

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



Update prepared by the Climate Prediction Center  
NWS / NCEP / CPC  
9 September 2024

# Overview

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- The MJO has recently slowed its eastward propagation and the amplitude of the RMM index decreased. This weakening MJO is likely due to interference from Equatorial Rossby waves.
- The GEFS and ECMWF models depict a strengthening MJO during mid to late September but large uncertainty exists on how quickly eastward propagation resumes.
- The large scale environment is expected to continue to be favorable for Tropical Cyclone (TC) Development in the Western Pacific, especially the next two weeks.
- There is an increased chance for a couple of tropical cyclones (TCs) to develop in the Gulf of Mexico and Main Development Region (MDR) of the Atlantic prior to week-2. During weeks 2 and 3 (September 18-October 1), climatology would favor at least an elevated chance of additional TC development in the MDR.

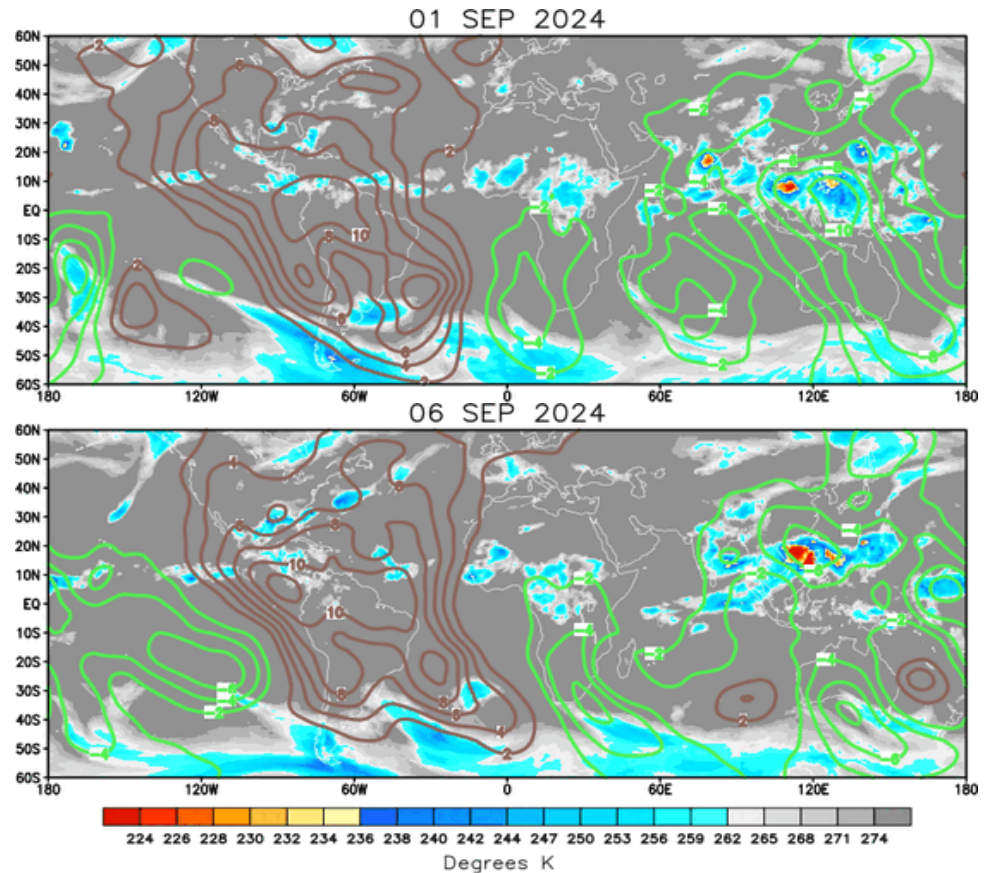
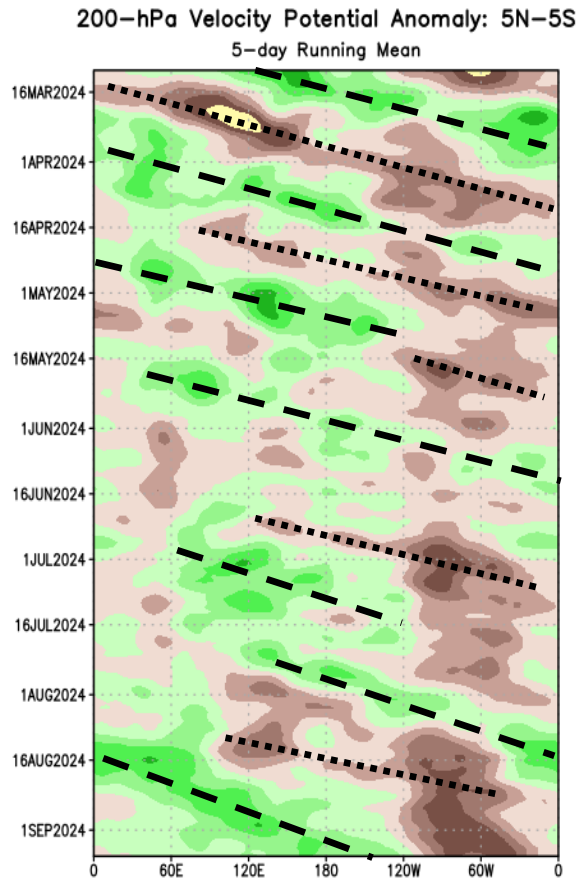
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:

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

# 200-hPa Velocity Potential Anomalies

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

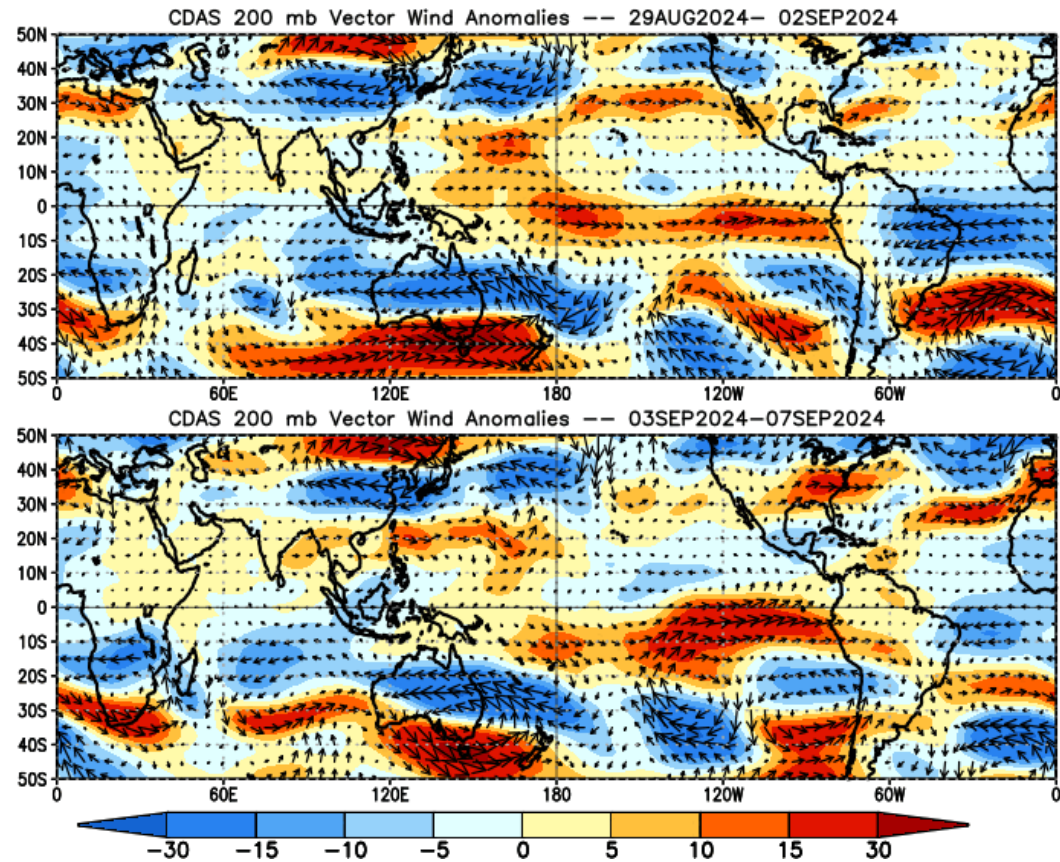
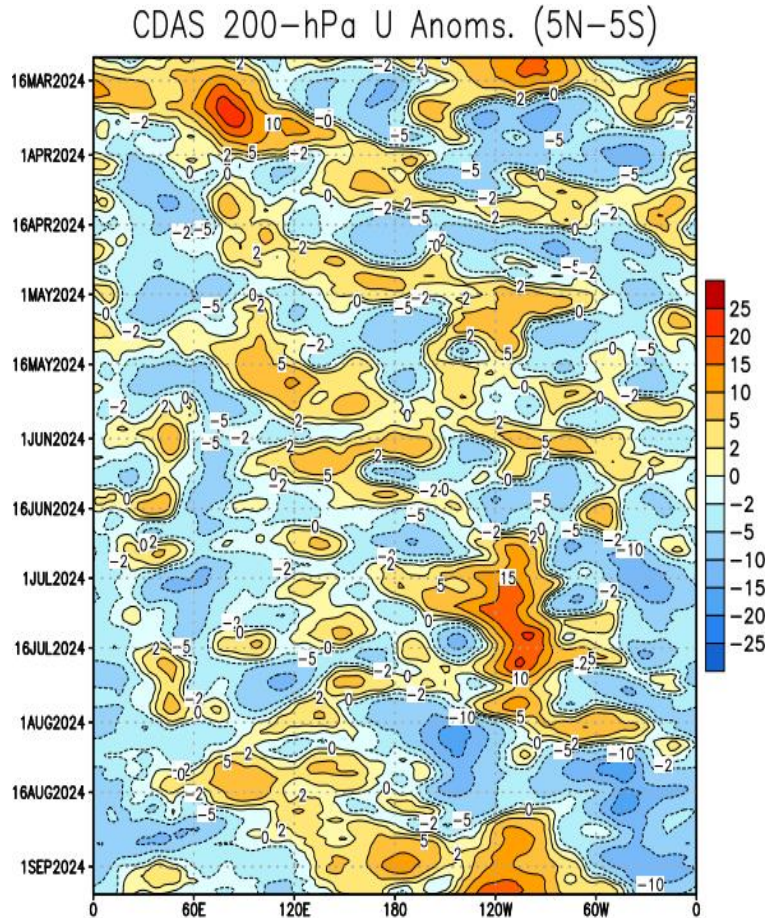
**Brown shades:** Anomalous convergence (unfavorable for precipitation)



- A well-defined wave-1 pattern has been present since early August, with the enhanced (suppressed) phase currently over the eastern (western) Hemisphere.
- At the end of August, the eastward propagation of the MJO began to slow due to increasing Equatorial Rossby Wave interaction and the development of more persistent anomalous upper-level divergence over the Maritime Continent and West Pacific.

# 200-hPa Wind Anomalies

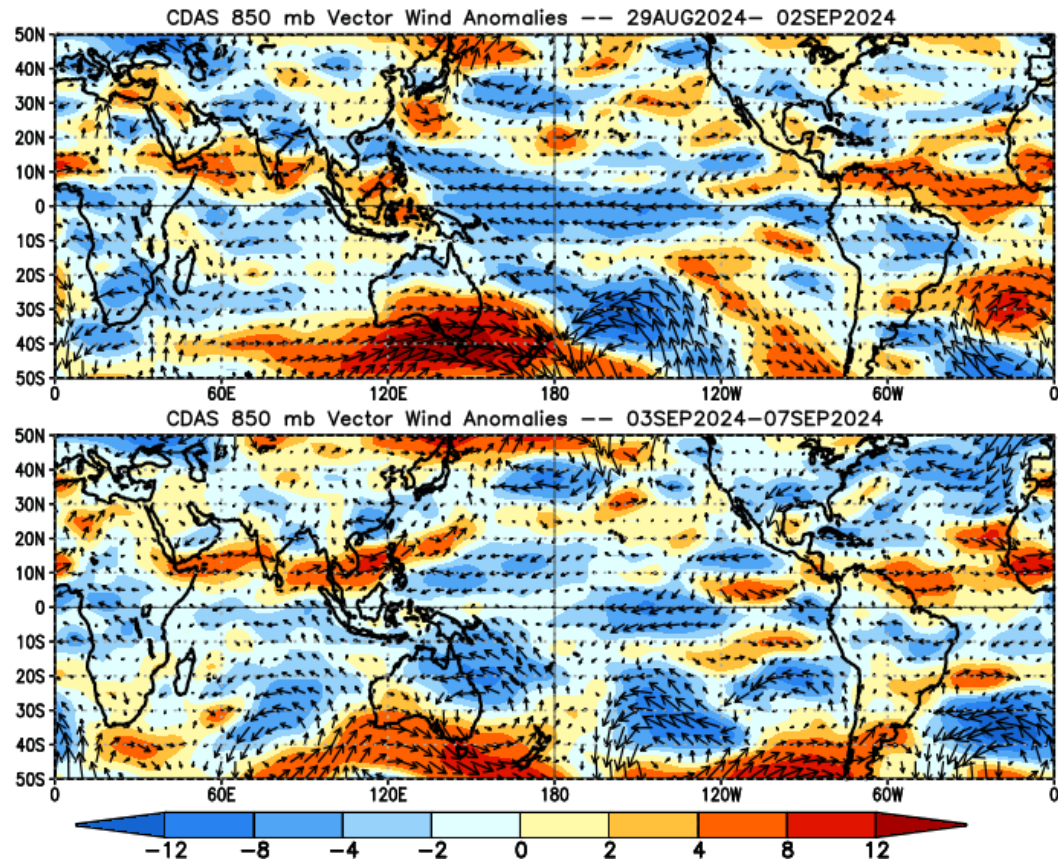
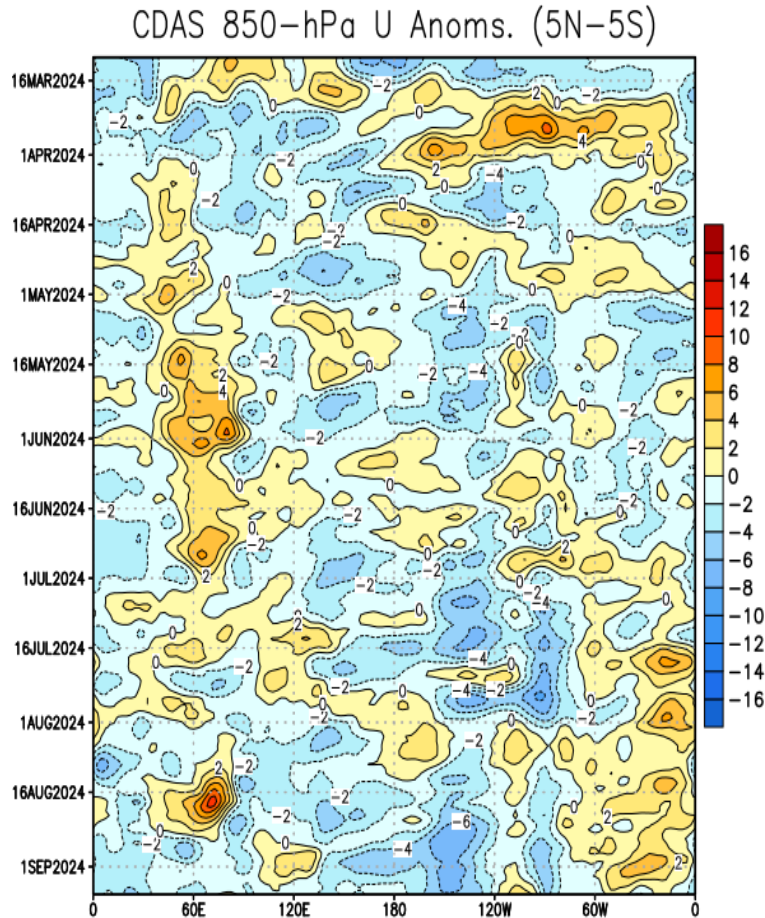
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Anomalous westerlies have been persistent and widespread over much of the tropical Pacific, while enhanced easterlies have been present over the tropical Atlantic since early August.
- The subtropical north Pacific is characterized by parallel easterly/westerly anomalies, suggesting a southward displacement of typical synoptic flow.
- Anomalous easterlies are noted over equatorial Africa, potentially enhancing African easterly wave activity.

# 850-hPa Wind Anomalies

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

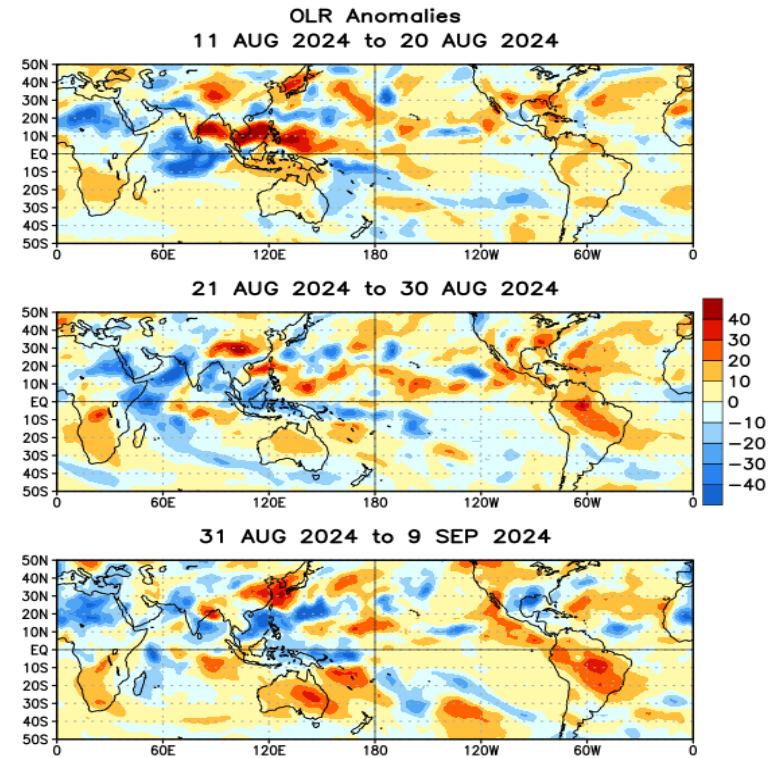
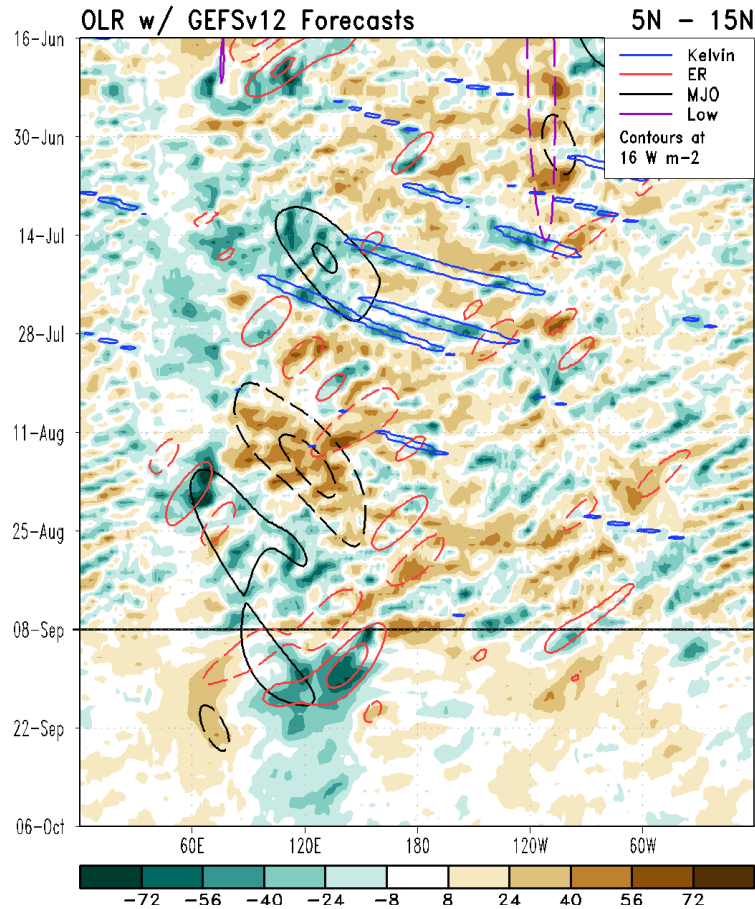


- An enhanced trade regime continues across the tropical Pacific which is expected to favor a transition to La Niña.
- Anomalous low-level westerlies persist over the tropical Atlantic with reduced wind shear for the Main Development Region of the Atlantic.

# Outgoing Longwave Radiation (OLR) Anomalies

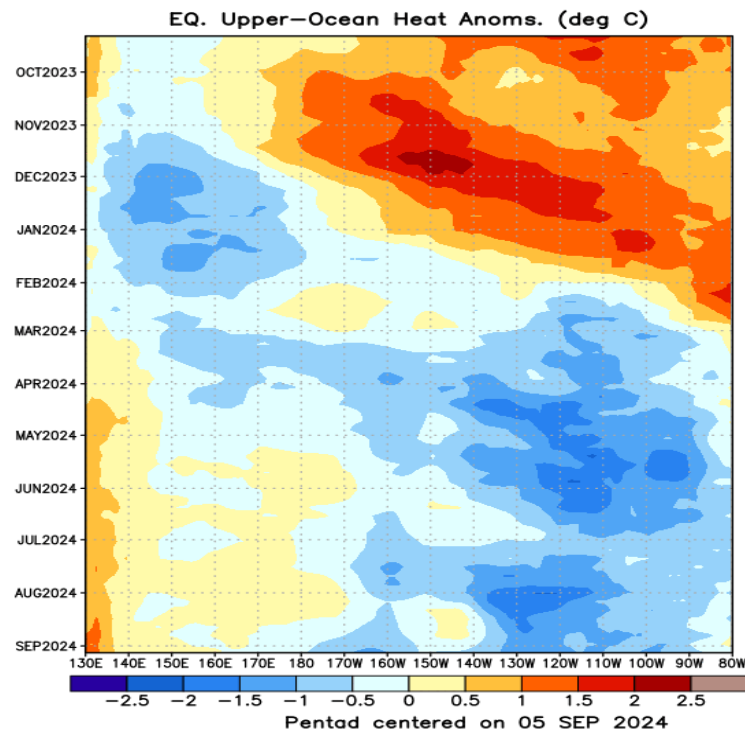
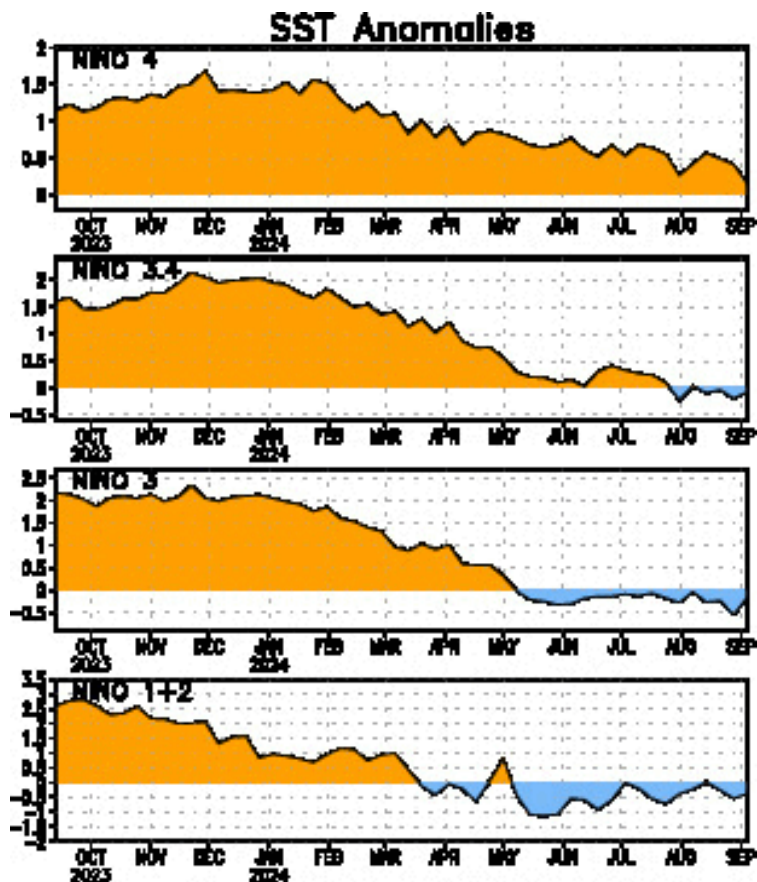
**Green shades:** Anomalous convection (wetness)

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



- Tied to the eastward propagating MJO and the WWB event, enhanced convection has been expanding eastward from Africa to the Maritime Continent and West Pacific during late August and early September.
- Objective filtering of OLR anomalies continue to show Equatorial Rossby waves coming through filtering, which could interfere with the MJO.

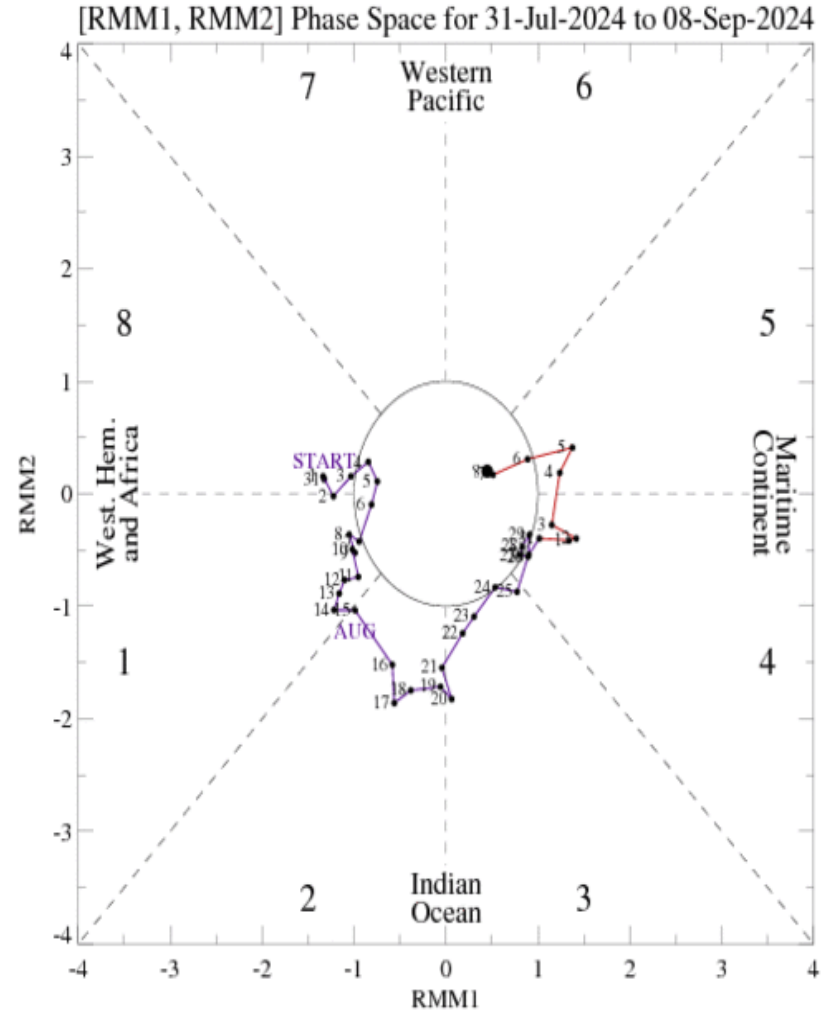
# SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- The downward trend in SST anomalies became nearly flat over the summer.
- Below normal subsurface heat content anomalies remain established from roughly 160°W eastward, except for a region between 150W-140W where warming was observed since early August.

# MJO Index: Recent Evolution

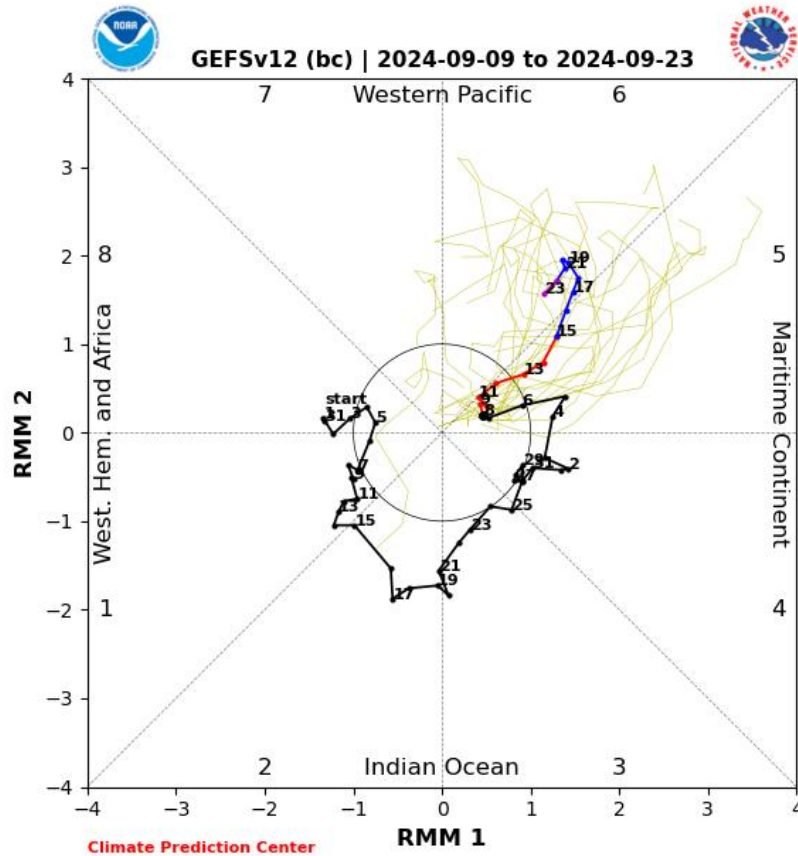
- Since reemerging over the Western Hemisphere in early August, the MJO gained amplitude and propagated eastward to the Maritime Continent by the end of August. The signal weakened somewhat as it approached the Maritime Continent, possibly due to Rossby wave interference.
- During the first week of September, the eastward propagation slowed and the amplitude of the RMM index decrease. This weakening MJO is likely due to destructive interference with Equatorial Rossby waves.



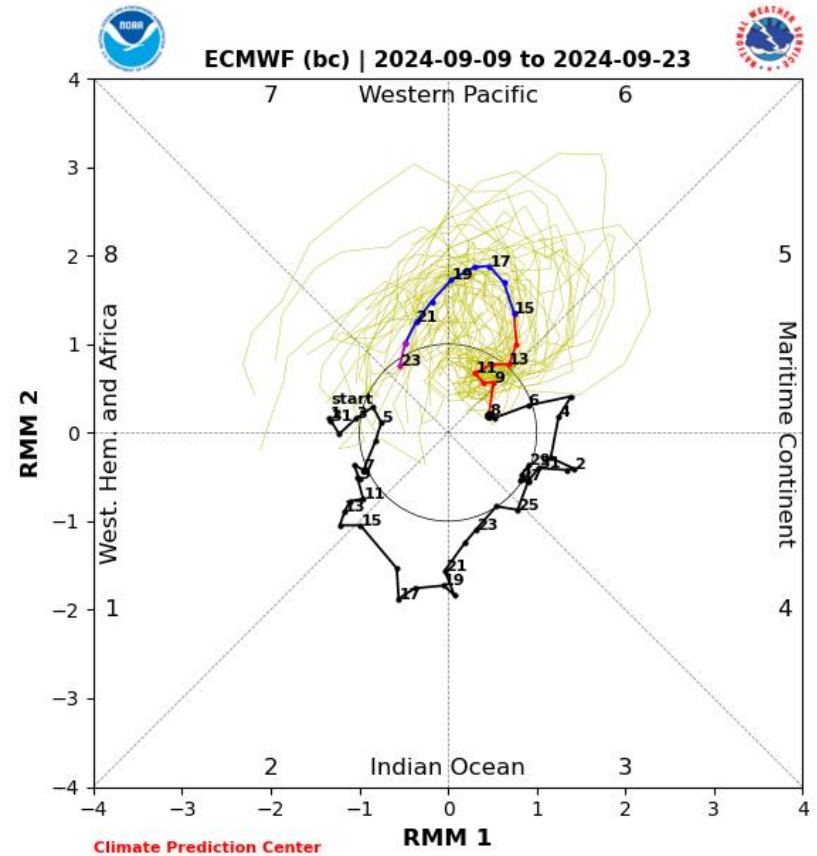
For more information on the RMM index and how to interpret its forecast please see:  
[https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC\\_MJOinformation.pdf](https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf)



# MJO Index: Forecast Evolution



**GEFS Forecast**



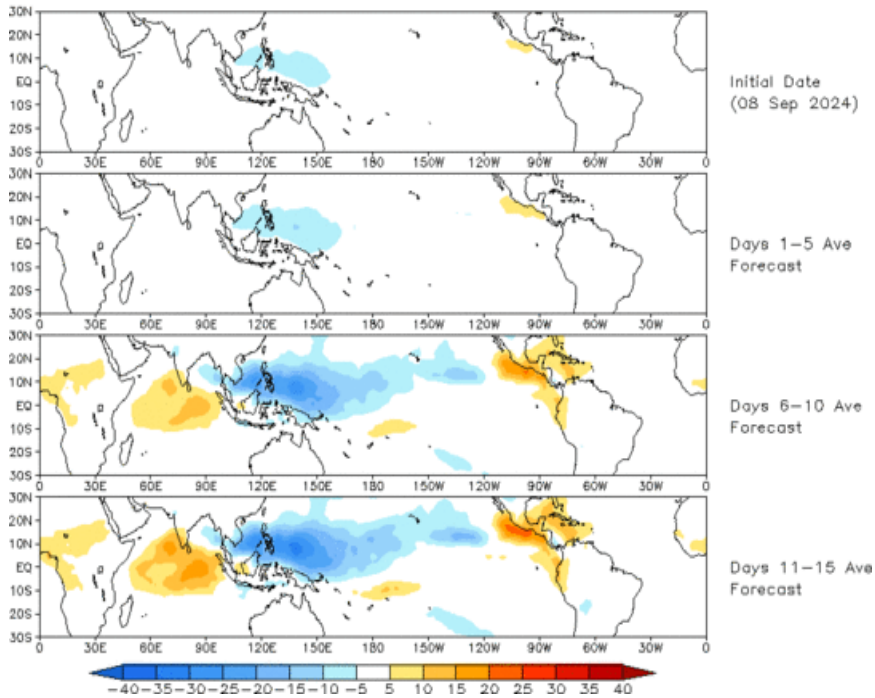
**ECMWF Forecast**

- Following the recent weakening, the GEFS and ECMWF ensemble mean depict an increase in amplitude of the RMM index during mid-September.
- The ECMWF model favors eastward propagation of the MJO resuming with a few ensemble members having the MJO shifting back to phases 8 and 1.

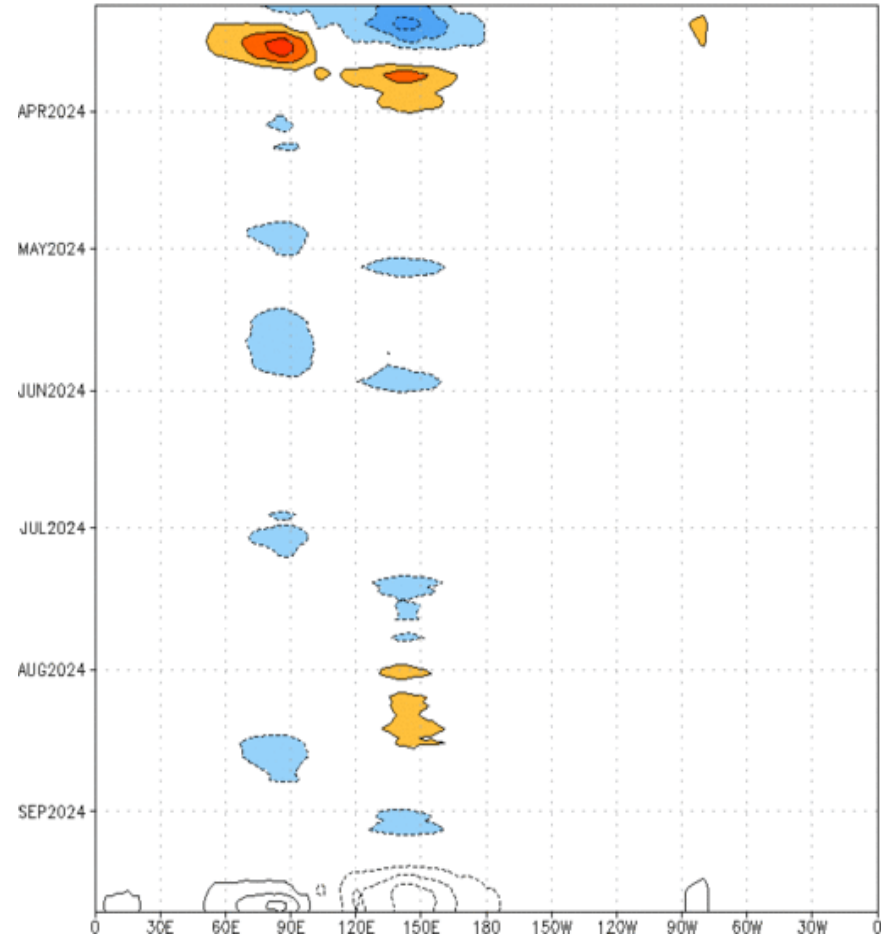
# MJO: GEFS Forecast Evolution

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: 08 Sep 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:09-Mar-2024 to 08-Sep-2024  
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

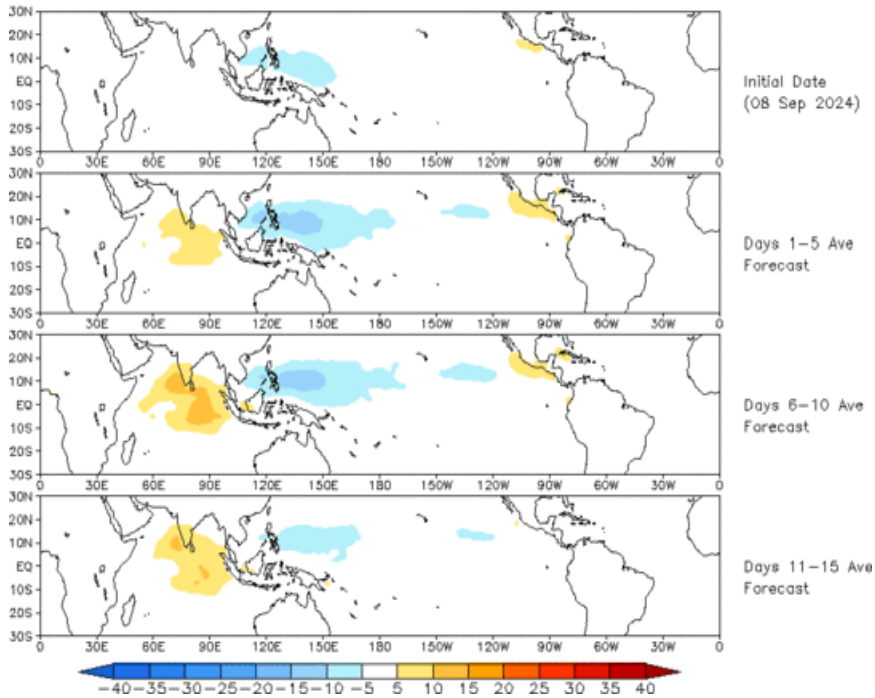


- The GEFS OLR anomaly forecast depicts a slow-moving MJO strengthening MJO with enhanced convection overspreading the Pacific Ocean and suppressed convection expanding east from the Americas to Africa.

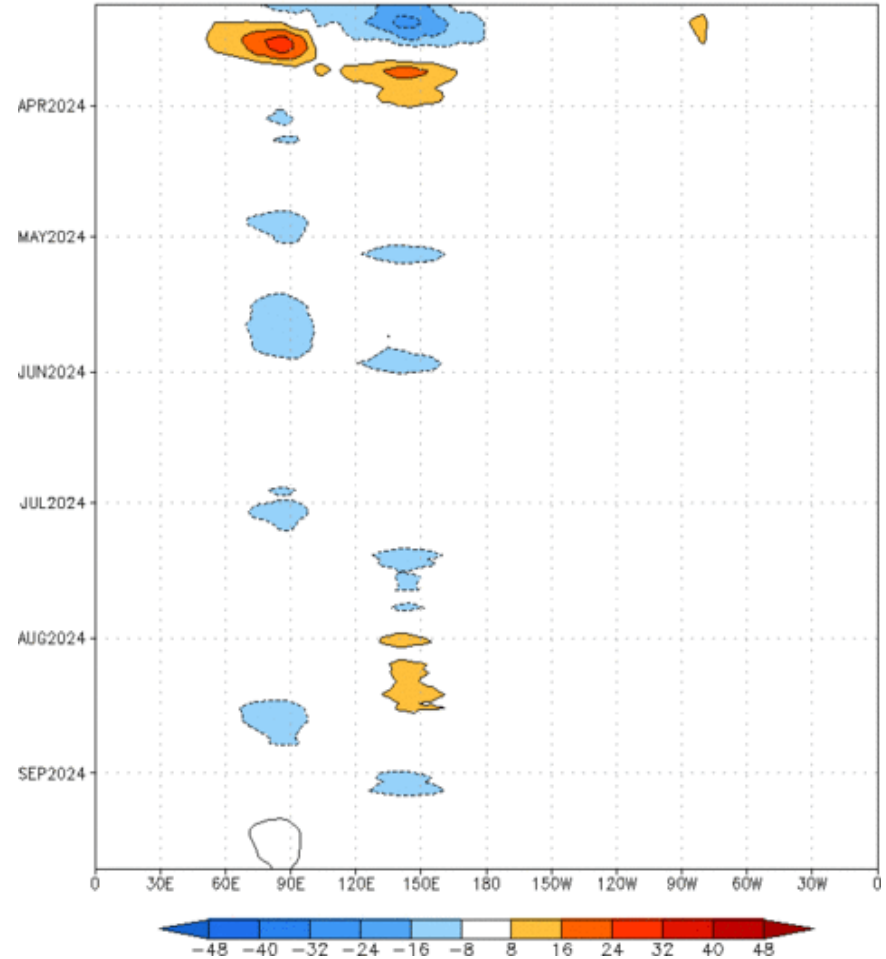
# MJO: Constructed Analog Forecast Evolution

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 (08 Sep 2024)



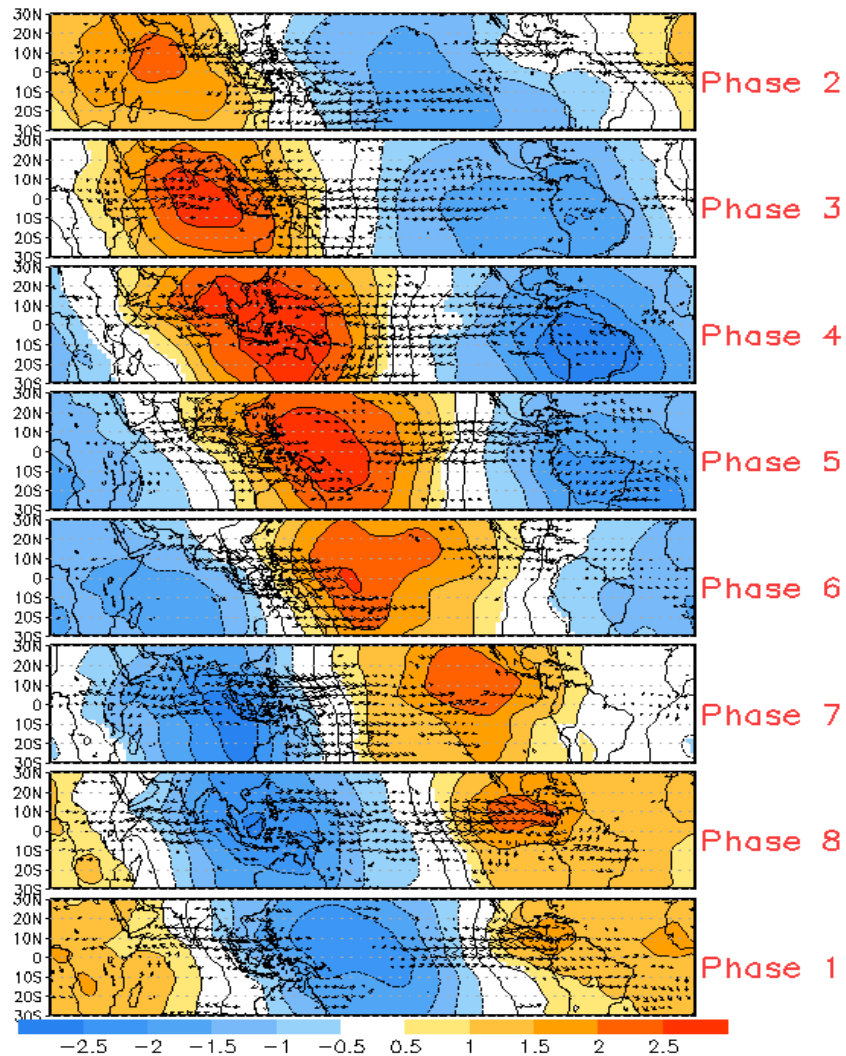
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm<sup>-2</sup>) Period:09-Mar-2024 to 08-Sep-2024  
The unfilled contours are CA forecast reconstructed anomaly for 15 days



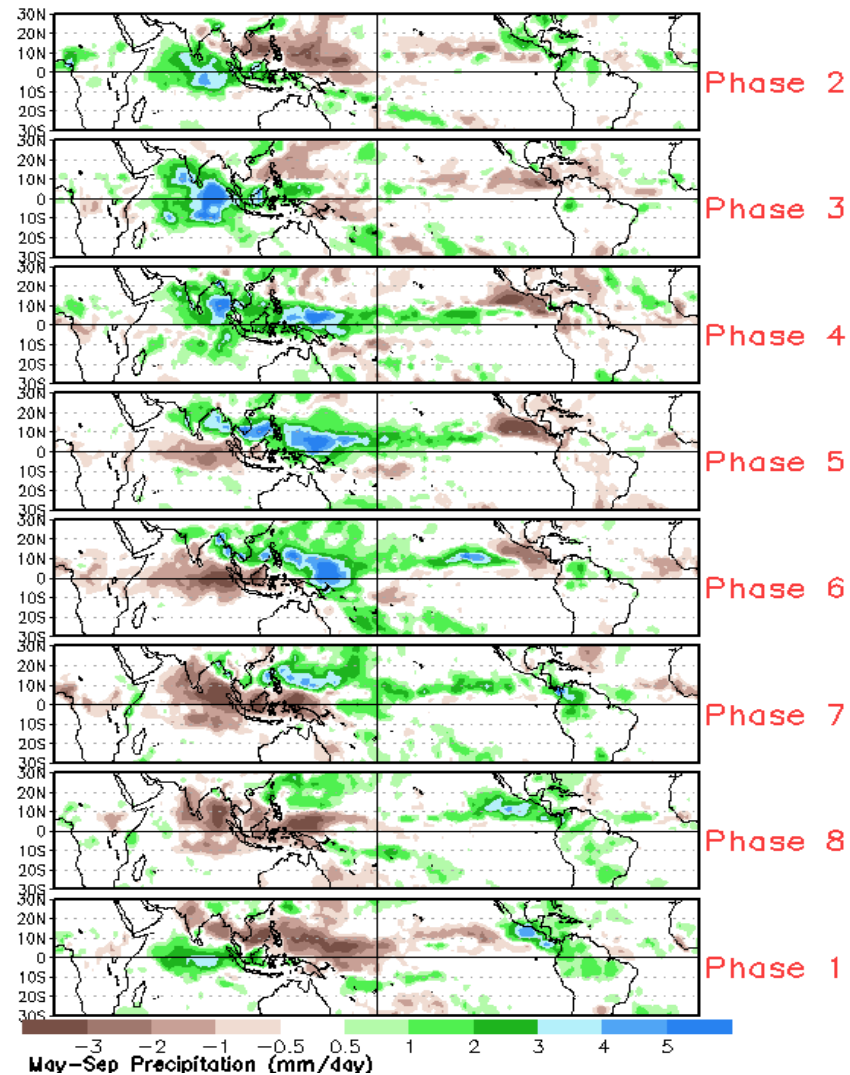
- The constructed analog shows no coherent MJO signal with little if any anomalies across the global tropics.

# MJO: Tropical Composite Maps by RMM Phase

## 850-hPa Velocity Potential and Wind Anomalies



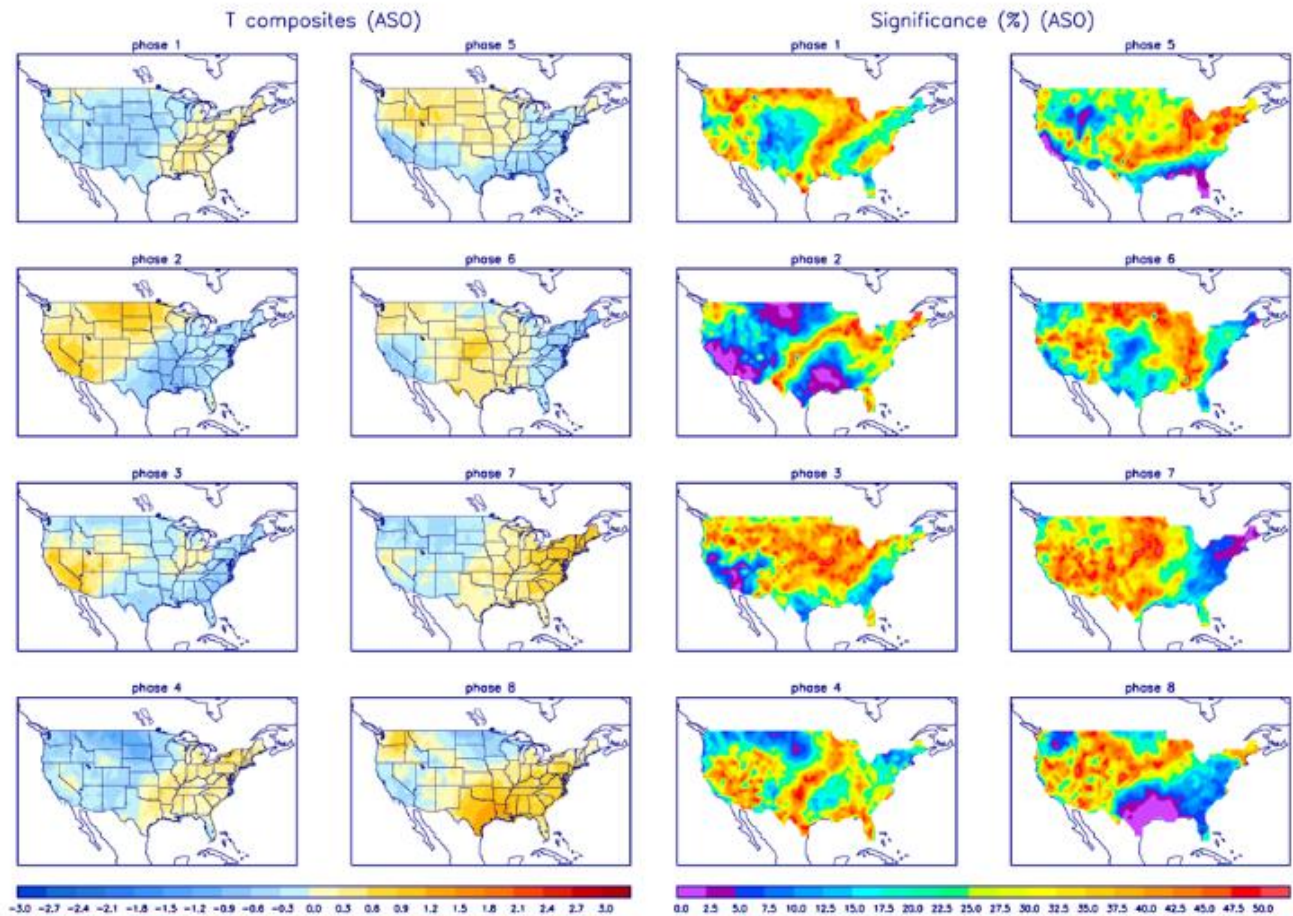
## Precipitation Anomalies



# 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.

