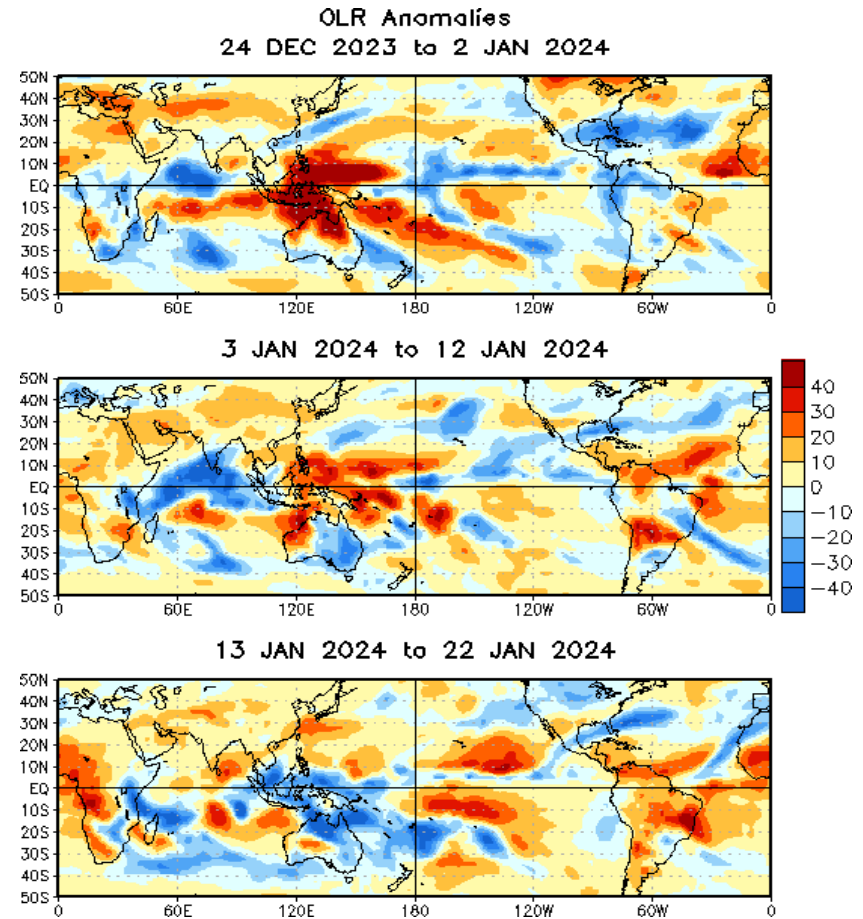
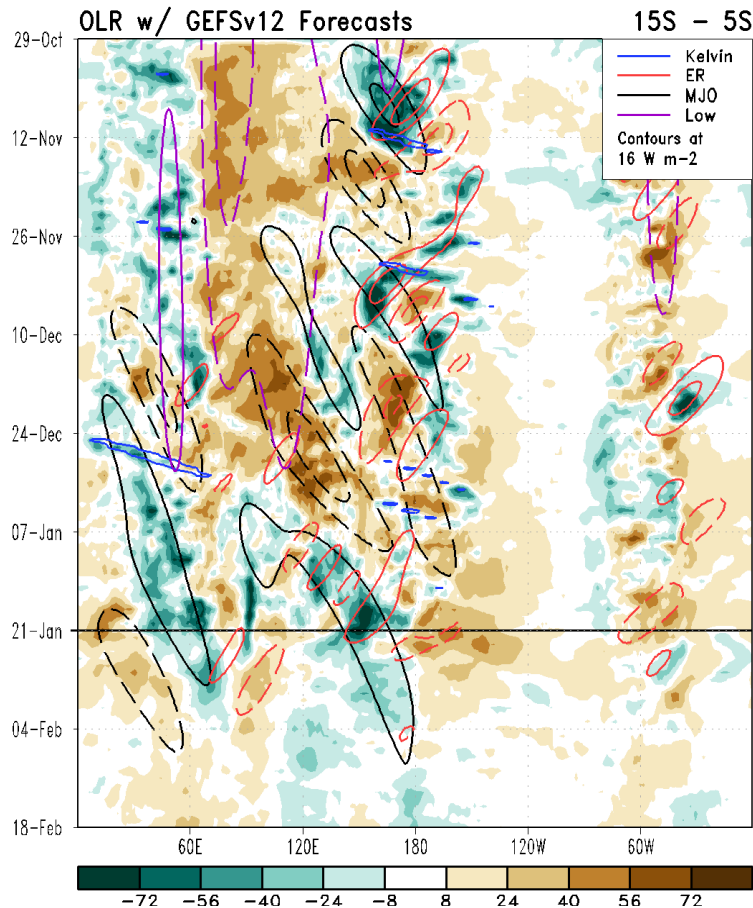


- The eastward propagation of anomalous westerlies stalled over the Indian Ocean in early January, possibly due to Rossby wave interference with the MJO during the last week. However, westerly anomalies strengthened over the Indian Ocean and have redeveloped recently east of New Guinea as the MJO continues eastward propagation.
- Anomalous easterlies continued over the central Pacific, consistent with the MJO destructively interfering with El Niño. Westerly anomalies are also present over the subtropical Central Pacific.

# Outgoing Longwave Radiation (OLR) Anomalies

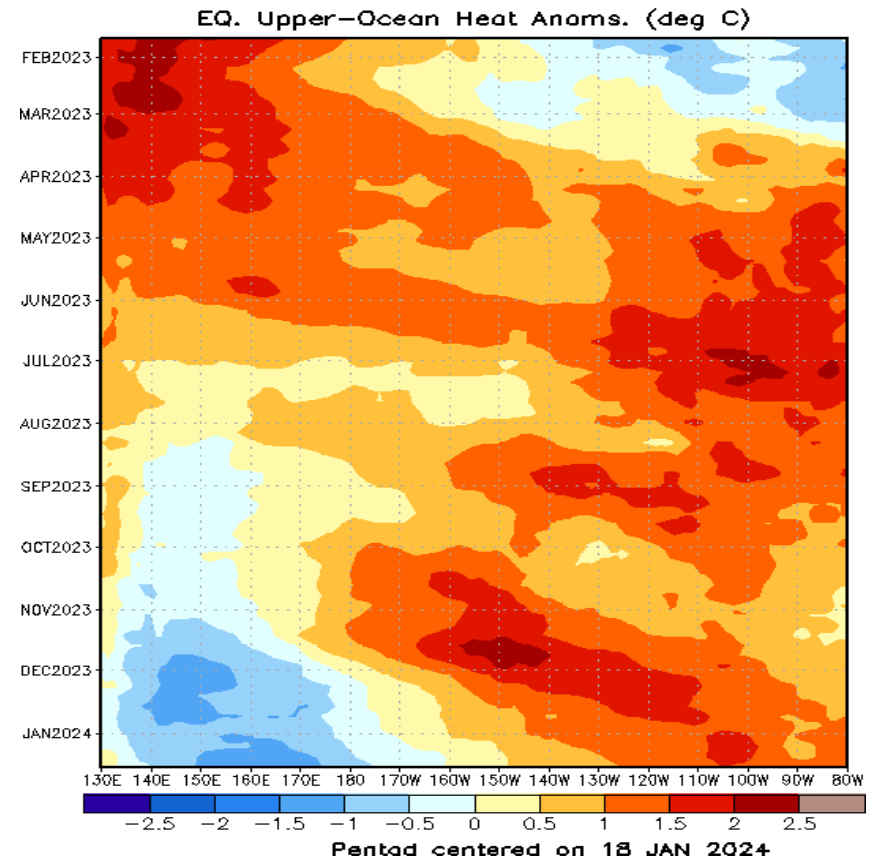
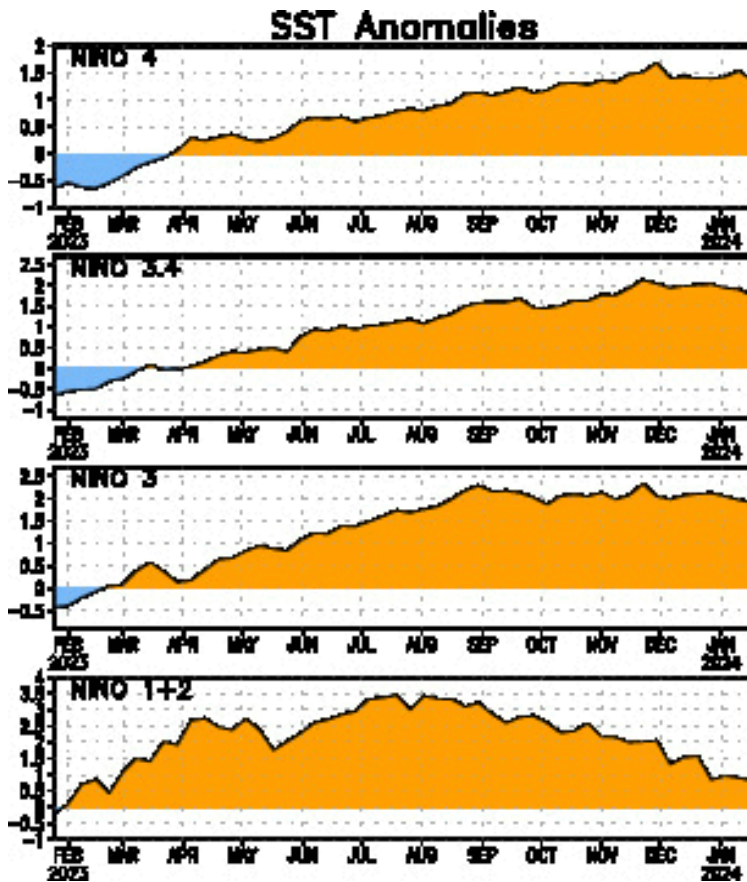
**Green shades:** Anomalous convection (wetness)

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



- Continued MJO activity resulted in the reversal of the convective pattern over the eastern Indian Ocean and Maritime Continent, with a much weaker low frequency convective response east of the Date Line.
- OLR forecasts show an envelope of enhanced convection propagating eastward then stalling in the western Pacific during the next several weeks, as the MJO looks to again constructively interfere with the El Niño response heading into February.

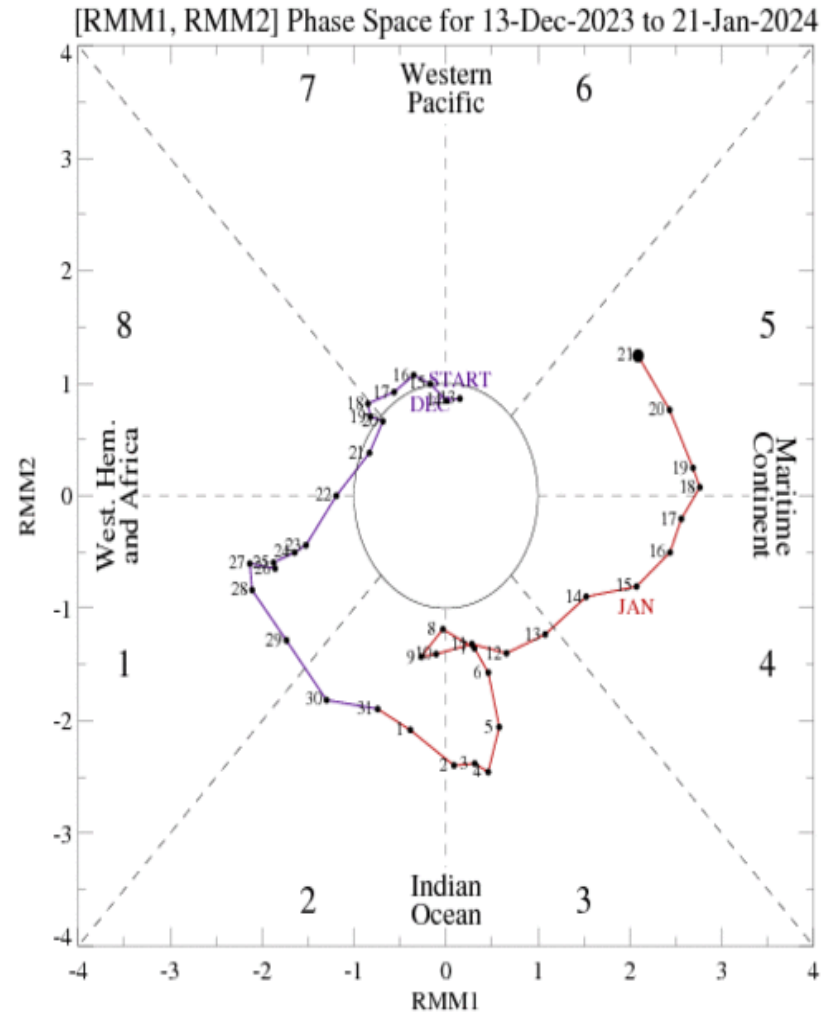
# SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- The strongly positive SST anomalies associated with El Niño have been fairly stable throughout much of the Pacific since last year, except for Niño 1+2 which continues to weaken and trend towards neutral.
- Tied to the upwelling phase of an oceanic Kelvin wave, negative upper-oceanic heat anomalies expanded eastward beyond the Date Line, with strongly positive subsurface anomalies persisting over the eastern Pacific.

# MJO Index: Recent Evolution

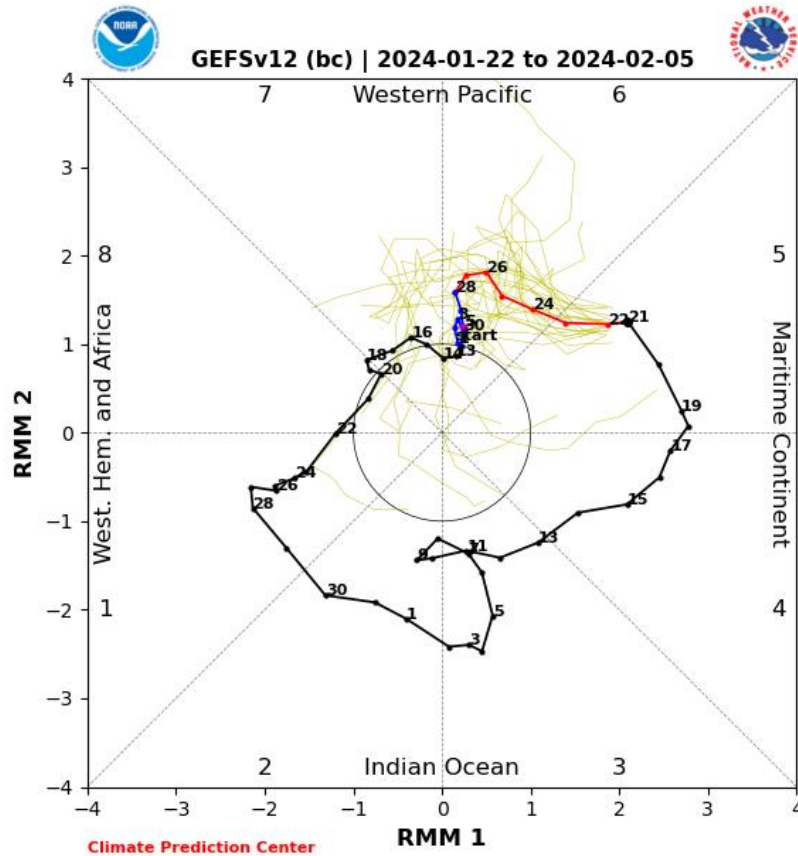
- Following a period where the MJO signal weakened and retreated westward over the Indian Ocean, it has since resumed its eastward propagation over the Indian Ocean and gained amplitude over the Maritime Continent.



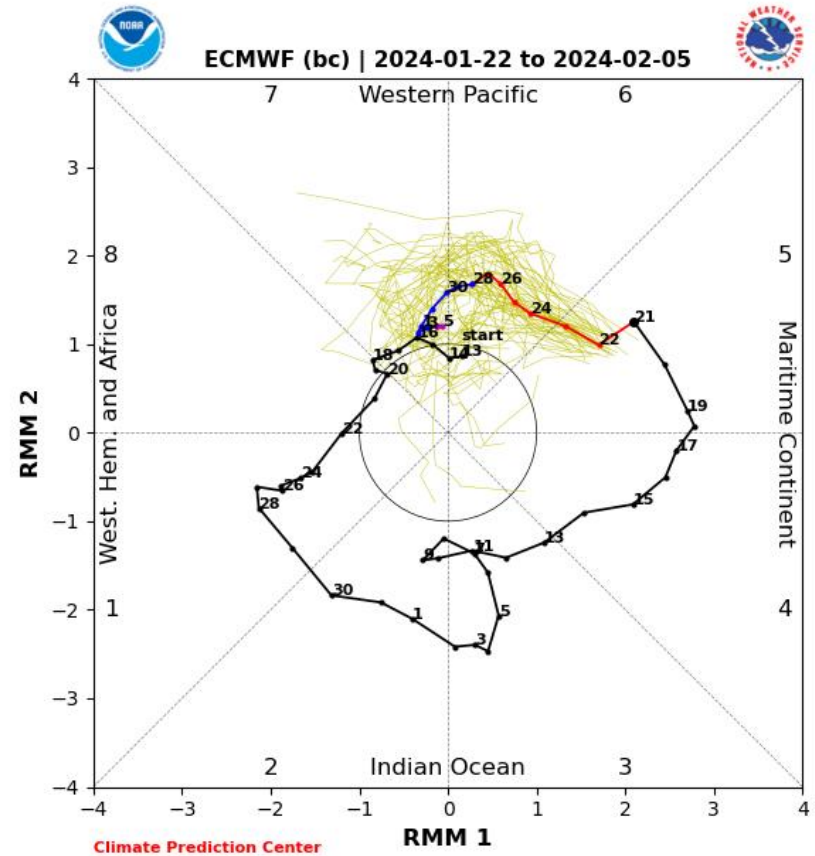
For more information on the RMM index and how to interpret its forecast please see:  
[https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC\\_MJOinformation.pdf](https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf)



# MJO Index: Forecast Evolution



**GEFS Forecast**



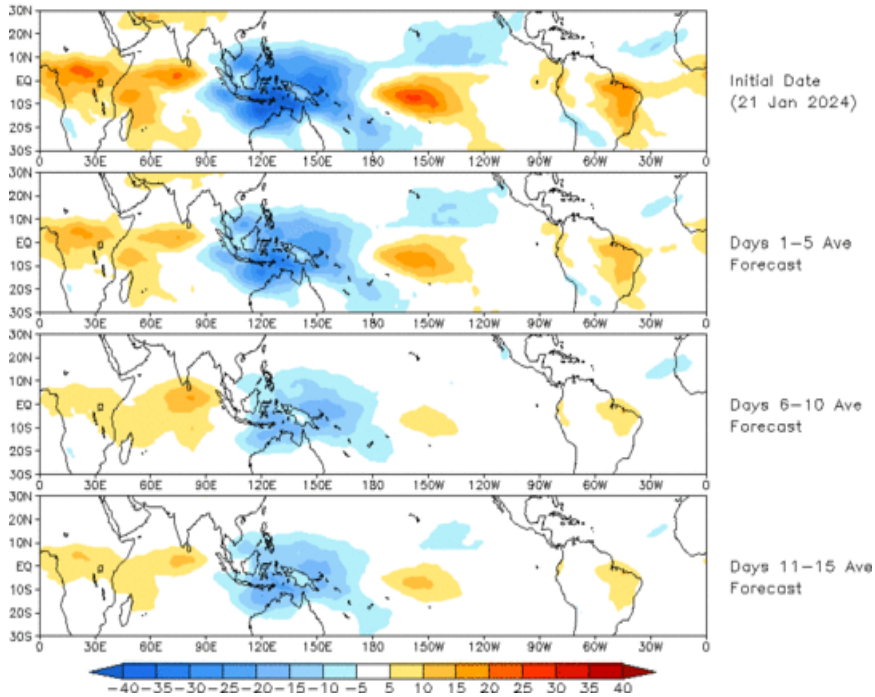
**ECMWF Forecast**

- There is good agreement in the dynamical models favoring the MJO to maintain a high amplitude and eastward propagation speed over the Western Pacific through the end of January.
- Uncertainty increases after week-1, but models generally favor a weaker amplitude and slower eastward movement of the RMM index, with some models stopping or even retrograding in week-3.

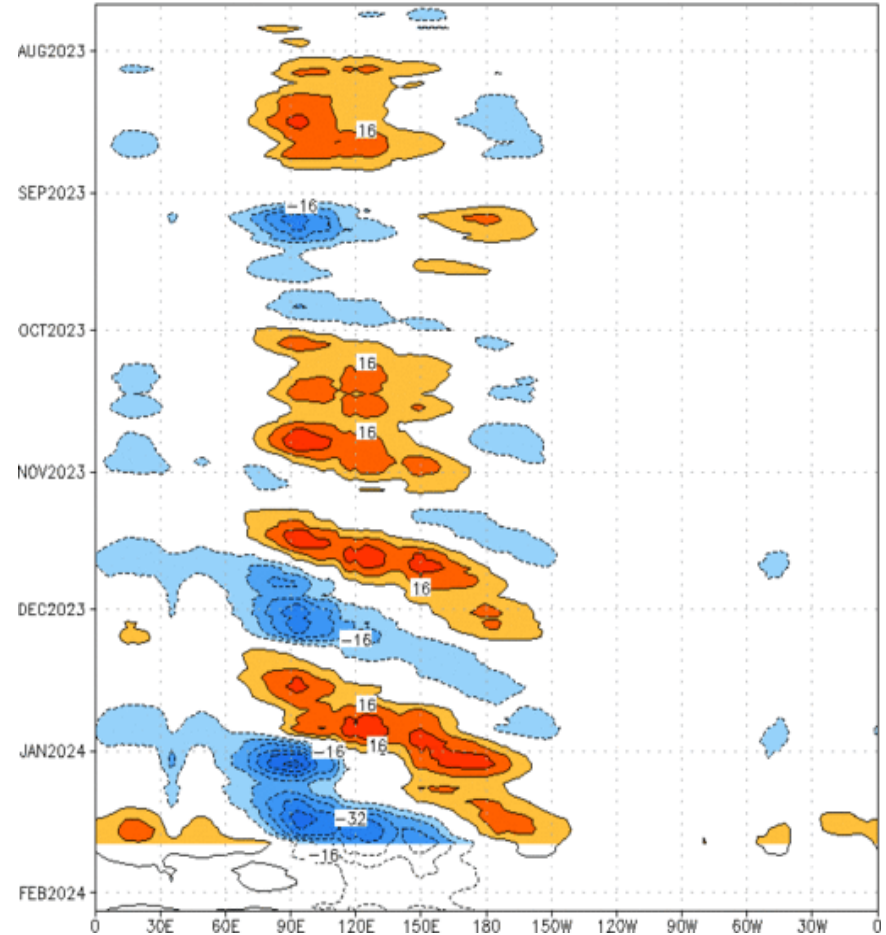
# MJO: GEFS Forecast Evolution

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: 21 Jan 2024  
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2  
OLR [7.5°S,7.5°N] (cont:4Wm<sup>-2</sup>) Period:22-Jul-2023 to 21-Jan-2024  
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

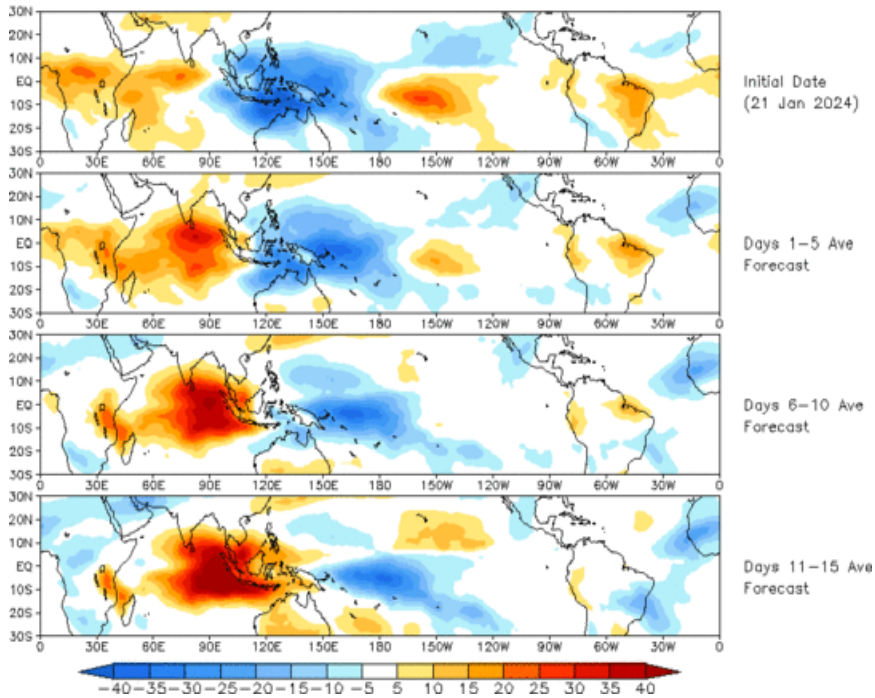


- The GEFS RMM-based OLR forecast depicts a fairly stationary pattern, with enhanced convection over the Maritime Continent and suppressed convection over the Western Indian Ocean. These features weaken but remain into week-2.

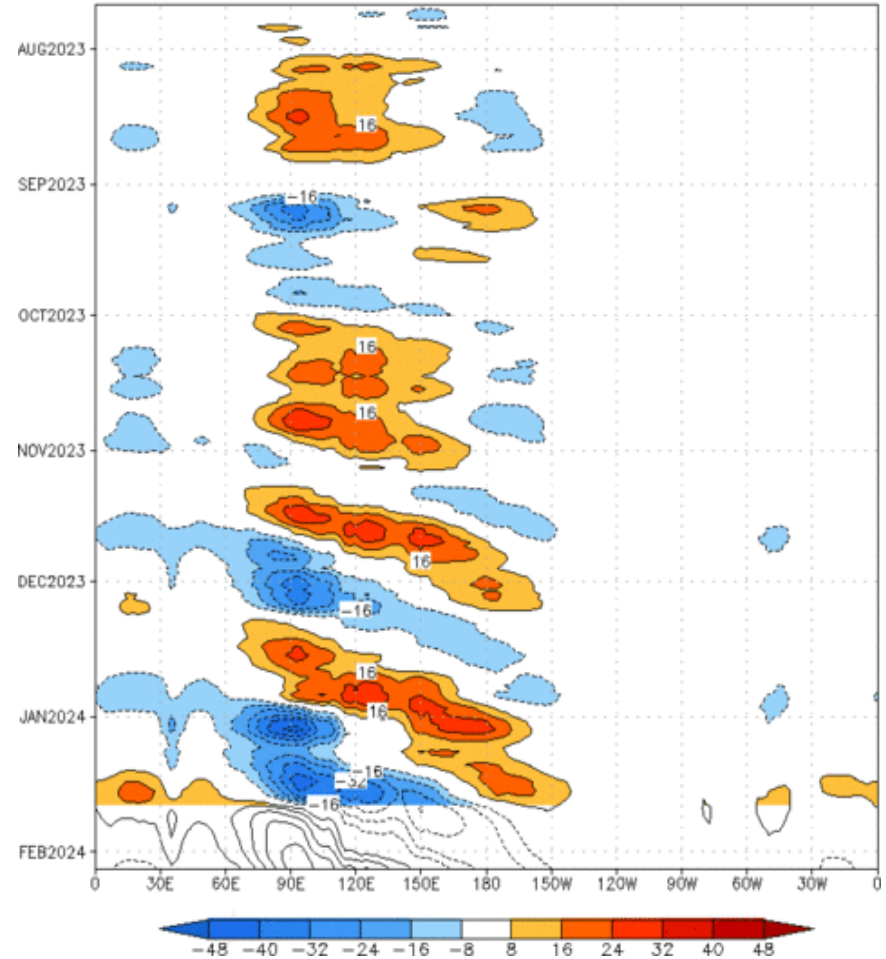
# MJO: Constructed Analog Forecast Evolution

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 (21 Jan 2024)



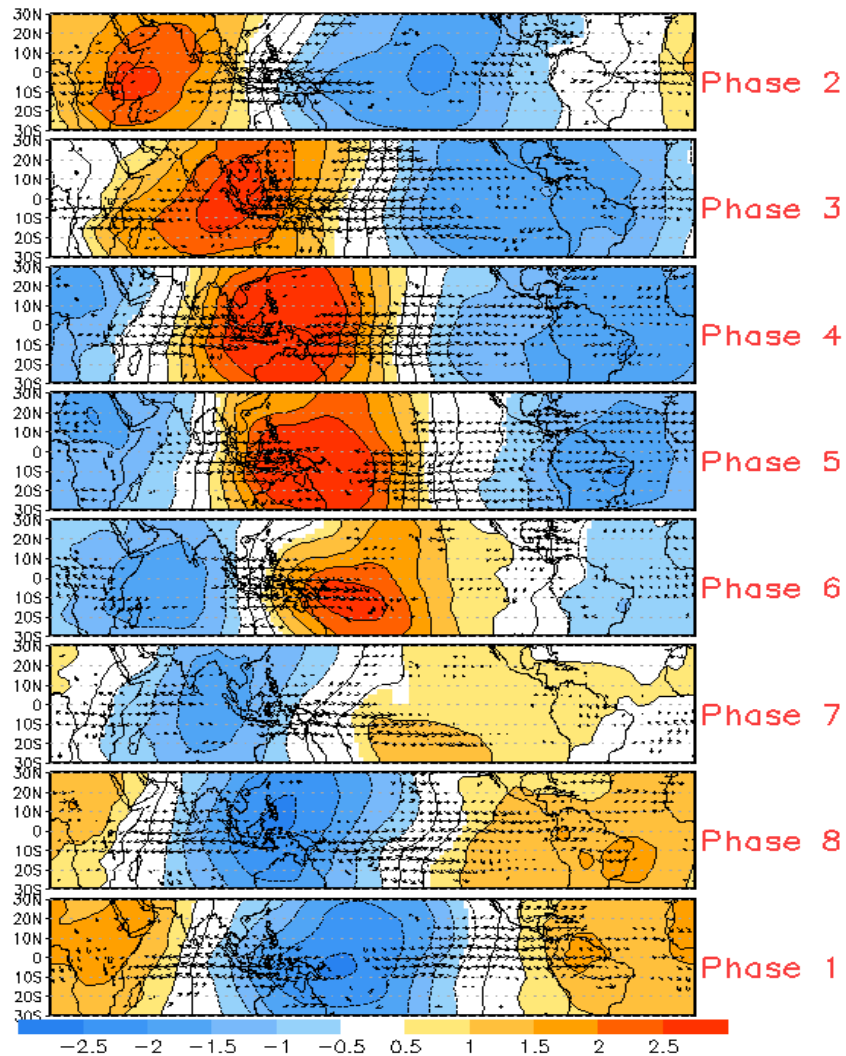
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm<sup>-2</sup>) Period:22-Jul-2023 to 21-Jan-2024  
The unfilled contours are CA forecast reconstructed anomaly for 15 days



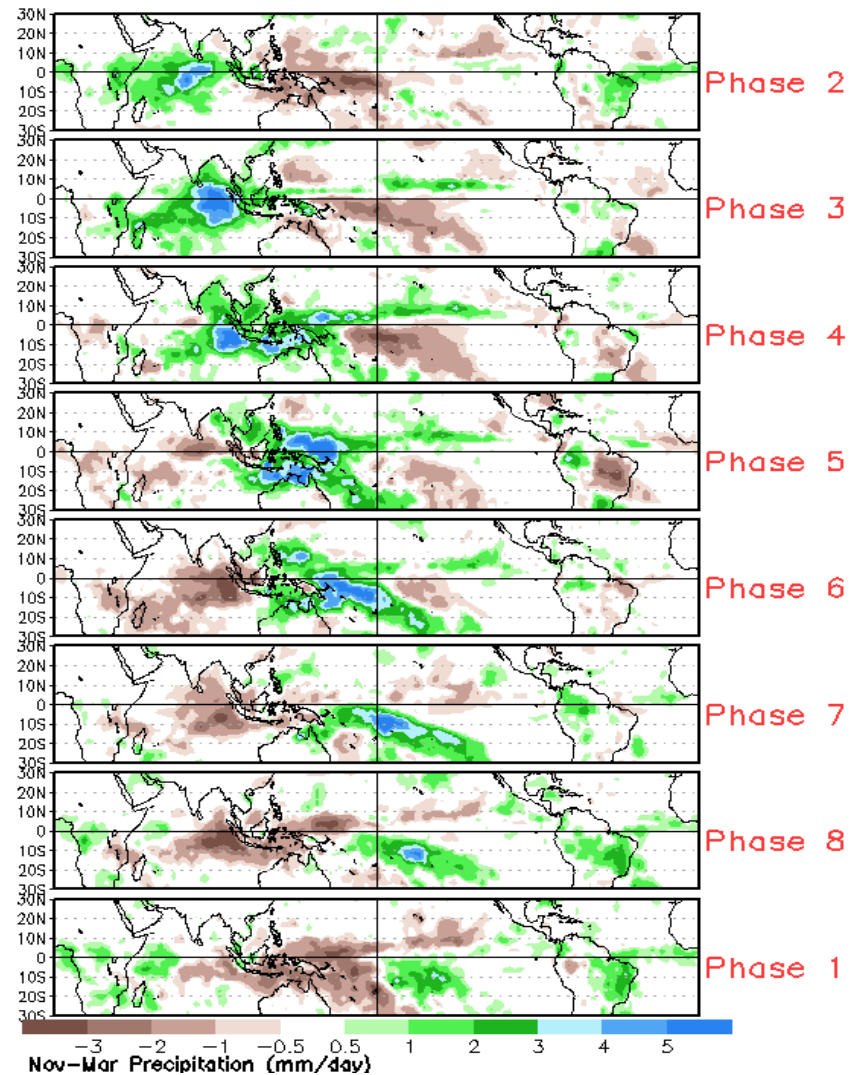
- The constructed analog (CA) RMM-based forecast is more progressive and favors stronger suppressed convection developing over the Indian Ocean.

# MJO: Tropical Composite Maps by RMM Phase

## 850-hPa Velocity Potential and Wind Anomalies



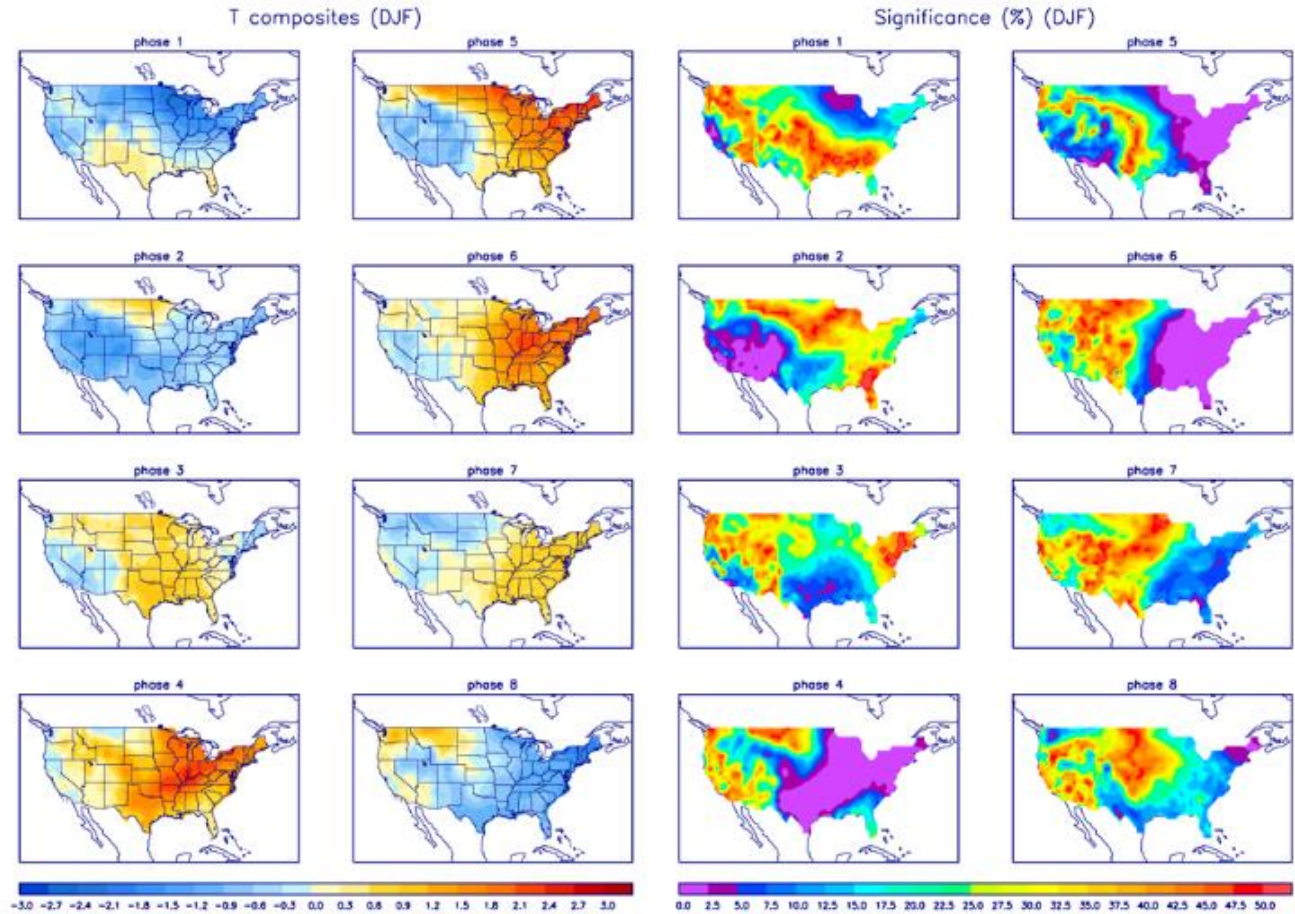
## Precipitation Anomalies



# 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.

