

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



**Update prepared by the Climate Prediction Center**  
**NWS / NCEP / CPC**  
**13 November 2023**

# Overview

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- El Niño and the positive Indian Ocean dipole continue to be the major influences on anomalous tropical rainfall.
- The RMM-based MJO index recently increased in amplitude. Dynamical model forecasts are in good agreement that a strengthening MJO propagates eastward from the Western Hemisphere to the Indian Ocean from mid-November through the beginning of December.
- Tropical cyclone (TC) development is favored across the South China Sea and Bay of Bengal during mid to late November.
- As the MJO shifts east to the Indian Ocean by the end of November, this would elevate chances of tropical cyclone development across the Arabian Sea during week-3 (November 29 to December 5).

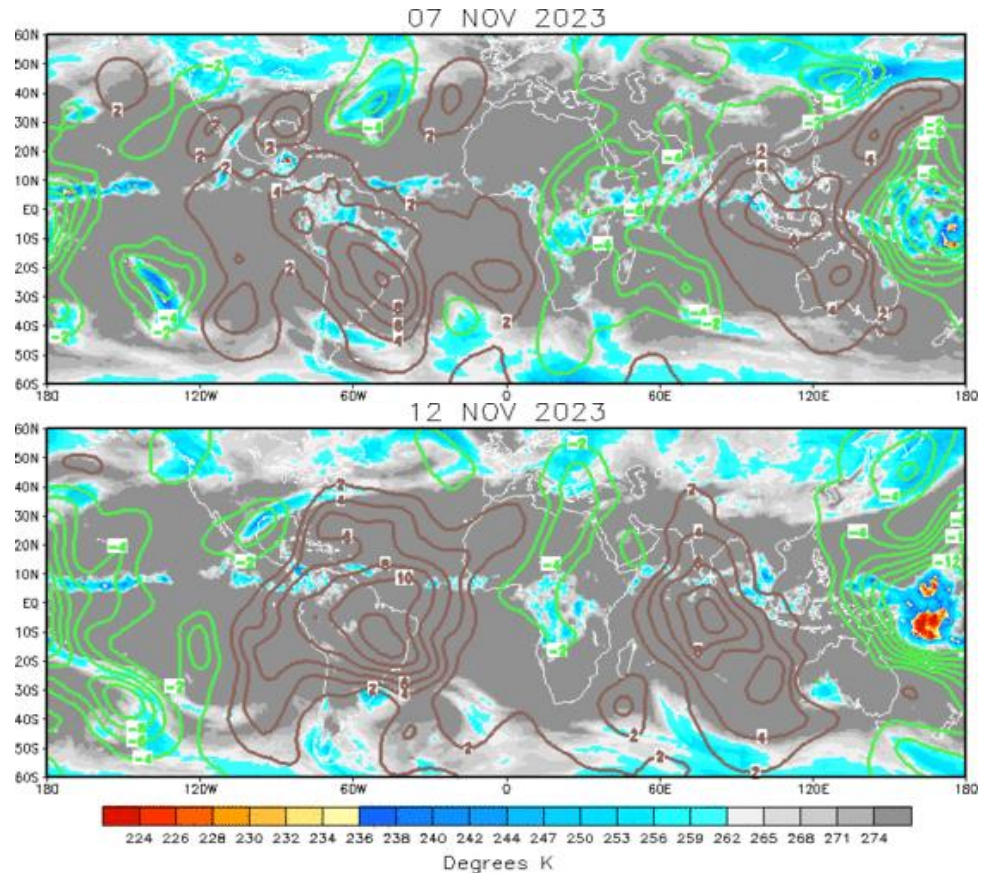
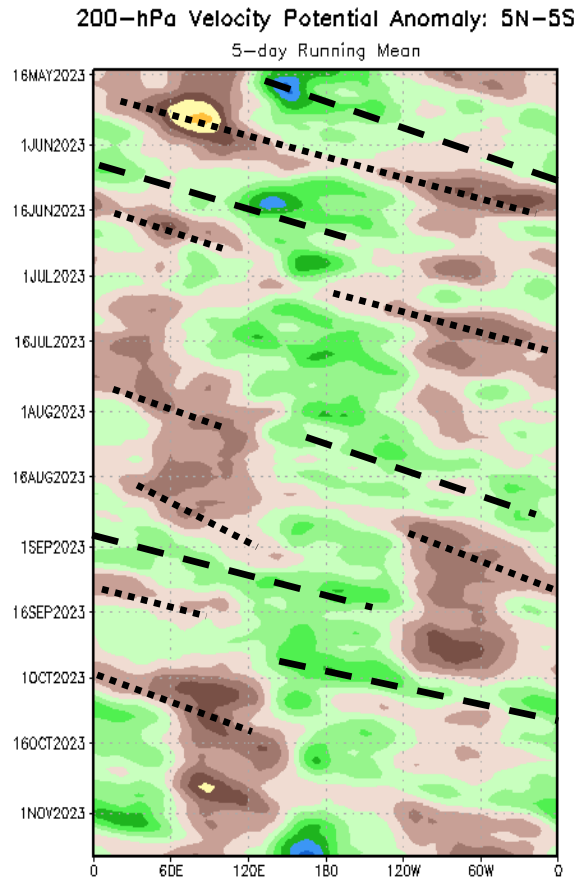
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:

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

# 200-hPa Velocity Potential Anomalies

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

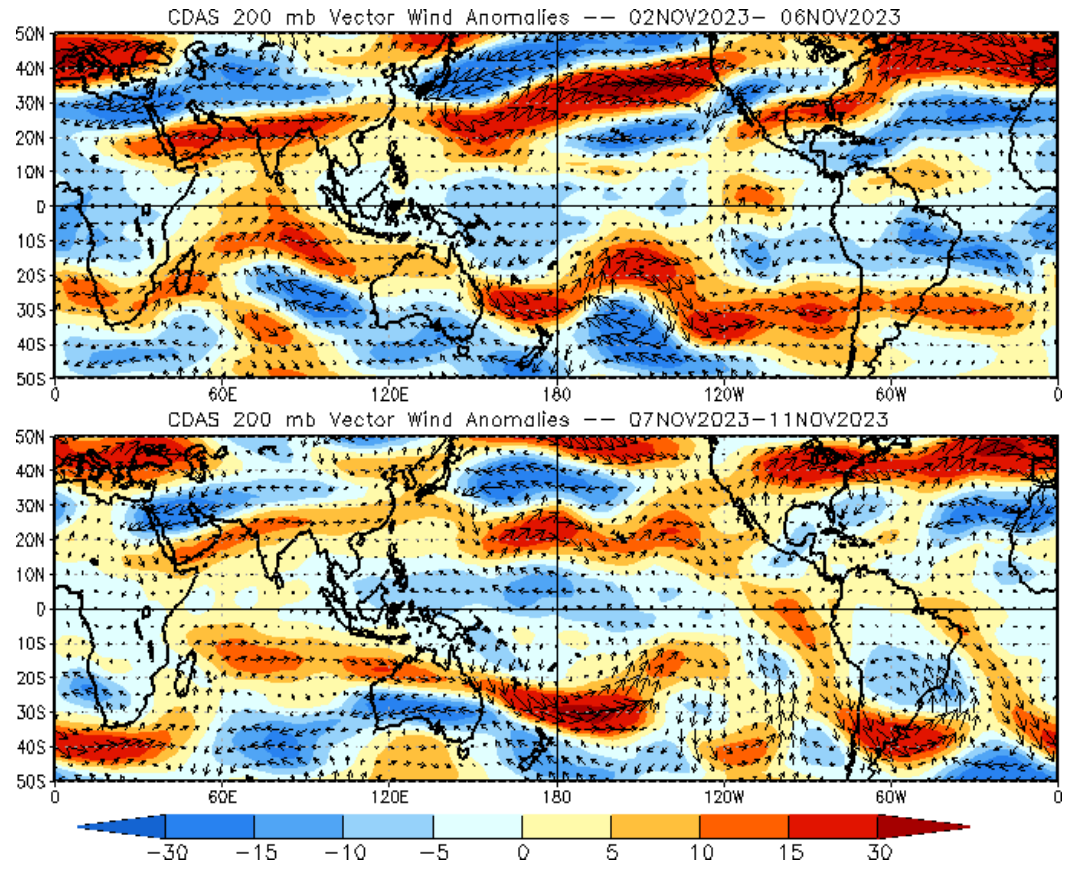
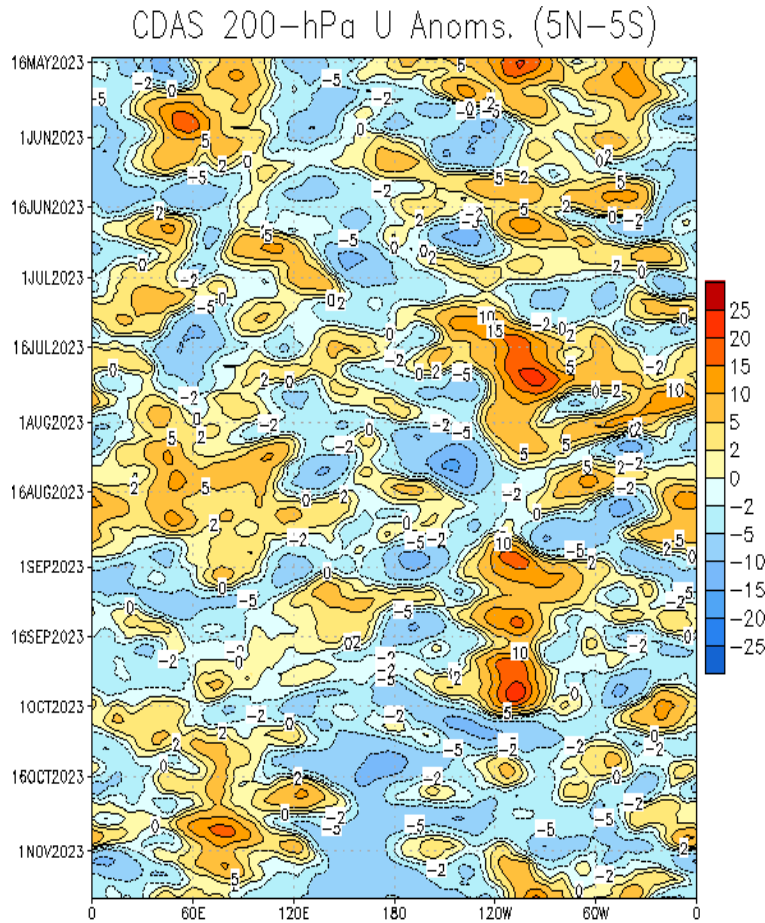
**Brown shades: Anomalous convergence (unfavorable for precipitation)**



- The large-scale pattern continues to be dominated by low-frequency signals, most notably the ongoing El Niño promoting enhanced divergence (convergence) over the central Pacific (Maritime Continent) and the positive Indian Ocean Dipole event promoting enhanced divergence (convergence) over Africa and the western Indian Ocean (eastern Indian Ocean and Maritime Continent).
- Recently the magnitude of the anomalous upper-level divergence increased over the West Pacific which may be a strengthening MJO constructively interfering with El Niño.

# 200-hPa Wind Anomalies

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

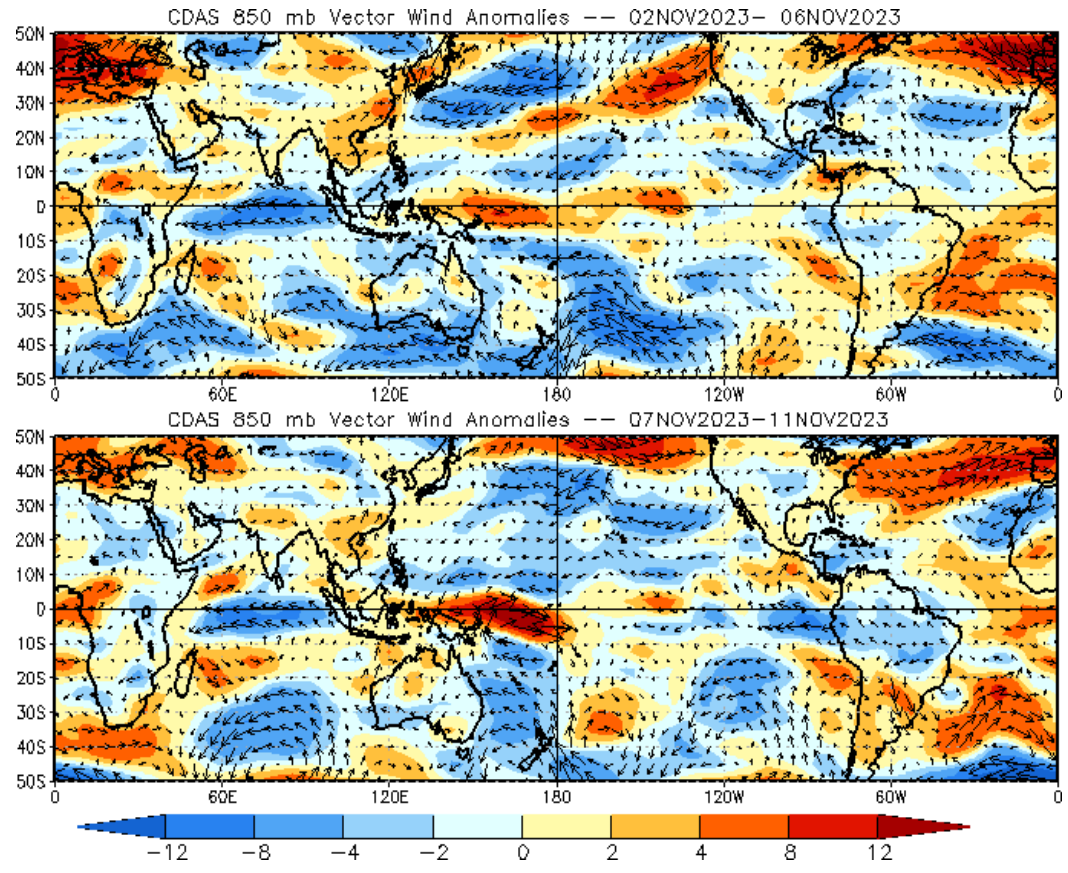
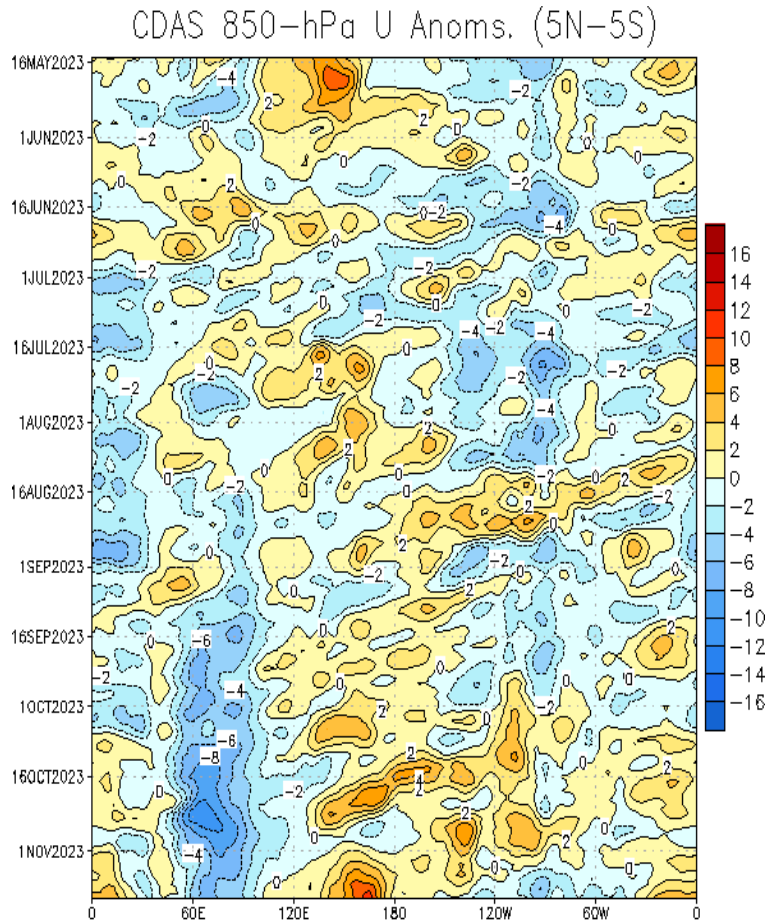


- Easterly anomalies aloft remain entrenched over much of the equatorial Pacific, consistent with El Niño.
- Westerly anomalies over the Indian Ocean, associated with the ongoing +IOD event, eased during early November.



# 850-hPa Wind Anomalies

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

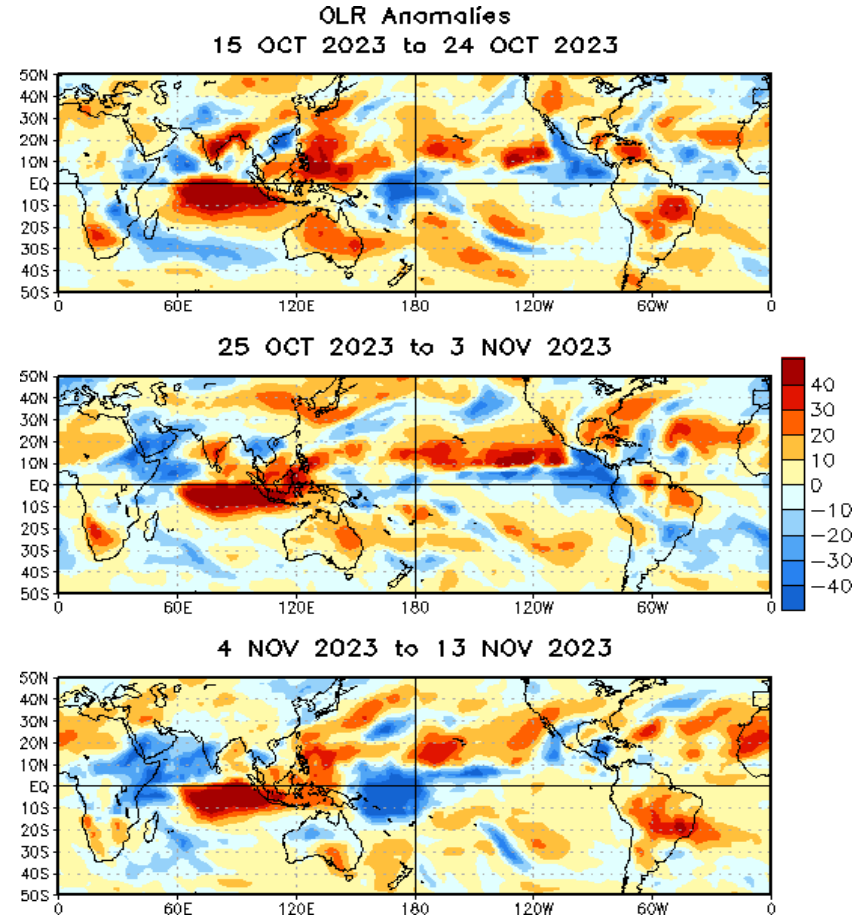
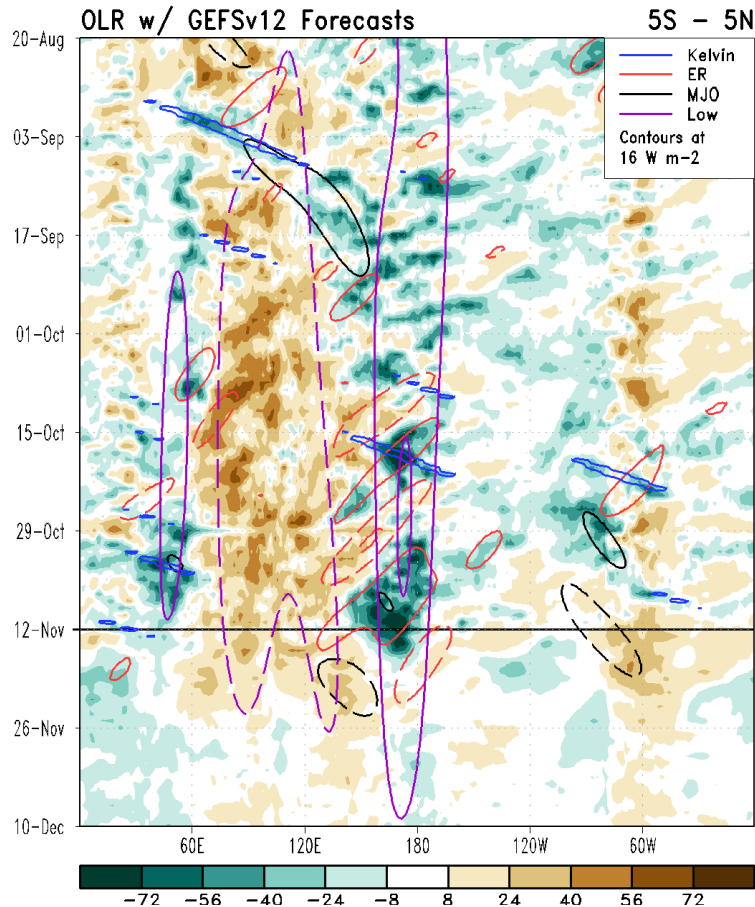


- Easterly anomalies associated with the +IOD event remain robust over the Indian Ocean.
- To the northeast of Papua New Guinea, a very strong Westerly Wind Burst (WWB) is observed during the past five days. This WWB may contribute to a strengthening El Niño by the end of November.

# Outgoing Longwave Radiation (OLR) Anomalies

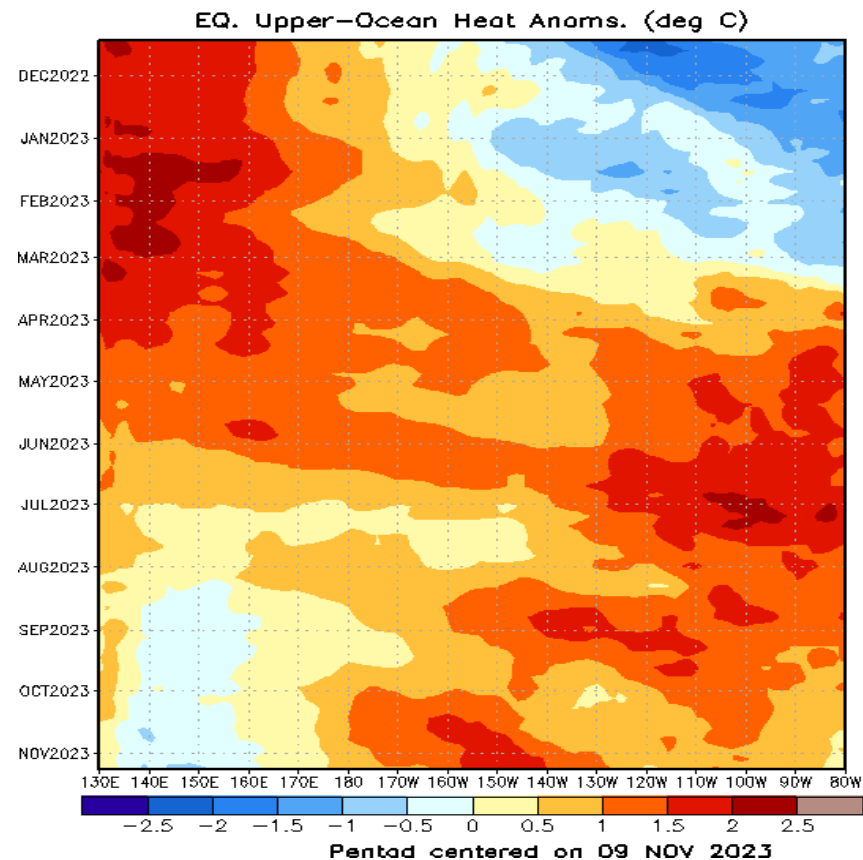
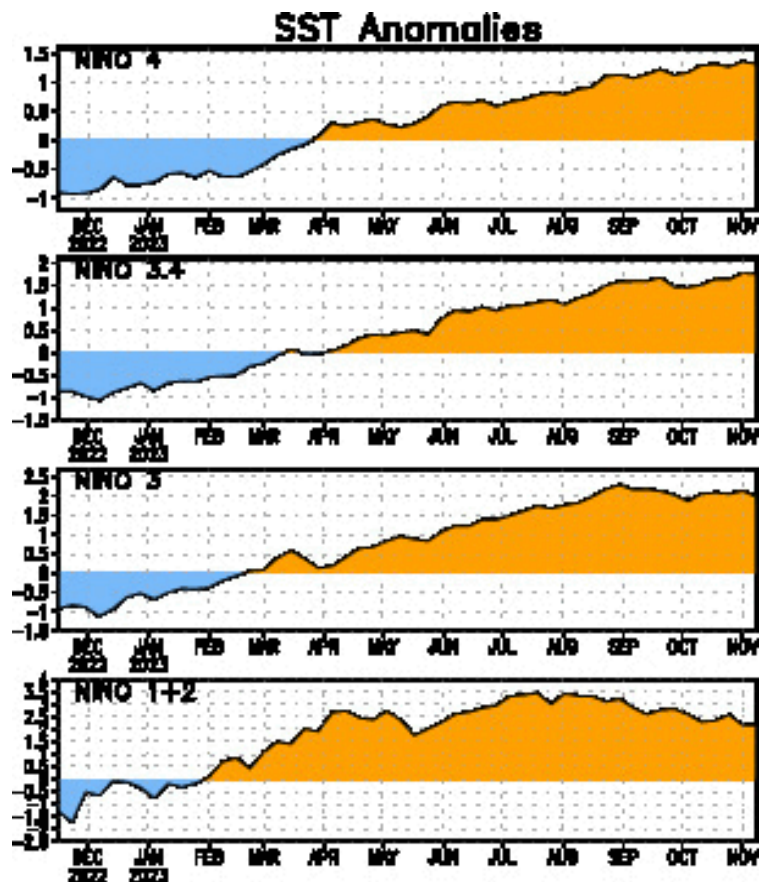
**Green shades: Anomalous convection (wetness)**

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



- The OLR pattern primarily reflects El Niño, modulated by Kelvin and Rossby wave activity.
- Enhanced convection in the vicinity of Central America during late October began to expand east to the western Caribbean by early November. This could contribute to tropical cyclone development during mid-November.

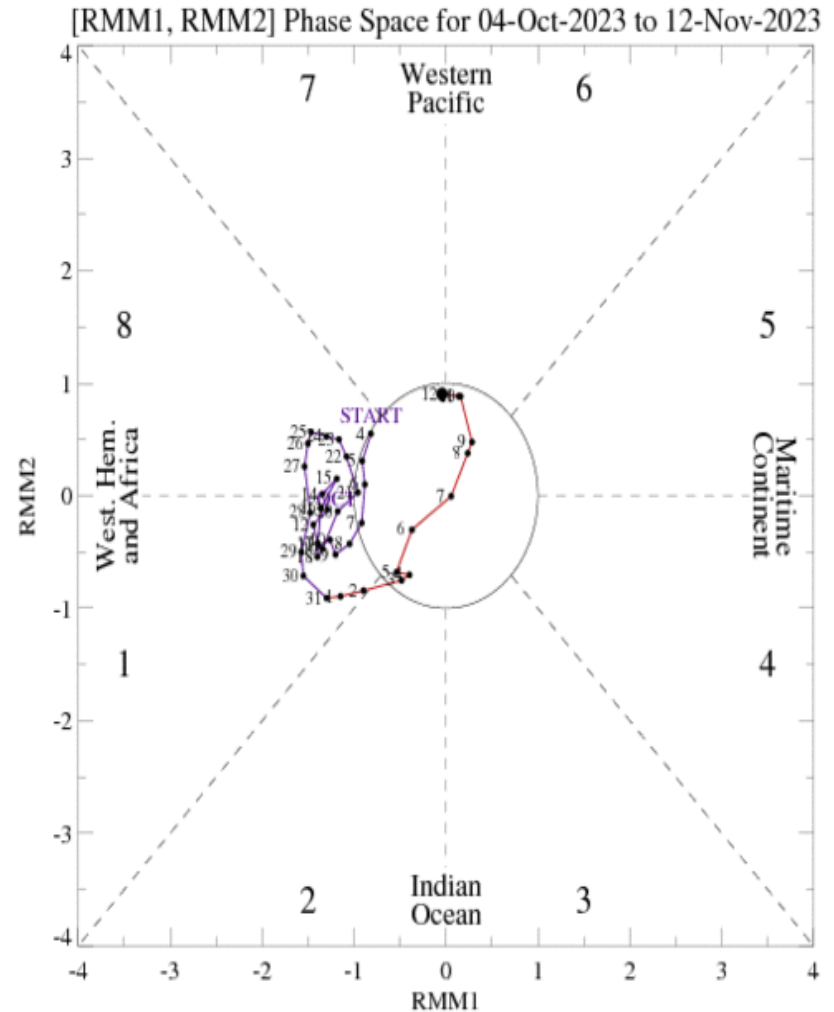
# SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- El Niño conditions are present across the equatorial Pacific with SST anomalies remaining strongly positive in all of the Niño basins.
- An area of slightly negative upper-ocean heat content anomalies continues across the Western Pacific and appears to have expanded slightly in recent observations.
- A new downwelling oceanic Kelvin wave initiated over the Central Pacific during October.

# MJO Index: Recent Evolution

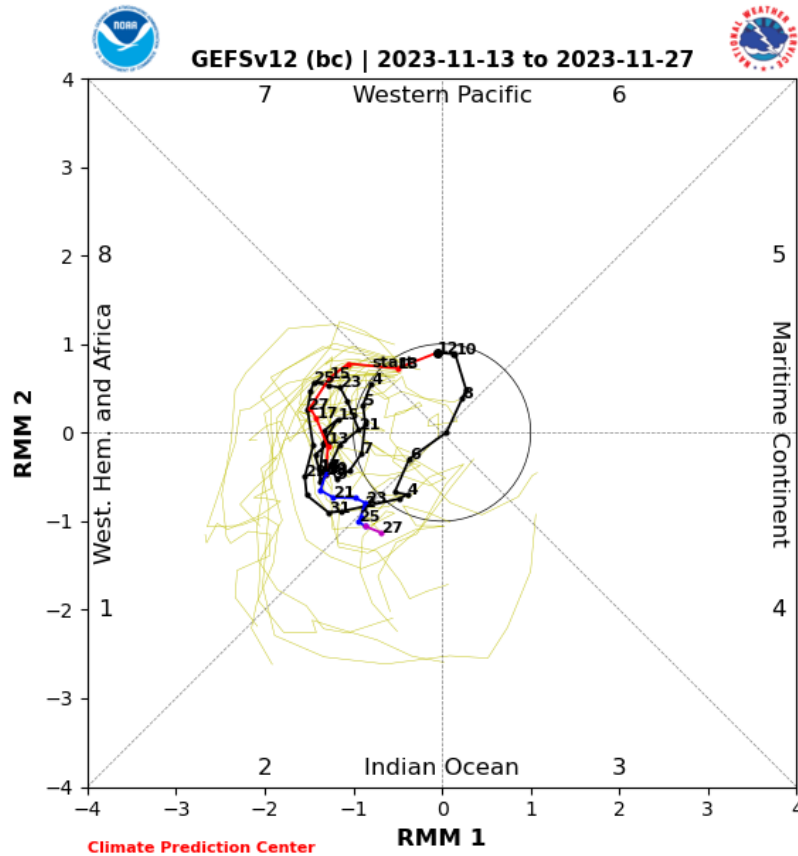
- Following no eastward propagation through October, the RMM-based MJO index depicts fast eastward propagation from the Indian Ocean to the West Pacific by early November.



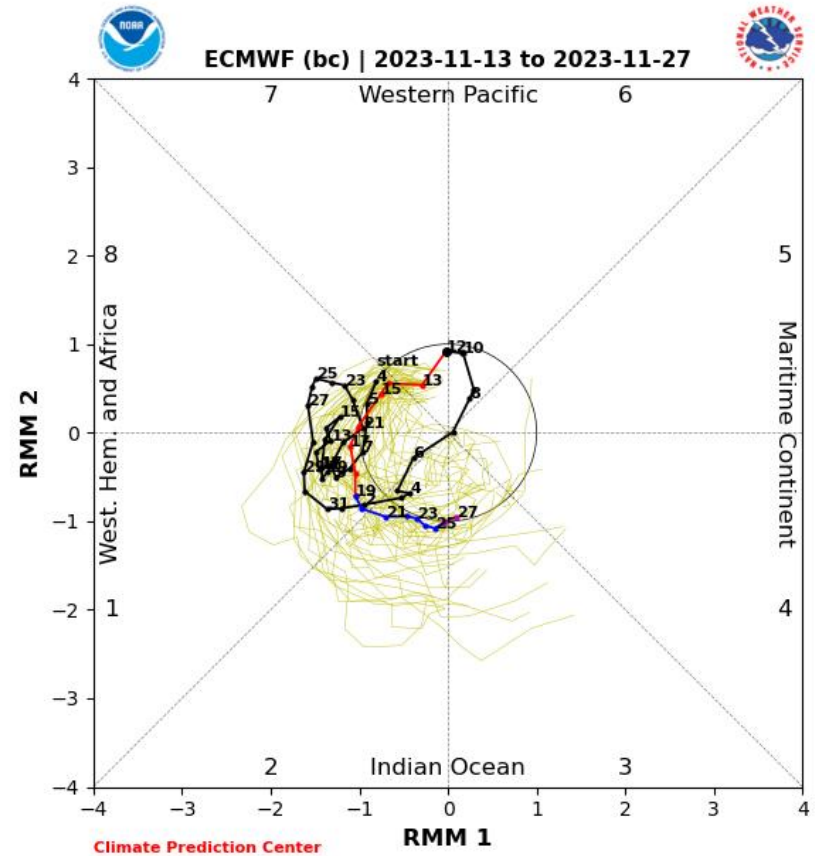
For more information on the RMM index and how to interpret its forecast please see:  
[https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC\\_MJOinformation.pdf](https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf)



# MJO Index: Forecast Evolution



**GEFS Forecast**



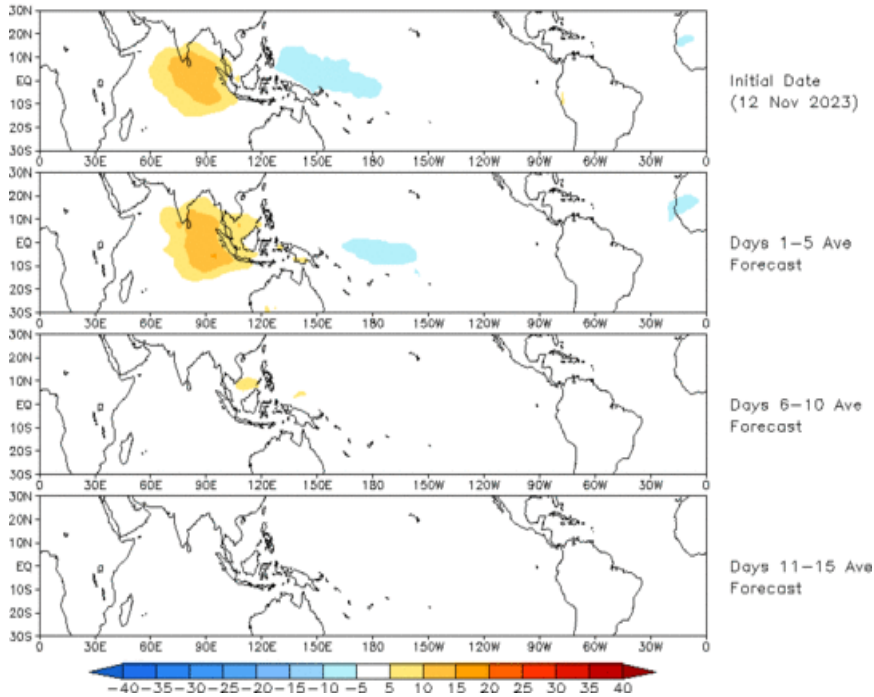
**ECMWF Forecast**

- Dynamical models are in good agreement that fast eastward propagation continues over the Western Hemisphere with the MJO returning to the Indian Ocean by the end of November.

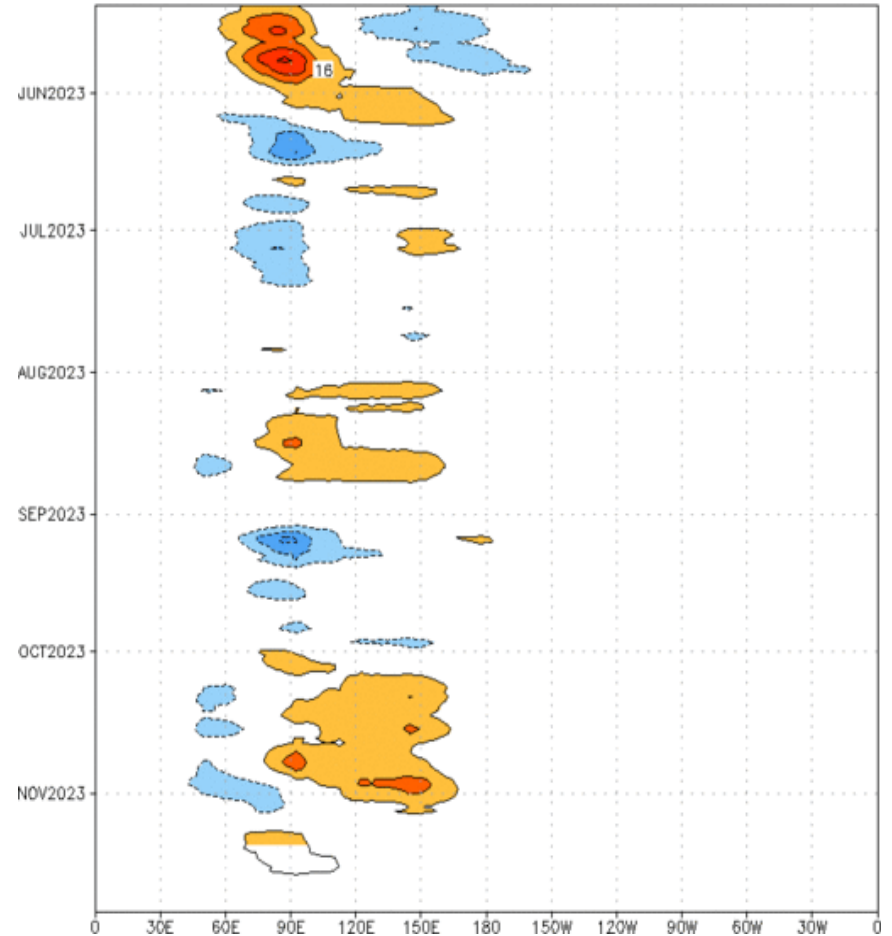
# MJO: GEFS Forecast Evolution

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: 12 Nov 2023  
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2  
OLR [7.5°S,7.5°N] (cont:4Wm<sup>-2</sup>) Period:13-May-2023 to 12-Nov-2023  
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

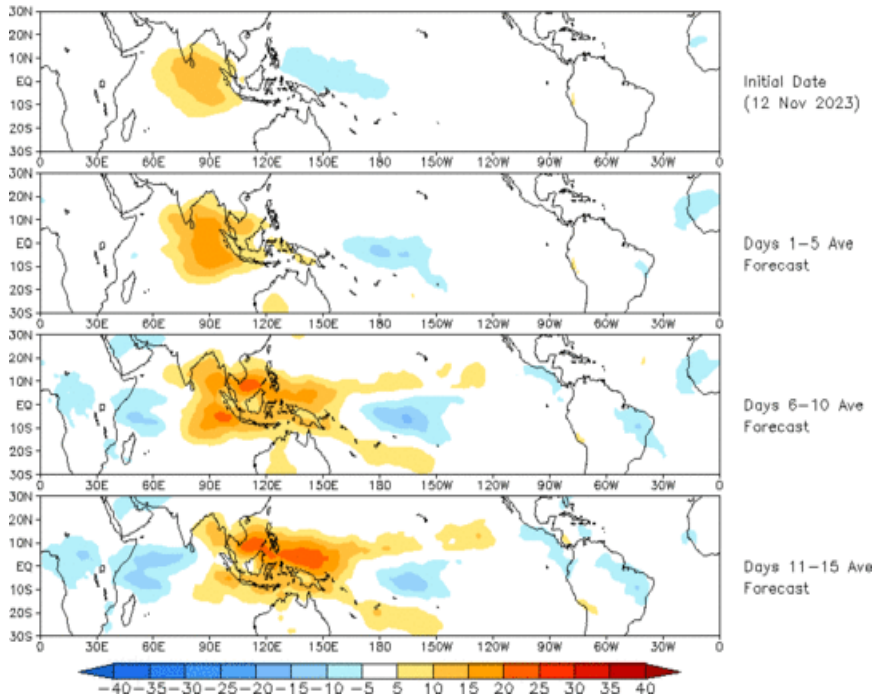


- The GEFS RMM-based OLR forecast depicts diminishing signals by week-2 as the MJO destructively interferes with El Niño.

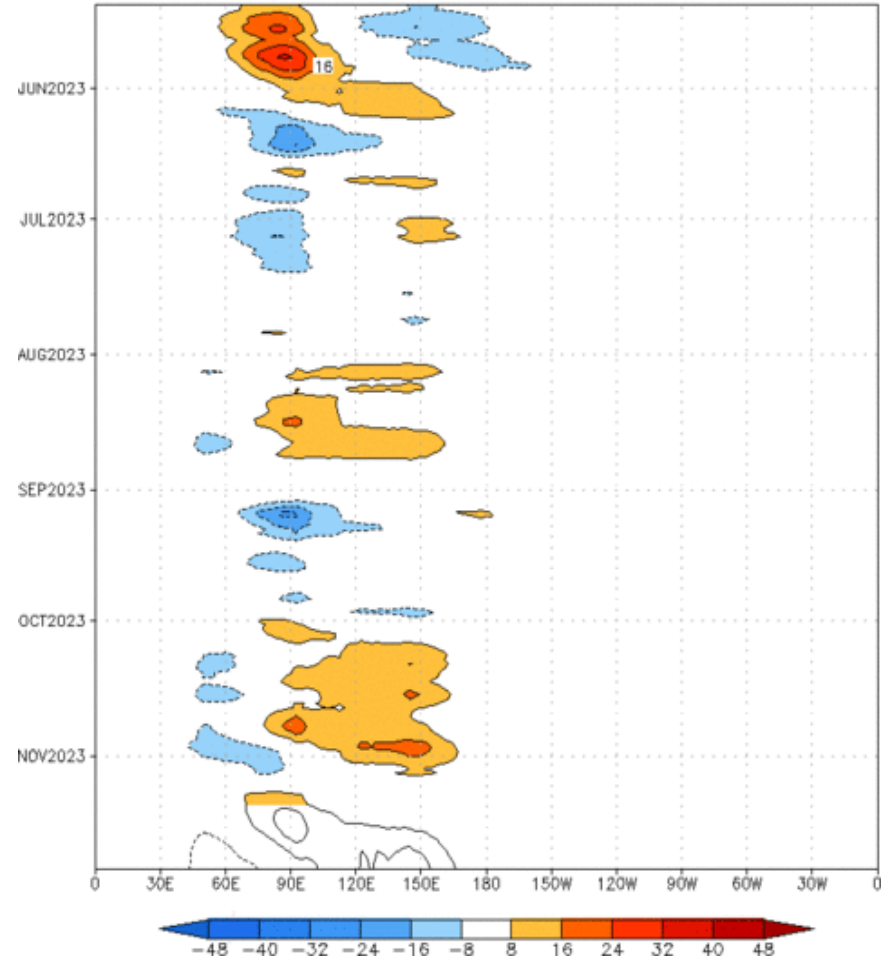
# MJO: Constructed Analog Forecast Evolution

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 (12 Nov 2023)



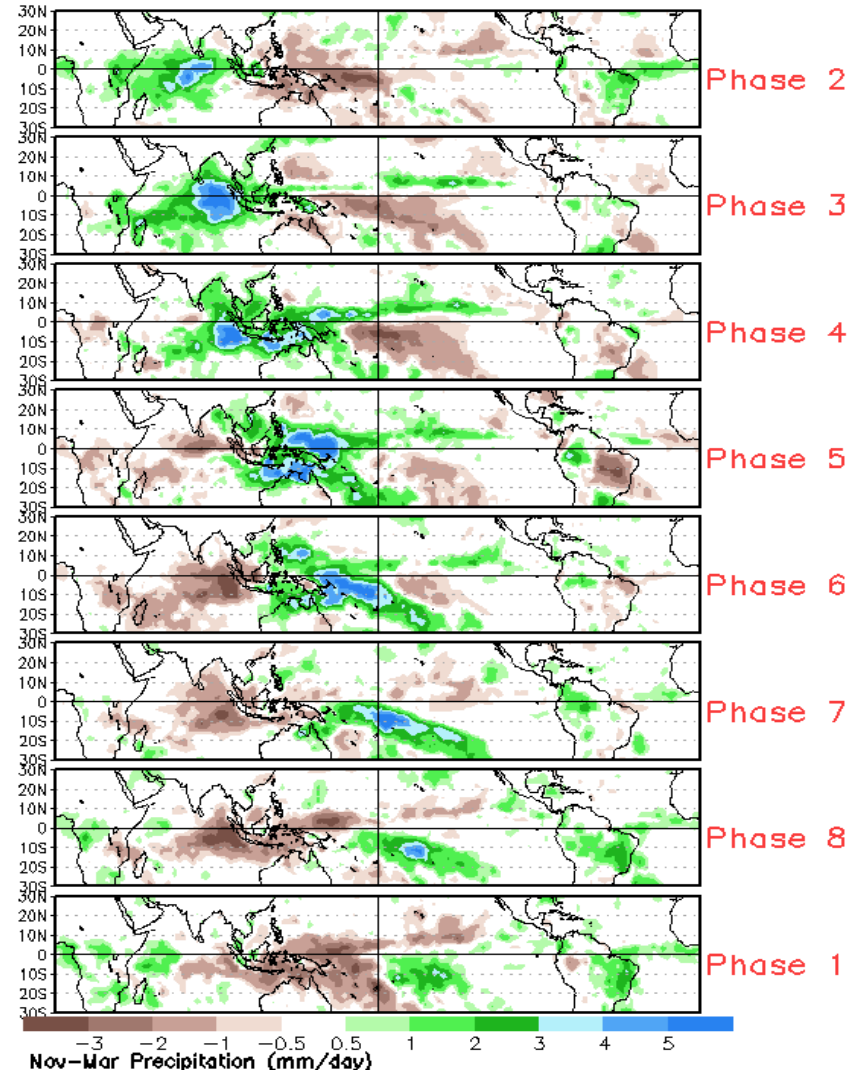
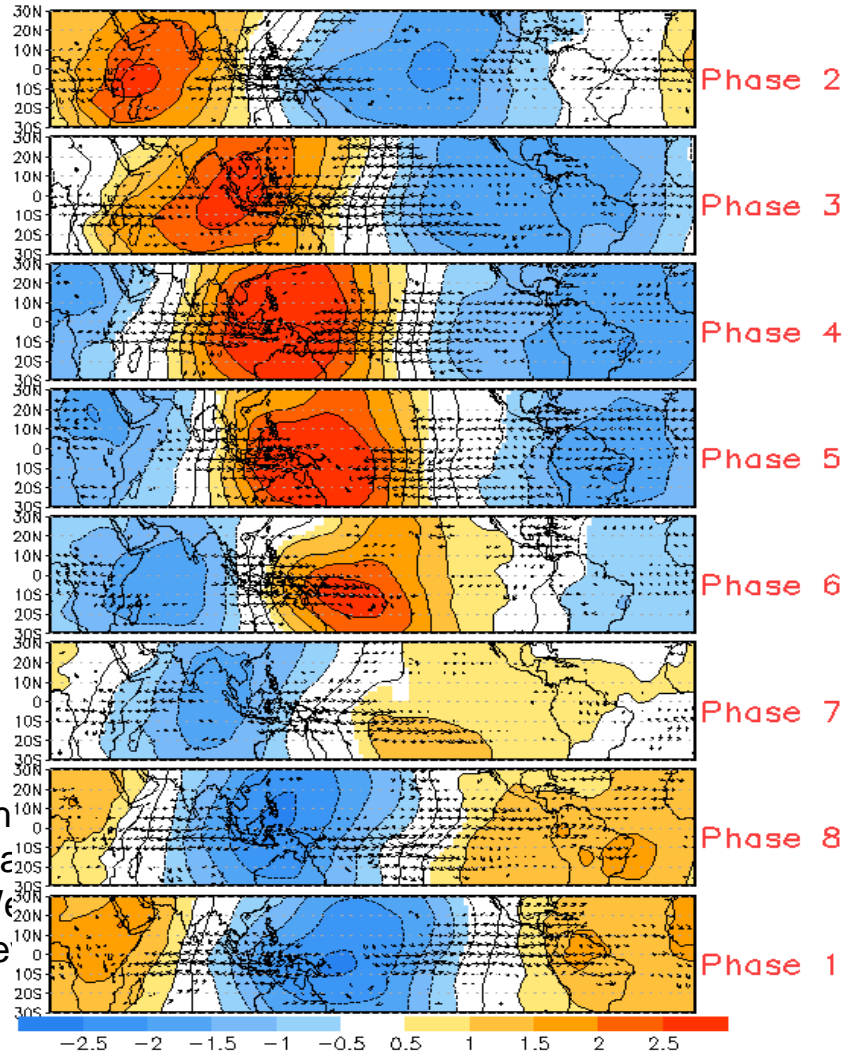
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm<sup>-2</sup>) Period:13-May-2023 to 12-Nov-2023  
The unfilled contours are CA forecast reconstructed anomaly for 15 days



- The constructed analog RMM-based forecast features suppressed convection shifting east to the West Pacific by week-2 with enhanced convection developing over 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.)

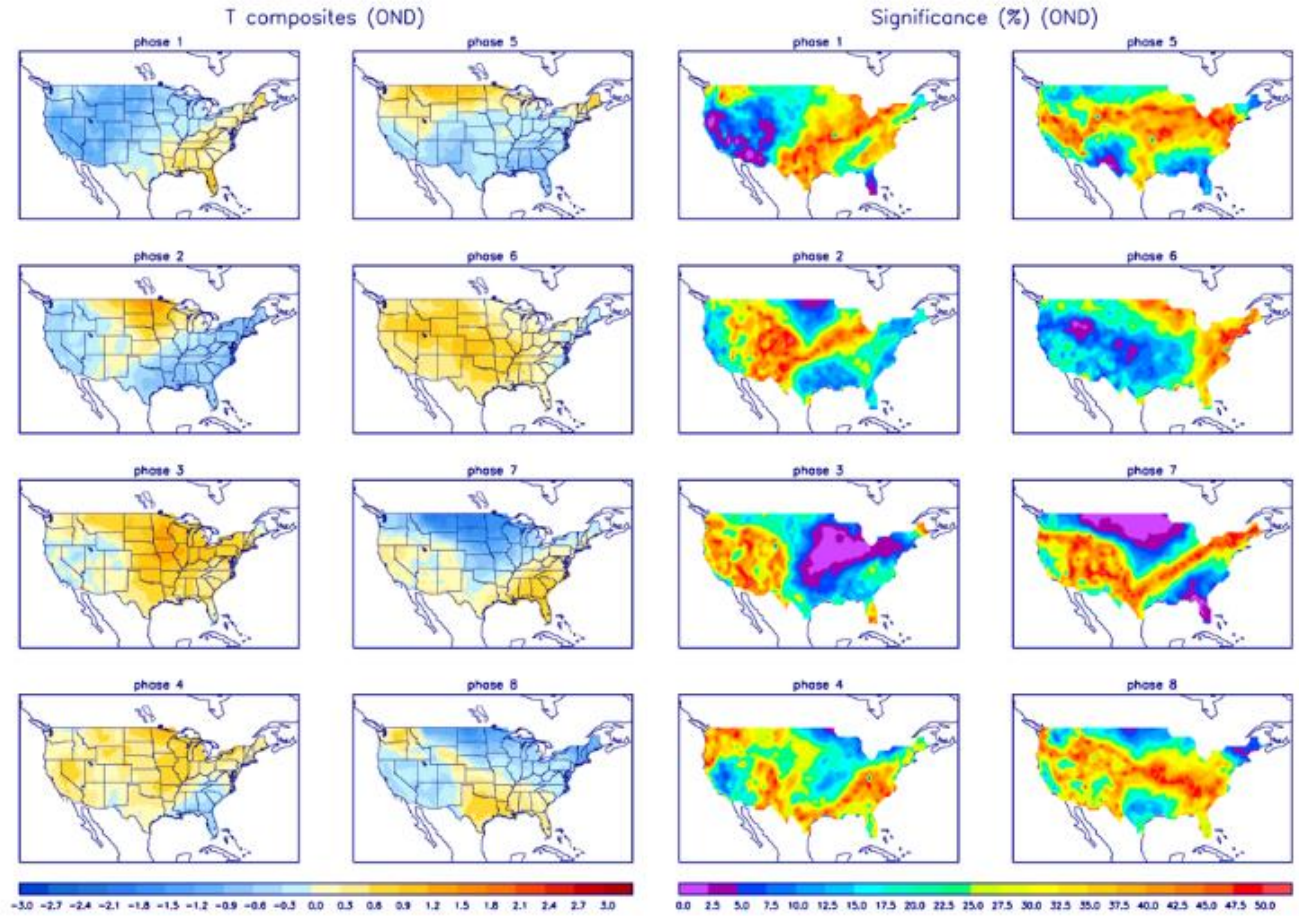




# MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and  
Wind Anomalies

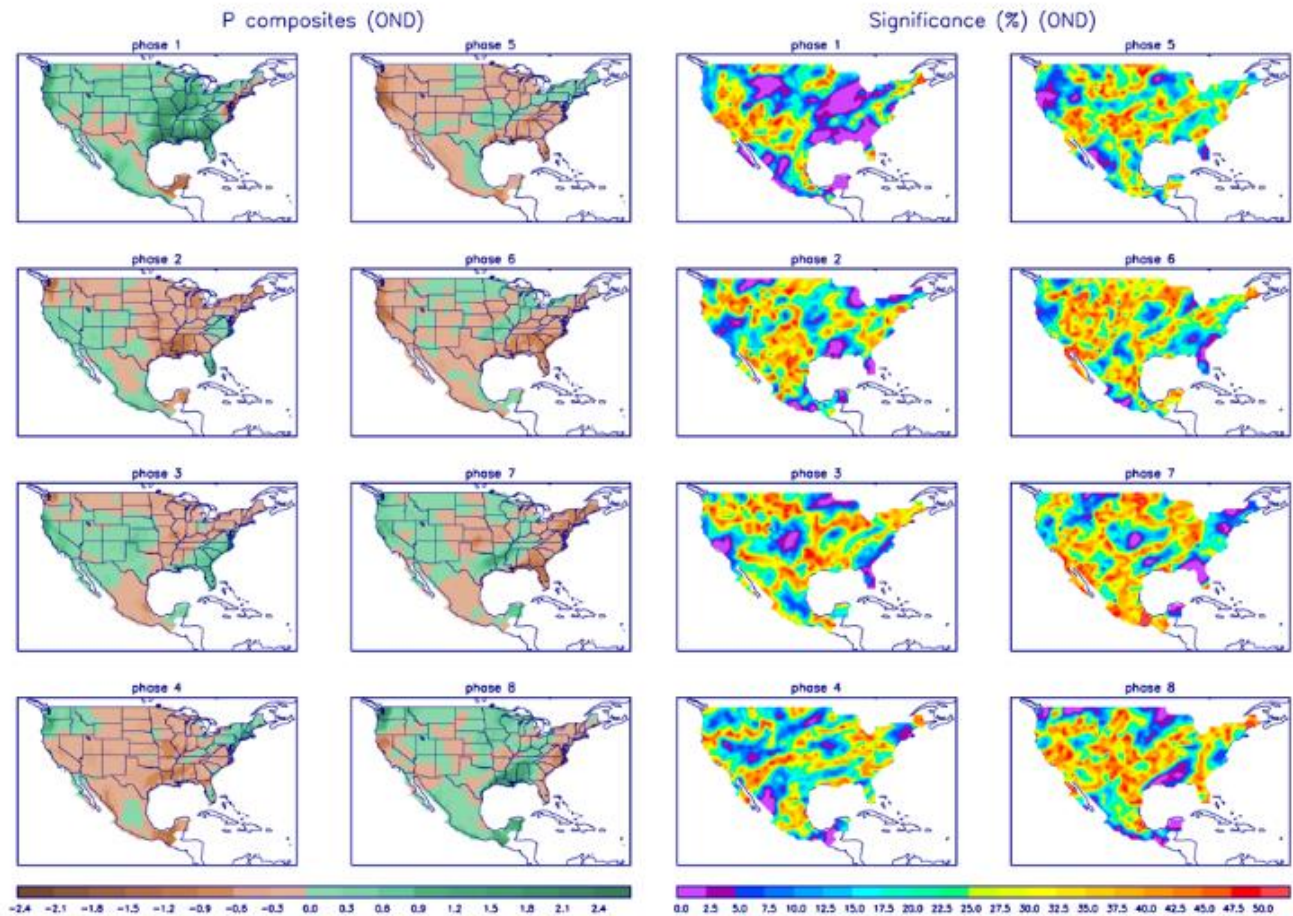
Precipitation Anomalies



# 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.

