

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



**Update prepared by the Climate Prediction Center**  
**NWS / NCEP / CPC**  
**30 December 2024**

# Overview

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- The MJO remains active and has propagated from the Maritime Continent into the Western Pacific since last month. The slowed progression of the MJO signal in RMM space is likely tied to emerging low frequency variability and Rossby wave activity.
- Upper-level velocity potential and zonal wind anomalies point to the MJO destructively interfering with La Nina conditions, with the former revealing the development of two separate enhanced envelopes. Both low frequency and subseasonal modes appear to be playing a strong roles in the tropics in late December.
- RMM forecasts from the dynamical models are in agreement favoring continued eastward propagation of the MJO signal across the Western Hemisphere during the next two weeks, and reaching the Indian Ocean towards the middle of January. Consequently, the return of a constructively interfering MJO could result in stronger La Nina conditions later this winter.
- An eastward propagating MJO favors increased chances for tropical cyclone development over the South Pacific and southern Indian Ocean during the next several weeks.
- The extratropical response associated with a Western Hemisphere MJO during Dec-Feb typically leads to increased troughing over the central and eastern CONUS, which is consistent with a negative Arctic Oscillation and North Atlantic Oscillation (-AO/-NAO) favored in the dynamical models.

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

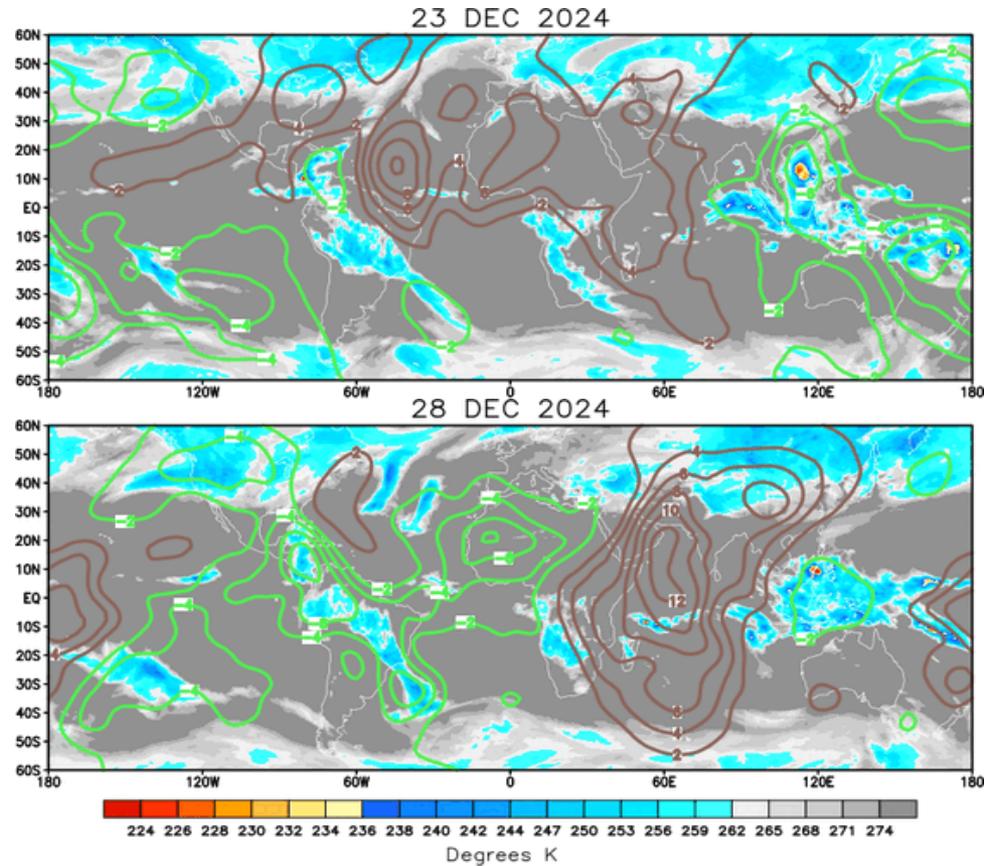
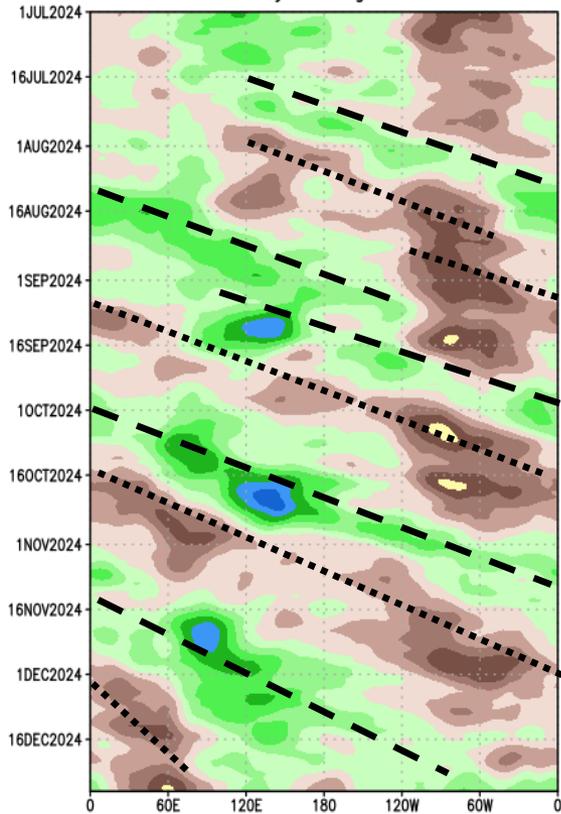
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

# 200-hPa Velocity Potential Anomalies

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

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

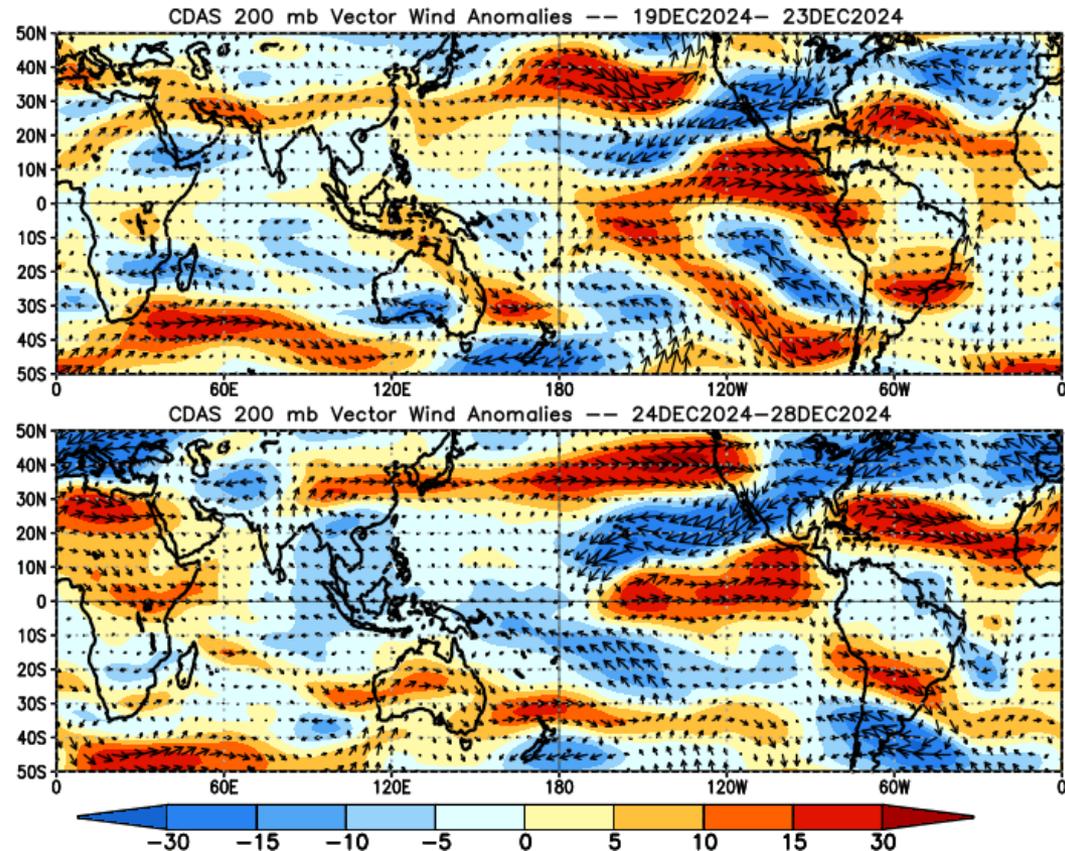
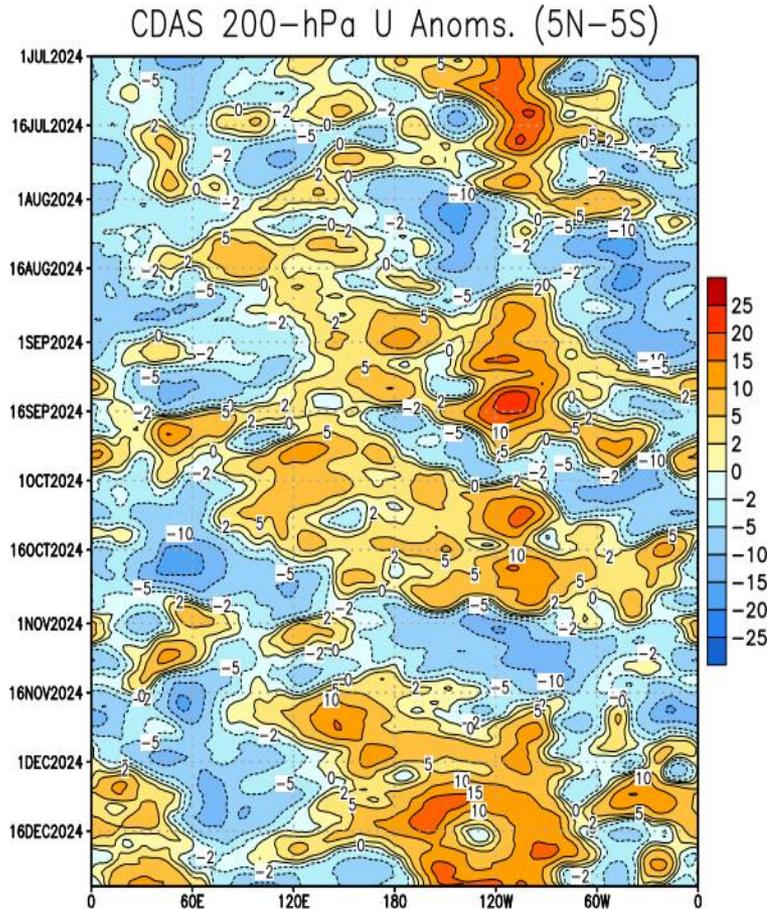
200-hPa Velocity Potential Anomaly: 5N-5S  
5-day Running Mean



- Since early December, suppressed divergence aloft has been a stationary feature over Africa, but has shown more eastward expansion into the central Indian Ocean more recently.
- Two enhanced envelopes of divergence aloft are now observed, suggestive of a low frequency response centered over the Maritime Continent, and intraseasonal activity propagating eastward into the Western Hemisphere.

# 200-hPa Wind Anomalies

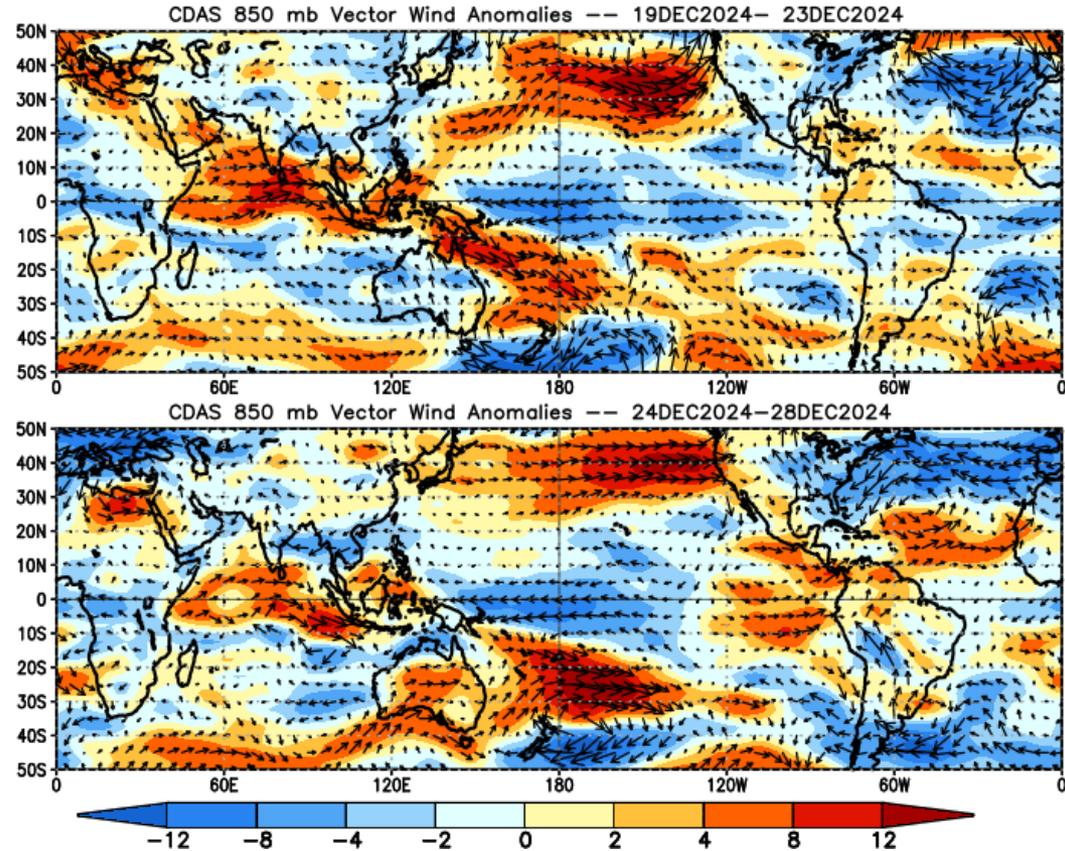
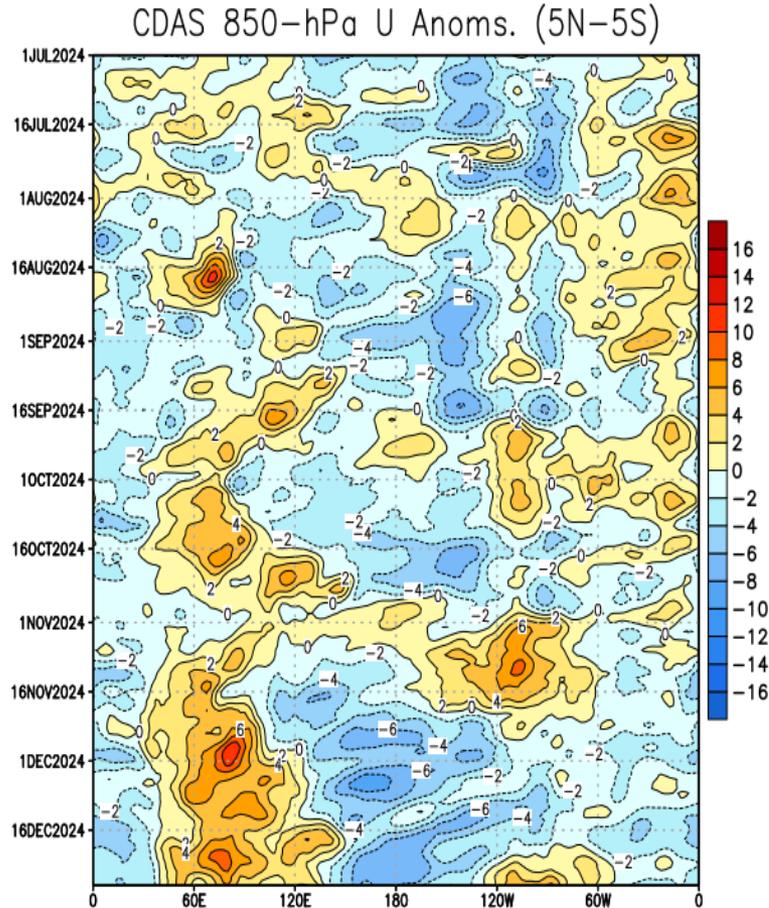
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- After equatorial Rossby wave activity was observed over the western Pacific during mid-December, the enhanced easterlies have begun to destructively interfere with the westerly base state to the west of the Date Line.
- An enhanced jet is observed over the northern Pacific, protruding into western North America.
- Anomalous westerlies aloft strengthened over Africa and the western Indian Ocean.

# 850-hPa Wind Anomalies

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

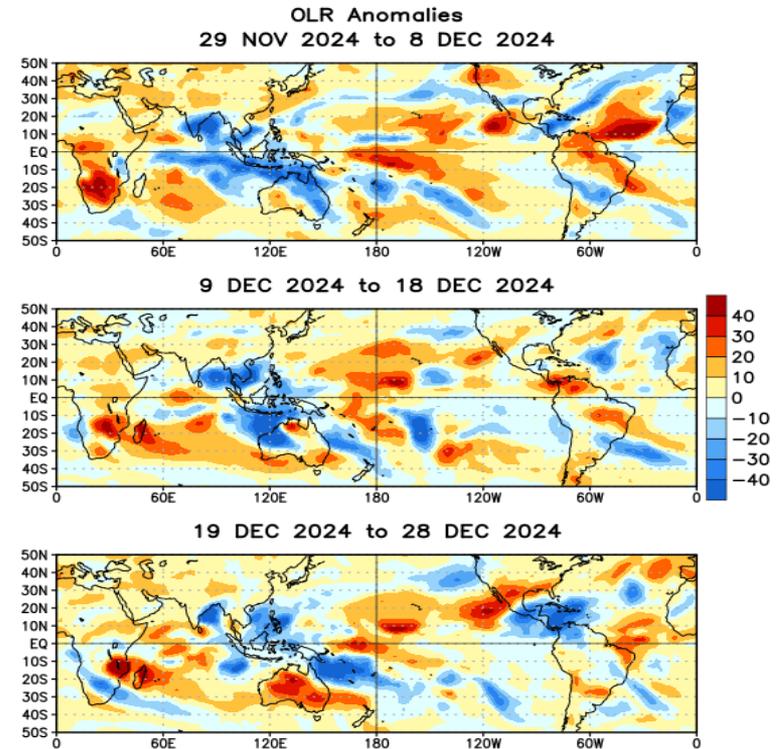
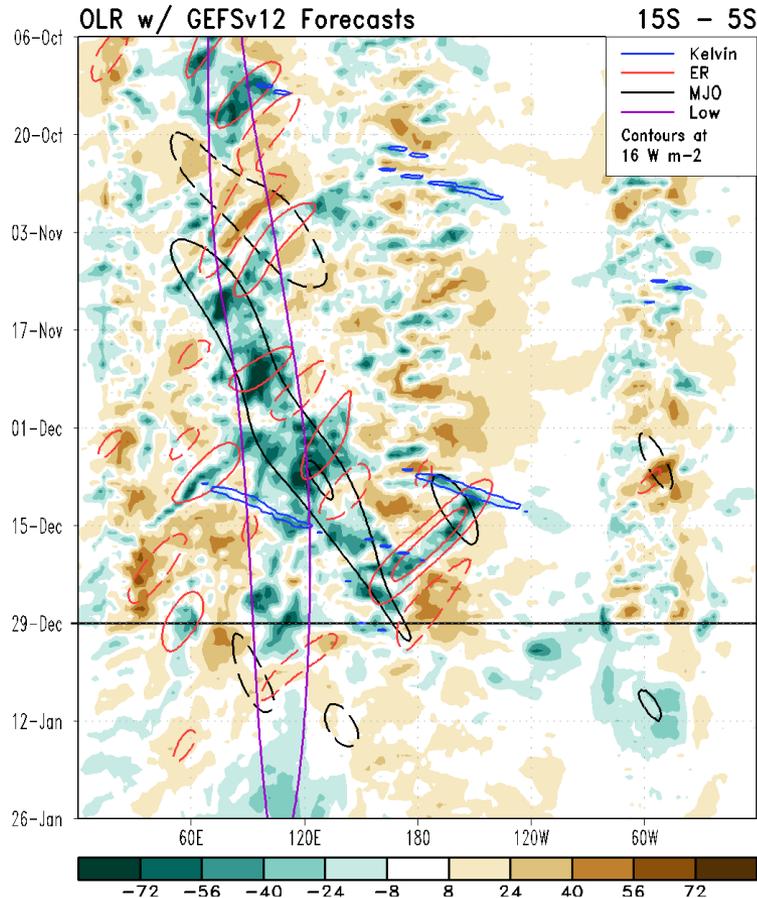


- Anomalous westerlies have emerged over the eastern equatorial Pacific.
- Enhanced trades remain firmly entrenched across the central equatorial Pacific, while strengthening to the west of the Date Line. Westerlies became more pronounced in the South Pacific, likely contributing to the first tropical cyclone developing in the South Pacific.
- Enhanced onshore flow persists over the West Coast of the U.S., consistent with Atmospheric River activity

# Outgoing Longwave Radiation (OLR) Anomalies

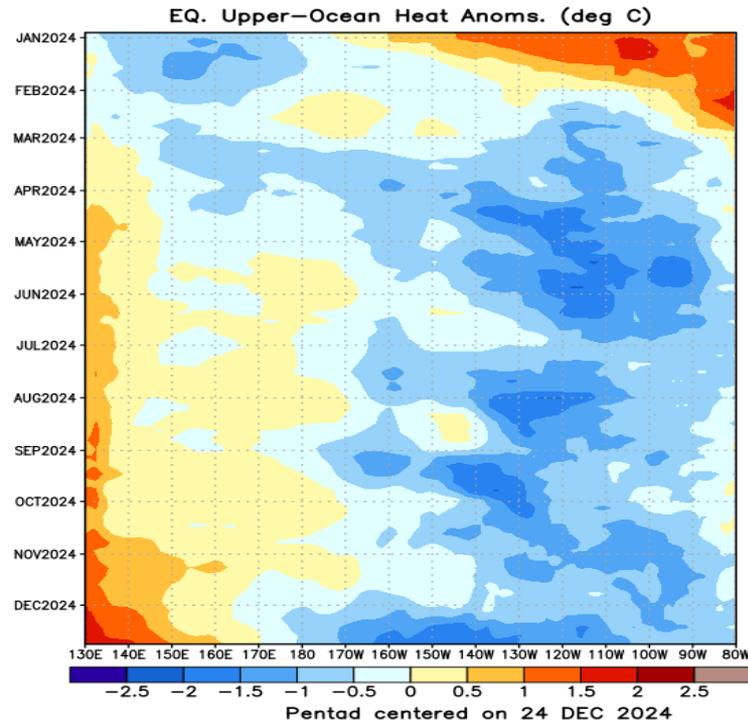
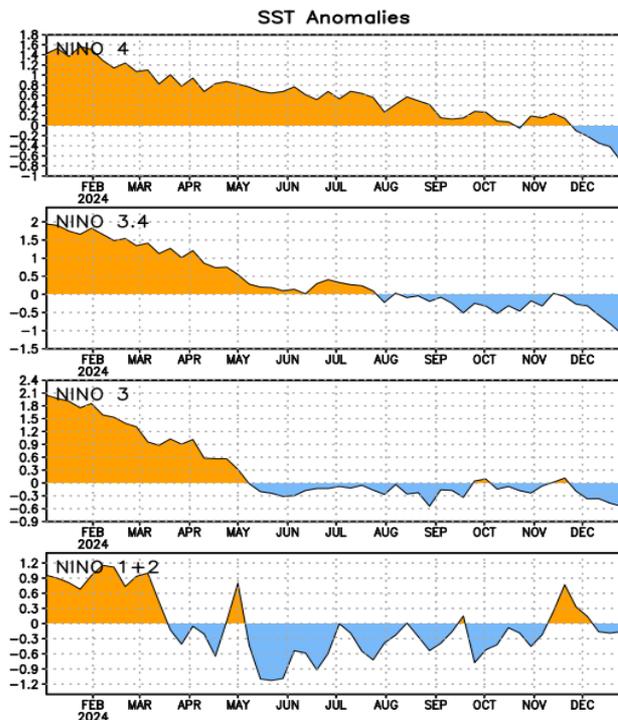
**Green shades:** Anomalous convection (wetness)

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



- Since November, enhanced convection has been a semi-permanent feature over the eastern Indian Ocean and Maritime Continent, with this enhancement shifting eastward in December (e.g. strengthening SPCZ), consistent with both low frequency variability and MJO activity.
- Wave filtered OLR forecasts from the GEFS suggest low frequency variability being the more dominant tropical mode during January 2025, however there are signs of enhanced convection returning to Indian Ocean in the longer leads.

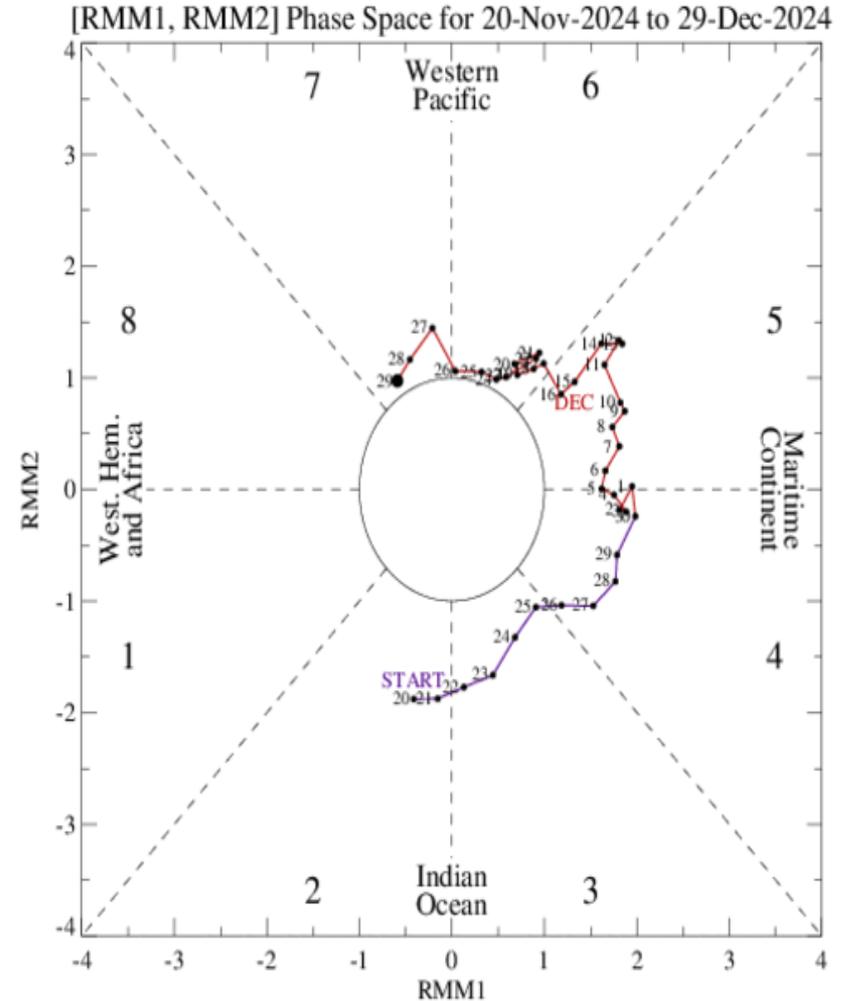
# SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- A constructively interfering MJO bringing a strong trades during November and into December likely led to the development of cooler waters at and below the surface across the equatorial Pacific.
- Niño 3.4 and Niño 4 SSTs have trended most sharply in the negative, with the former now dropping below  $-1.0\text{C}$  below average, supportive of the developing La Niña event.

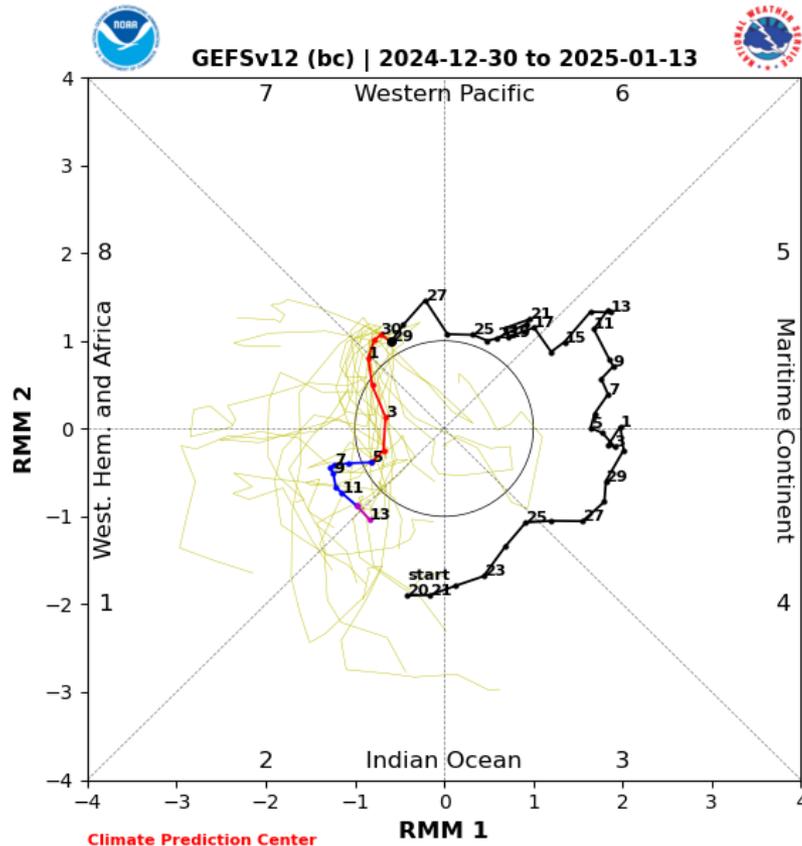
# MJO Index: Recent Evolution

- Influence from the base state and equatorial Rossby wave activity are likely playing a role in a slowed presentation of the MJO index since early December, with the signal having just reached phase 7 in recent days.

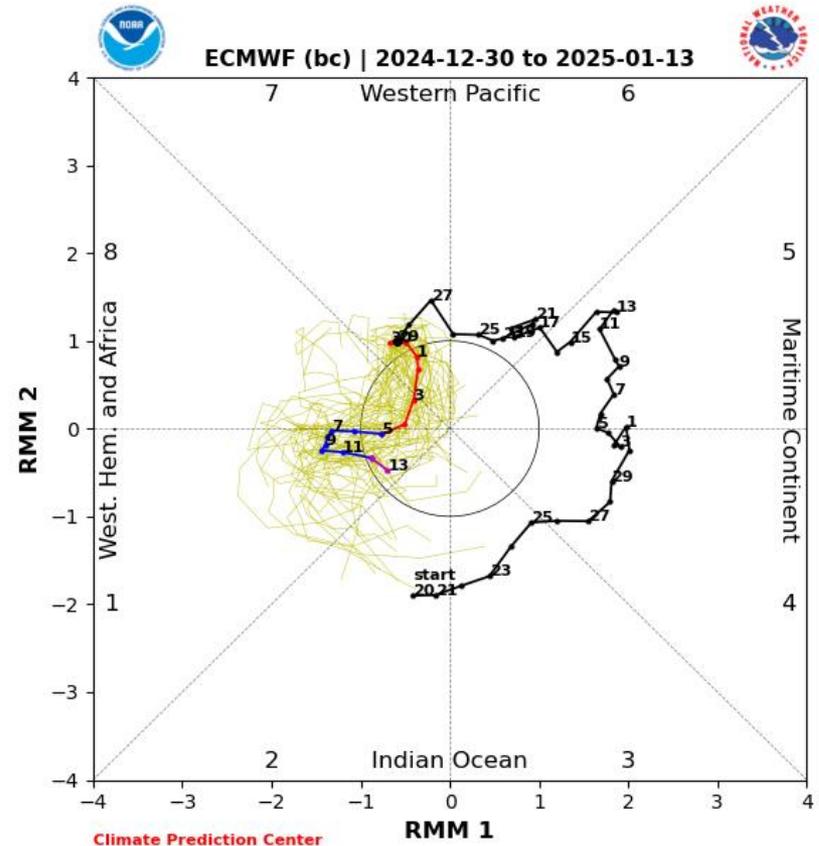


For more information on the RMM index and how to interpret its forecast please see:  
[https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC\\_MJOinformation.pdf](https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf)

# MJO Index: Forecast Evolution



**GEFS Forecast**



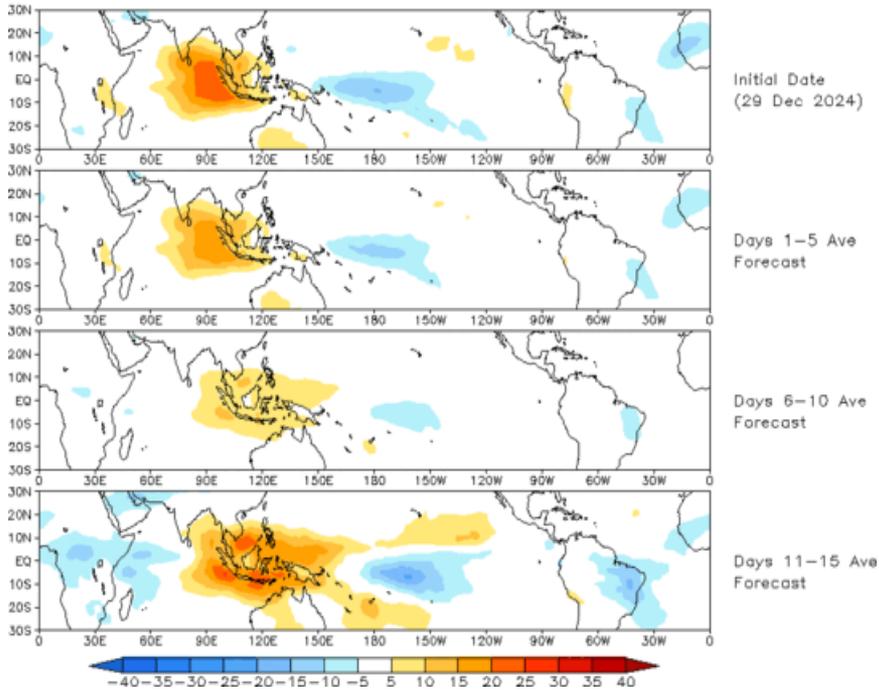
**ECMWF Forecast**

- Dynamical models favor continued eastward propagating of the MJO into and across the Western Hemisphere during the next two weeks. Ensemble means reflect a relatively low amplitude event, though several ensemble members favor a high amplitude event possibly unfolding.
- Beyond Week-2, there is decent support in the extended range guidance (not shown) for the MJO to propagate over the Indian Ocean.

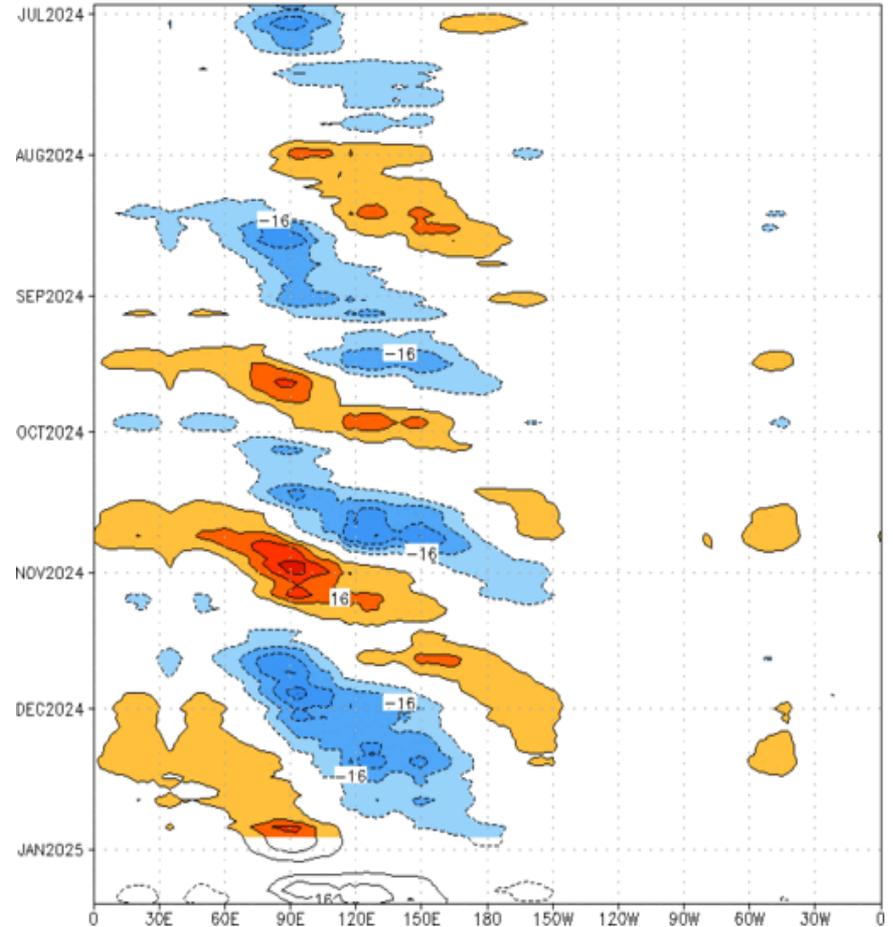
# MJO: GEFS Forecast Evolution

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: 29 Dec 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:29-Jun-2024 to 29-Dec-2024  
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

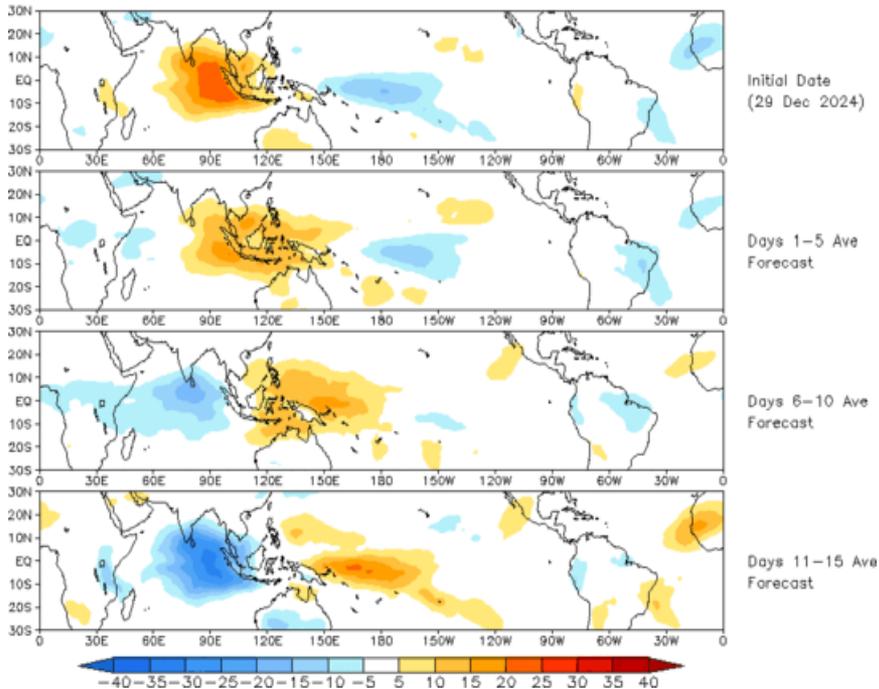


- The GEFS OLR anomaly forecast based on the RMM index shows continued MJO activity with enhanced convection returning to Africa and the western Indian Ocean.

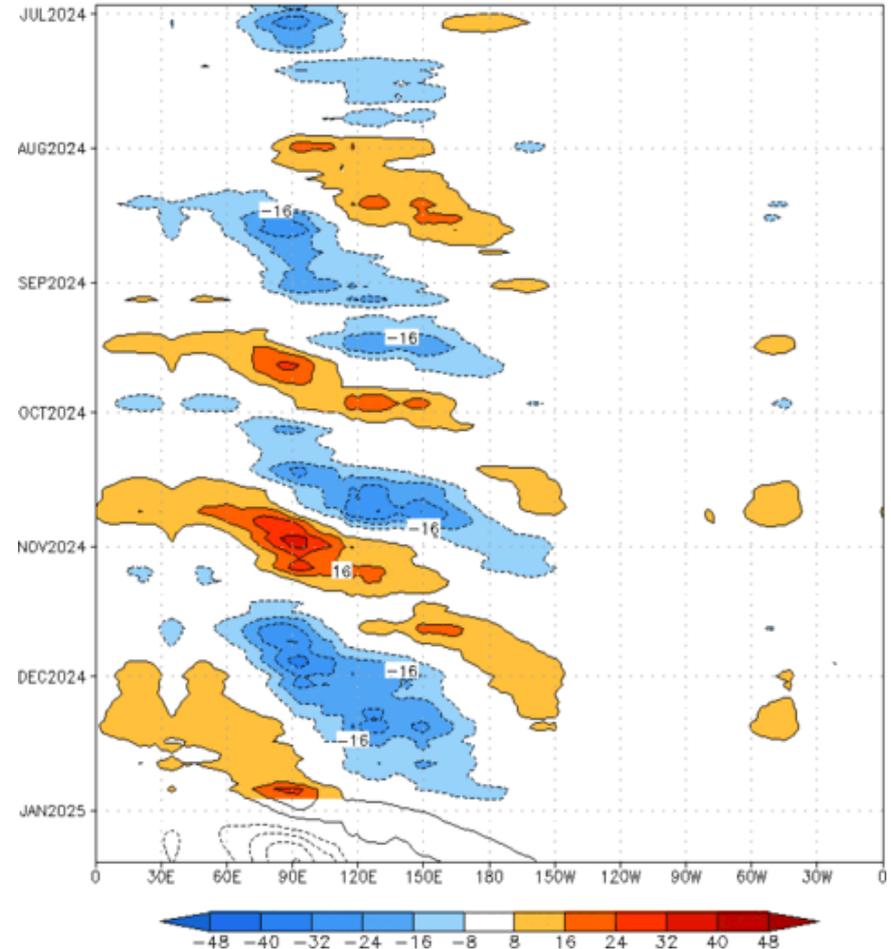
# MJO: Constructed Analog Forecast Evolution

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 (29 Dec 2024)



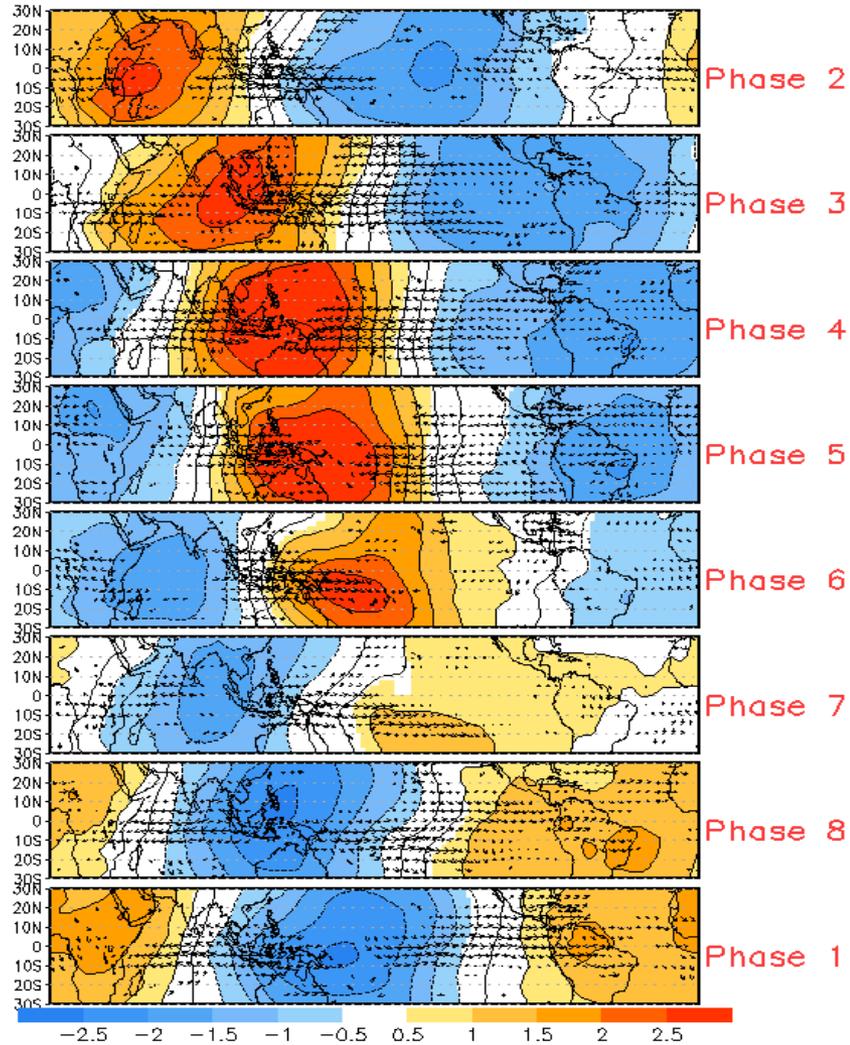
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm<sup>-2</sup>) Period:29-Jun-2024 to 29-Dec-2024  
The unfilled contours are CA forecast reconstructed anomaly for 15 days



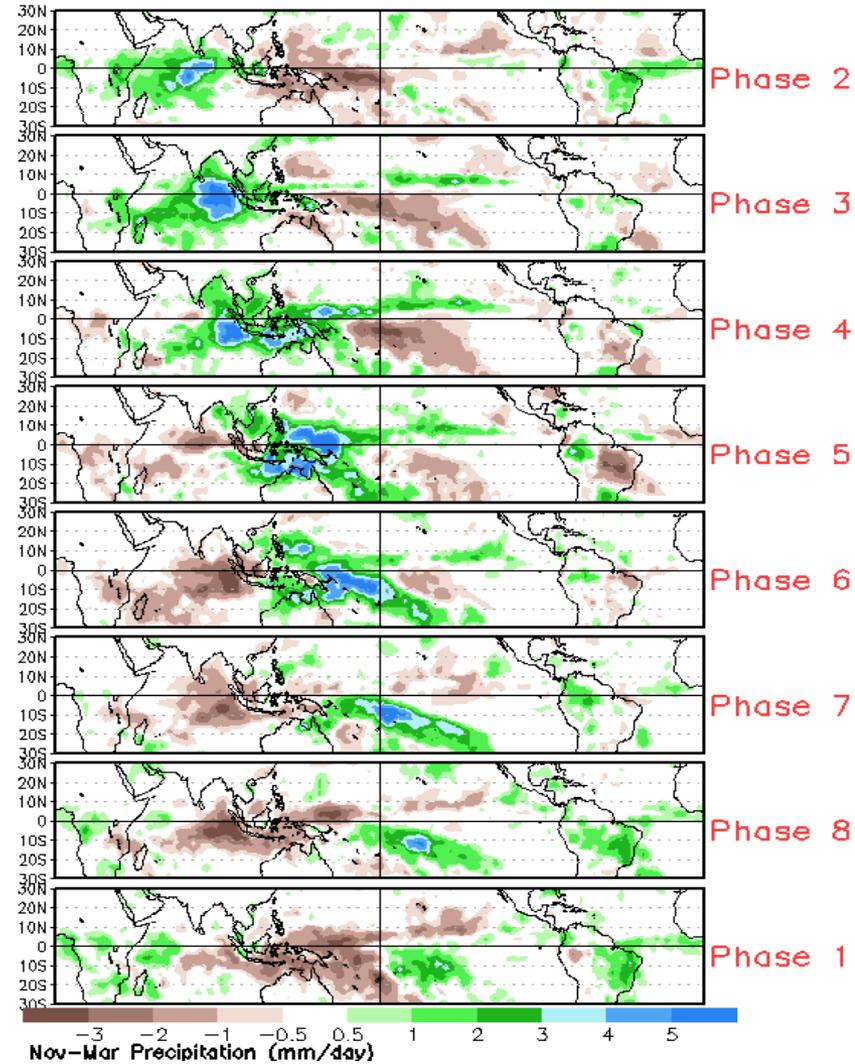
- The constructed analog forecast depicts a stronger and faster solution than the GEFS, with enhanced convection reaching the eastern Indian Ocean by late week-2.

# MJO: Tropical Composite Maps by RMM Phase

## 850-hPa Velocity Potential and Wind Anomalies



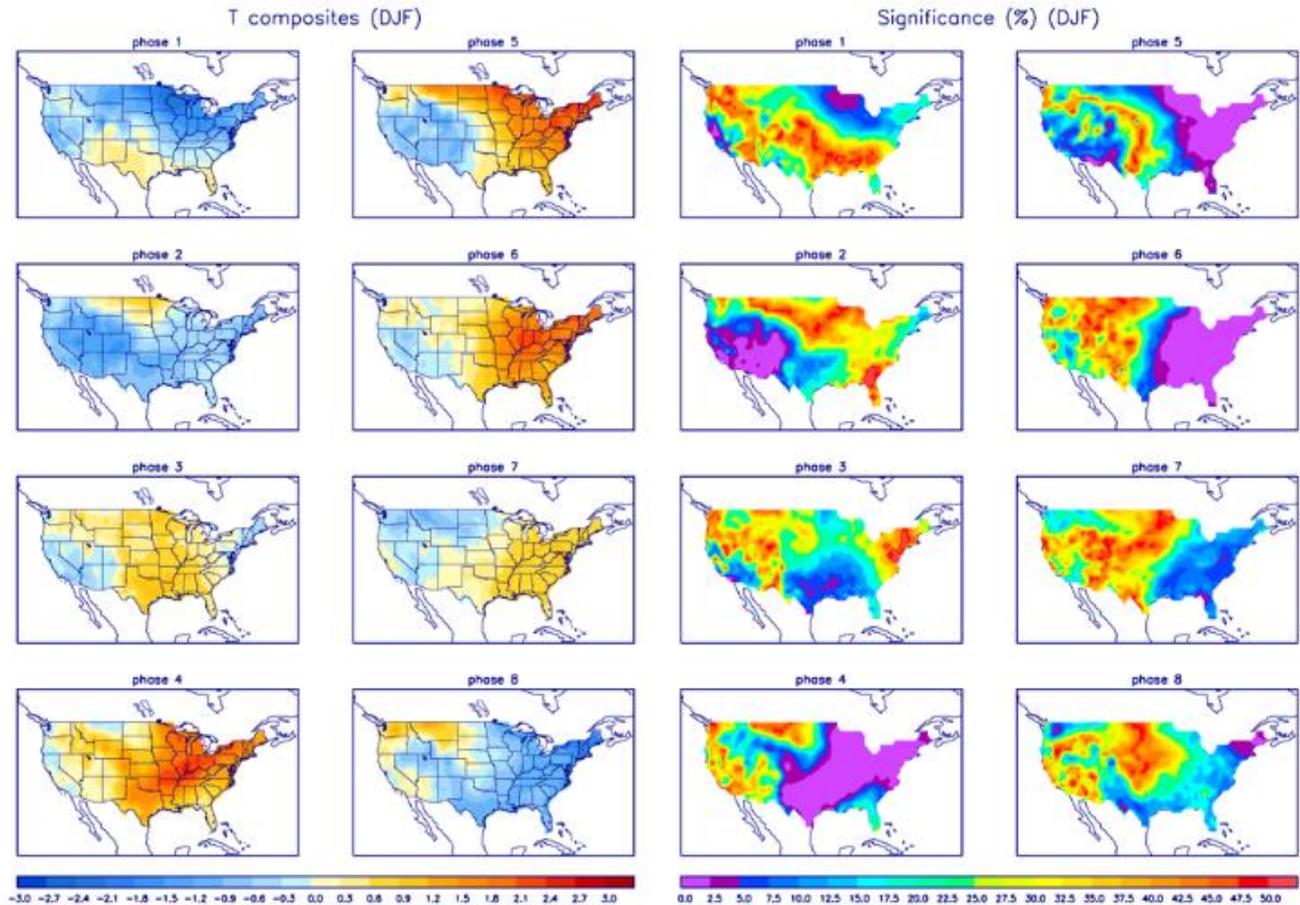
## Precipitation Anomalies



# 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.

