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

**Update prepared by the Climate Prediction Center**
**NWS / NCEP / CPC**
**25 December 2023**

# Overview

- The MJO remains active, with the enhanced convective phase now rapidly crossing the Western Hemisphere.

- Dynamical and statistical model guidance are in good agreement supporting continued eastward propagation of the MJO across the Indian Ocean through the end of Week-2. Much of the guidance shows a fairly high amplitude signal.

- The MJO is likely to destructively interfere with both the +IOD signal over the Indian Ocean and the El Niño signal during the next few weeks. Despite this interference, ENSO will likely remain a strong driver of global tropical convective anomalies.

- Longer range dynamical model forecasts show continued MJO activity across the Maritime Continent during Week-3, with many GEFS ensemble members returning the signal to the Pacific by Week-4.

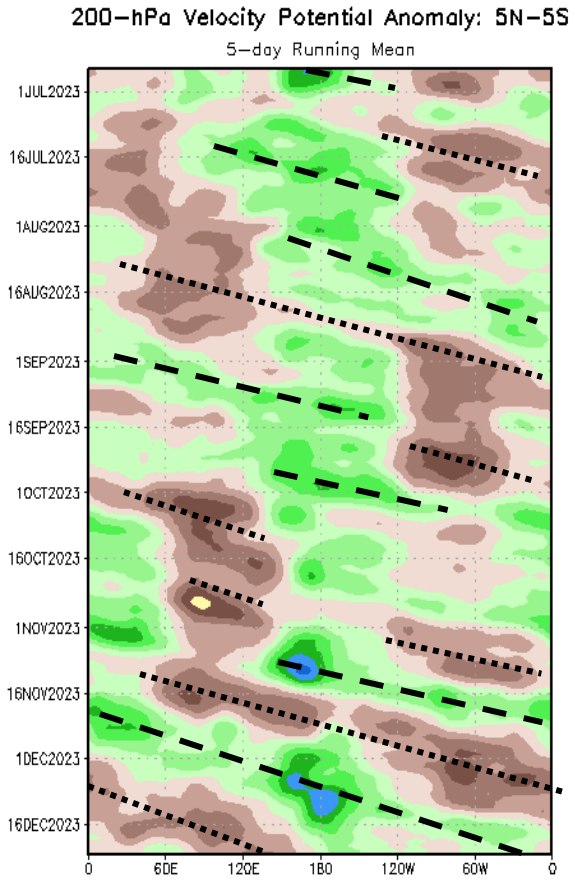
- An active MJO pattern is likely to induce pattern changes across the midlatitudes; however, these impacts will be strongly influenced by the ongoing ENSO response.

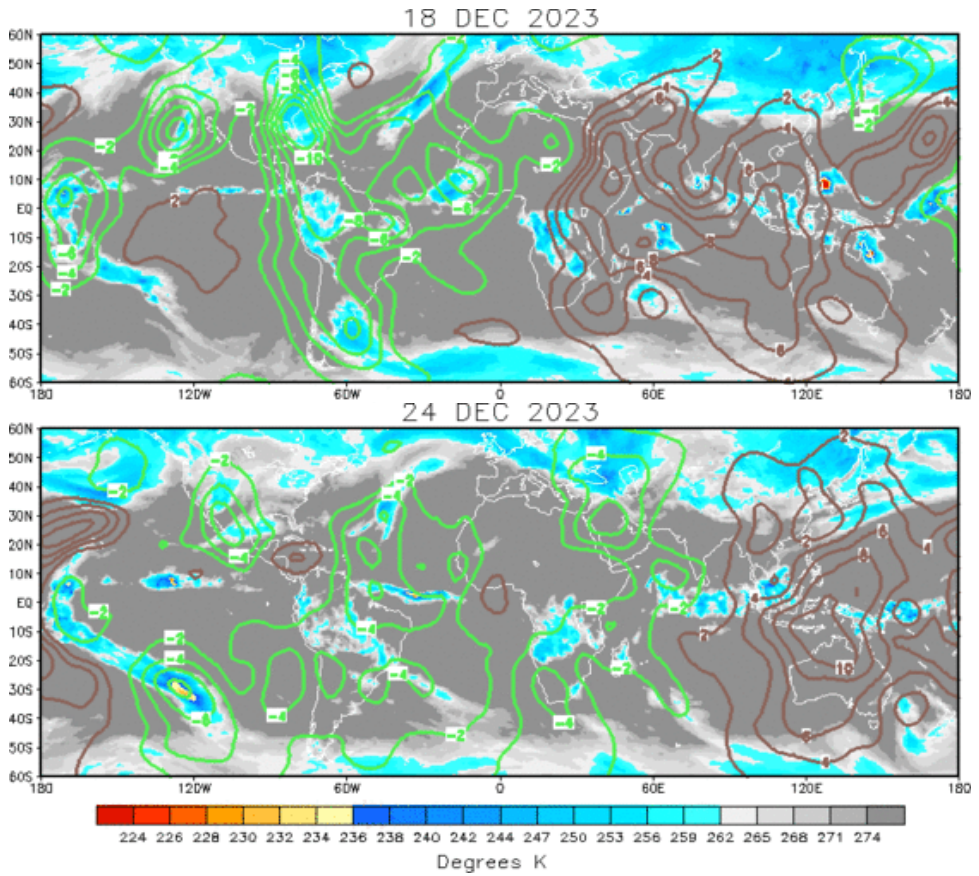
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

# 200-hPa Velocity Potential Anomalies

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

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

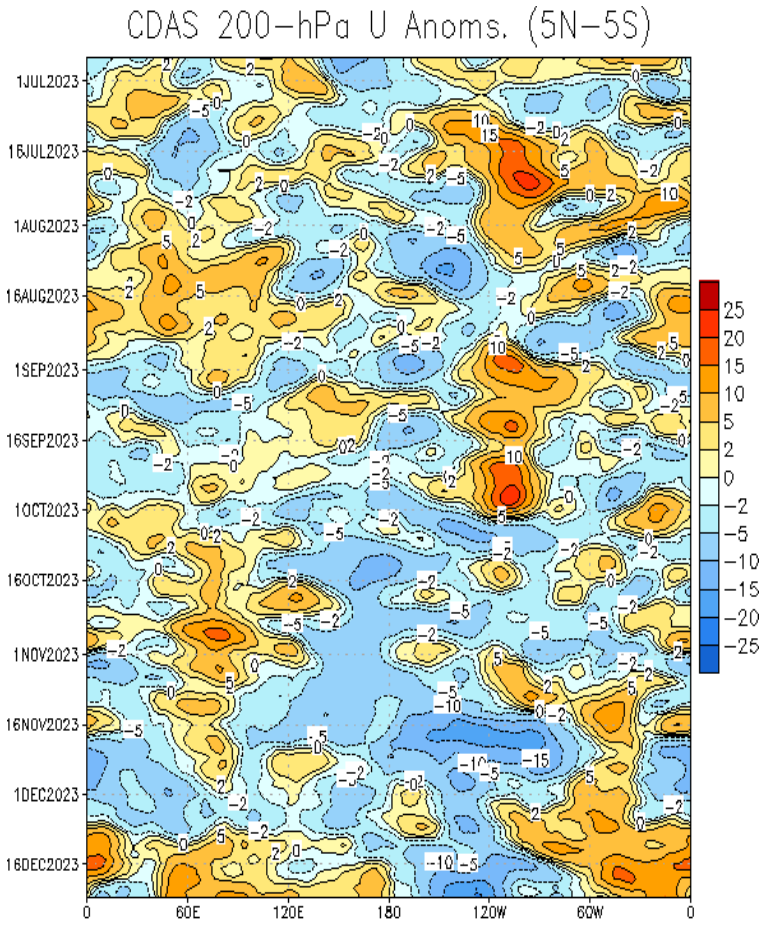


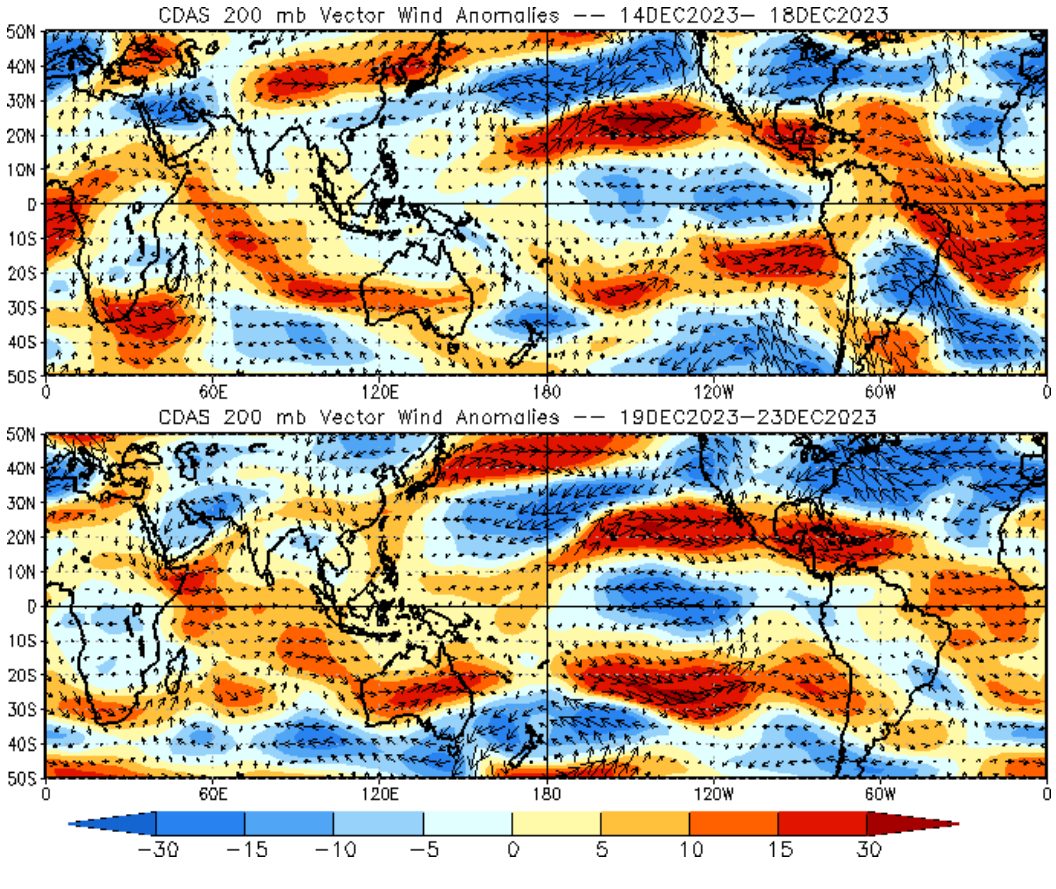




- The MJO remains active, with the enhanced phase rapidly crossing the Western Hemisphere.
- The low frequency El Niño base state is destructively interfering with the MJO suppressed envelope over the Pacific.

# 200-hPa Wind Anomalies

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

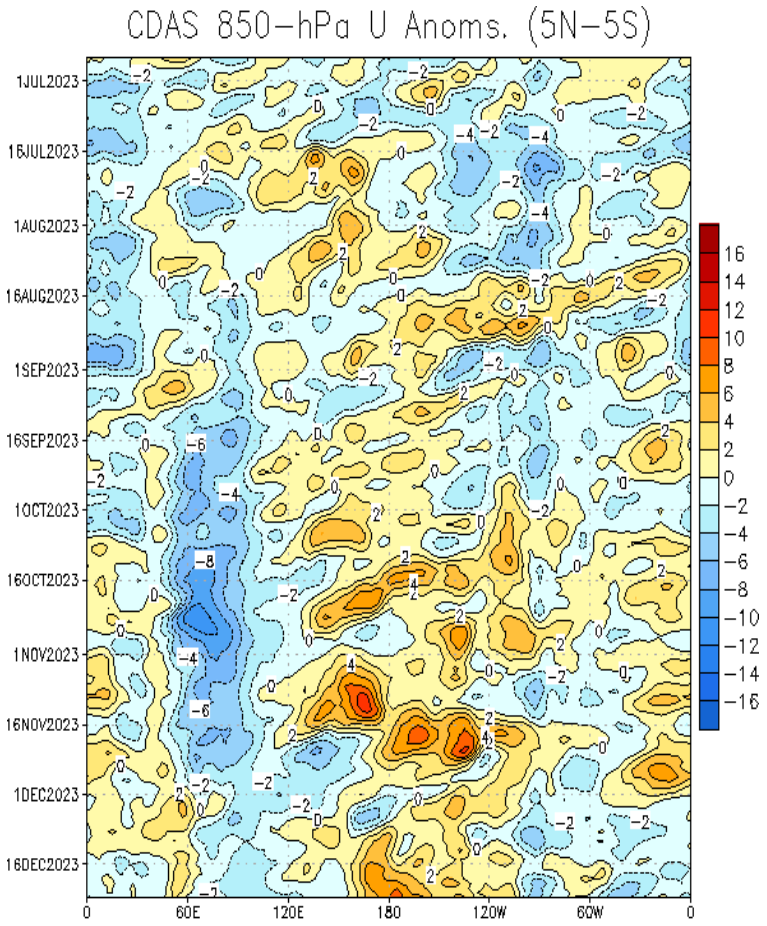


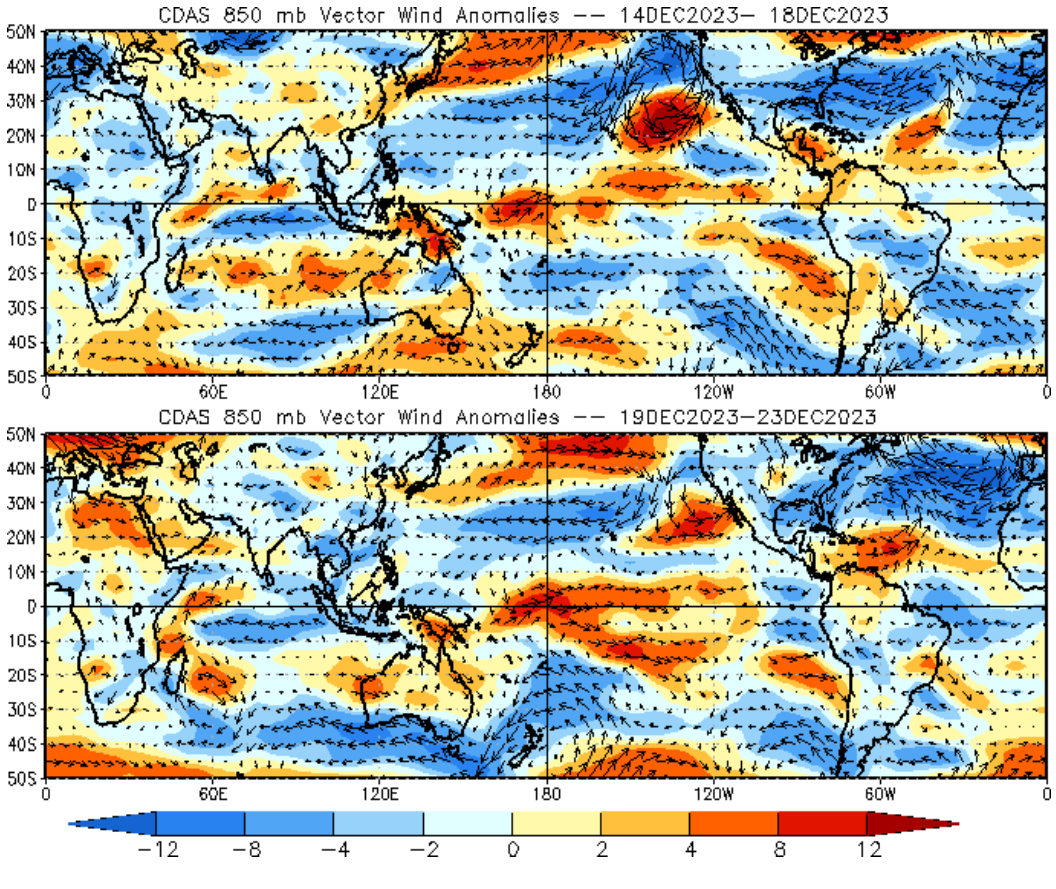




- Consistent with MJO activity, anomalous westerlies overspread the Indian Ocean and western Pacific.
- Strong easterlies over the eastern Pacific with a robust midlatitude Pacific jet to the north are consistent with the atmospheric response to El Niño conditions.
- Despite the destructive interference between the MJO and ENSO, both signals favor easterlies aloft across the East Pacific.

# 850-hPa Wind Anomalies

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

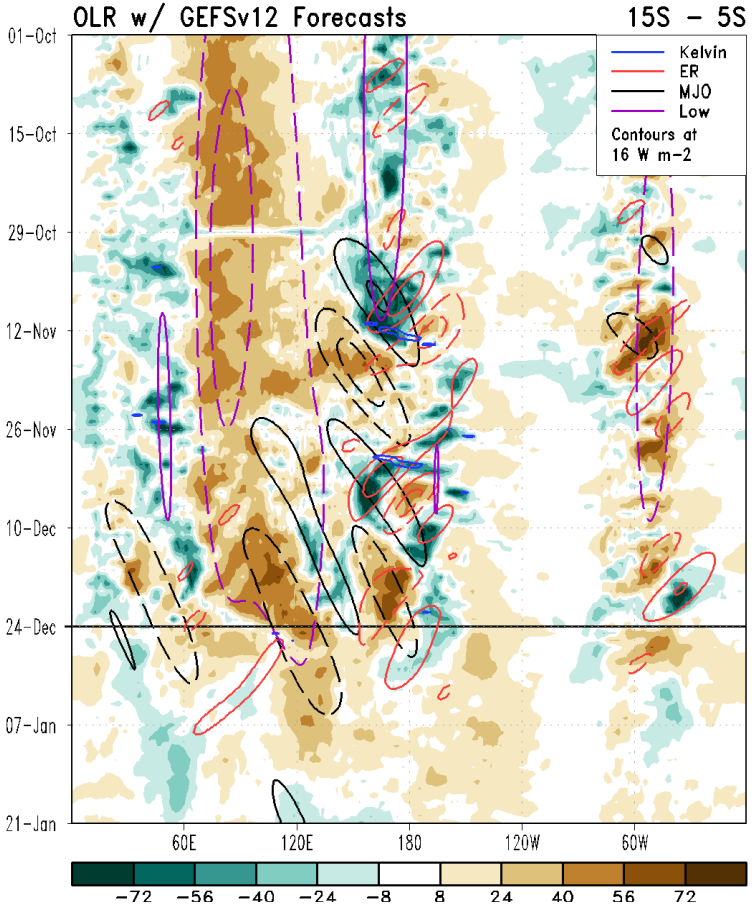


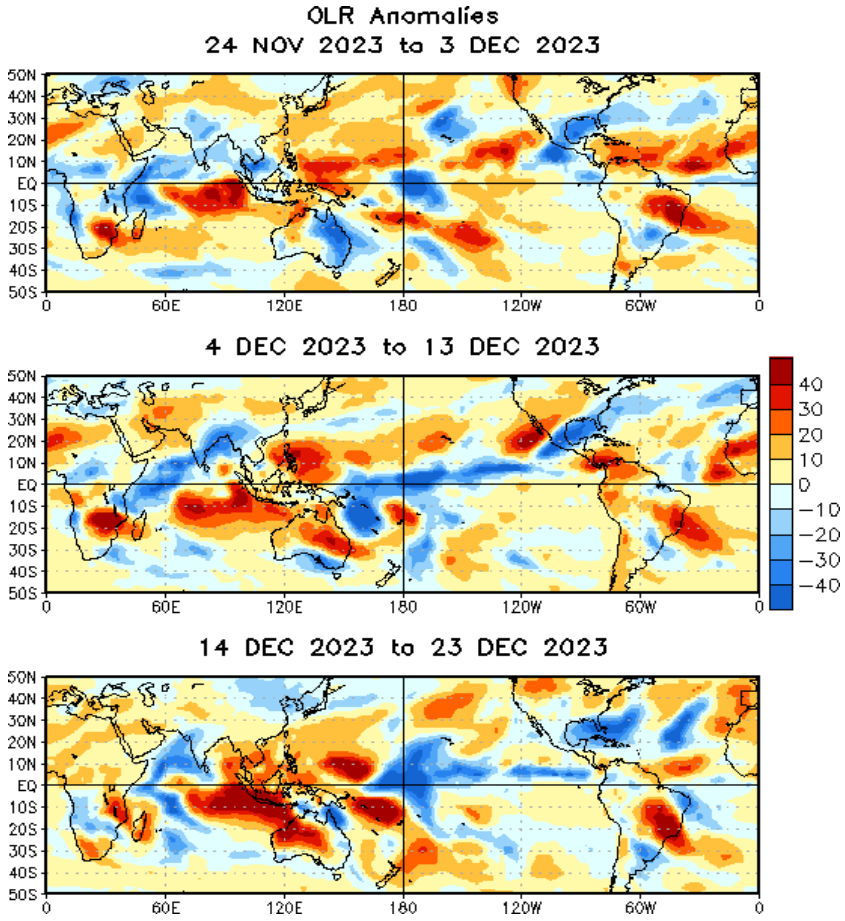




- Anomalous easterlies remain broadly in place across the Indian Ocean, consistent with ongoing +IOD conditions. The signal has been a bit more incoherent recently due to MJO interference.
- Westerly anomalies across much of the Pacific basin are consistent with the El Niño atmospheric response.
- A strong westerly wind burst (WWB) is ongoing across the central Pacific due to recent MJO activity that constructively interfered with the El Niño base state.

# Outgoing Longwave Radiation (OLR) Anomalies

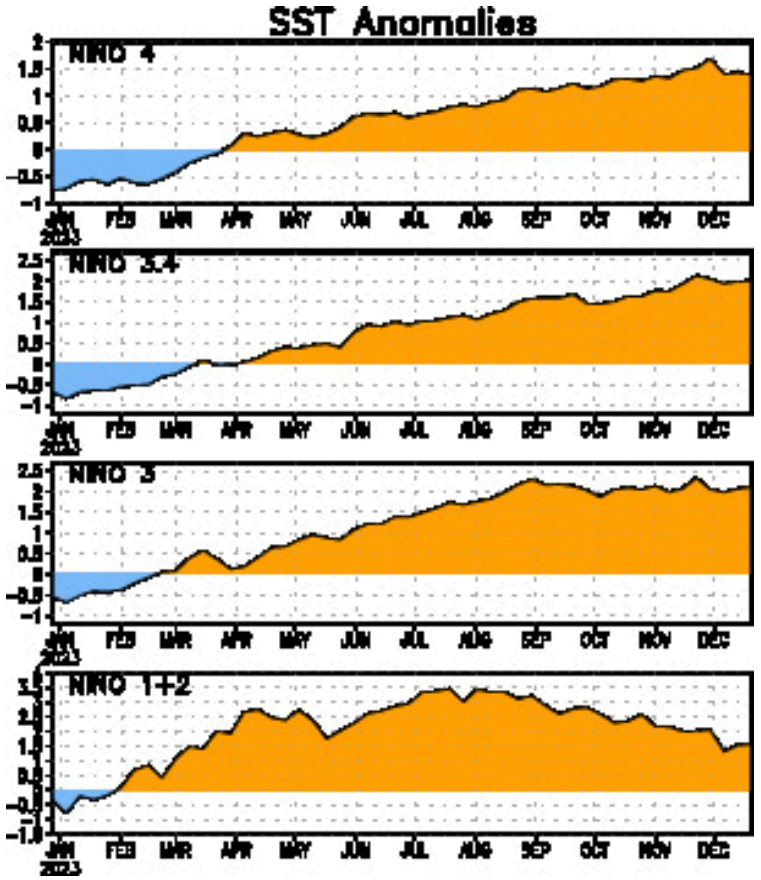
**Green shades: Anomalous convection (wetness)**
**Brown shades: Anomalous subsidence (dryness)**

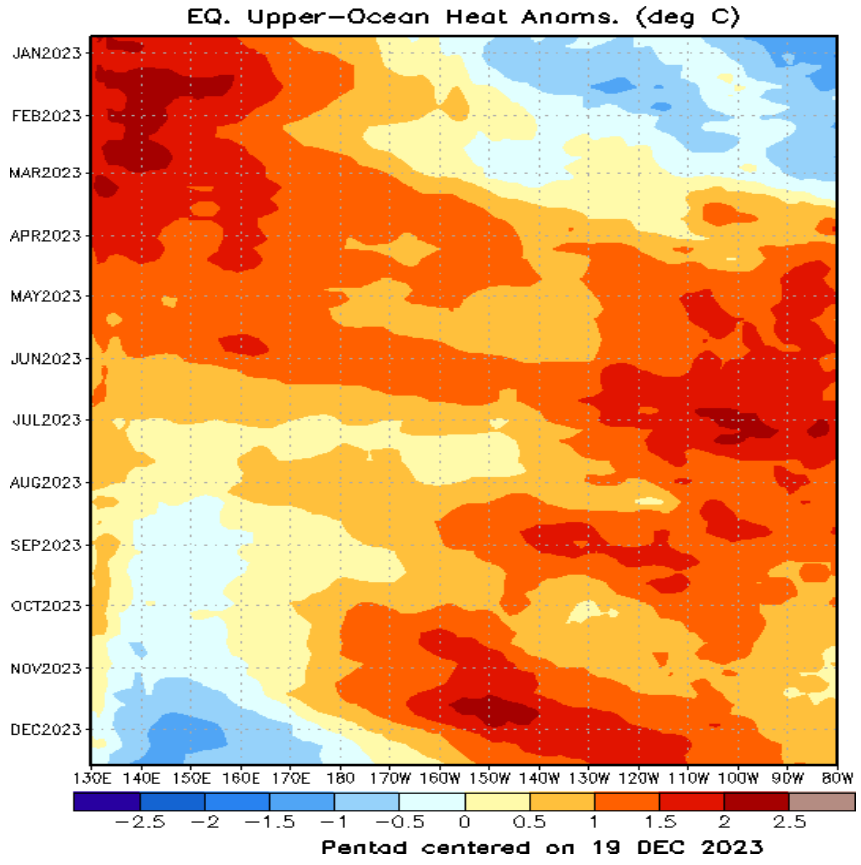



- A "Kona" low event brought a brief period of intense precipitation to Hawaii at the end of November and early December.
- El Niño and +IOD remain the primary drivers of global tropical convective anomalies, with enhanced (suppressed) convection across the central and eastern Pacific (Maritime Continent and eastern Indian Ocean).
- Some eastward propagation of the convective anomalies is apparent, but not on a global scale, suggesting interference from other modes.

# SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

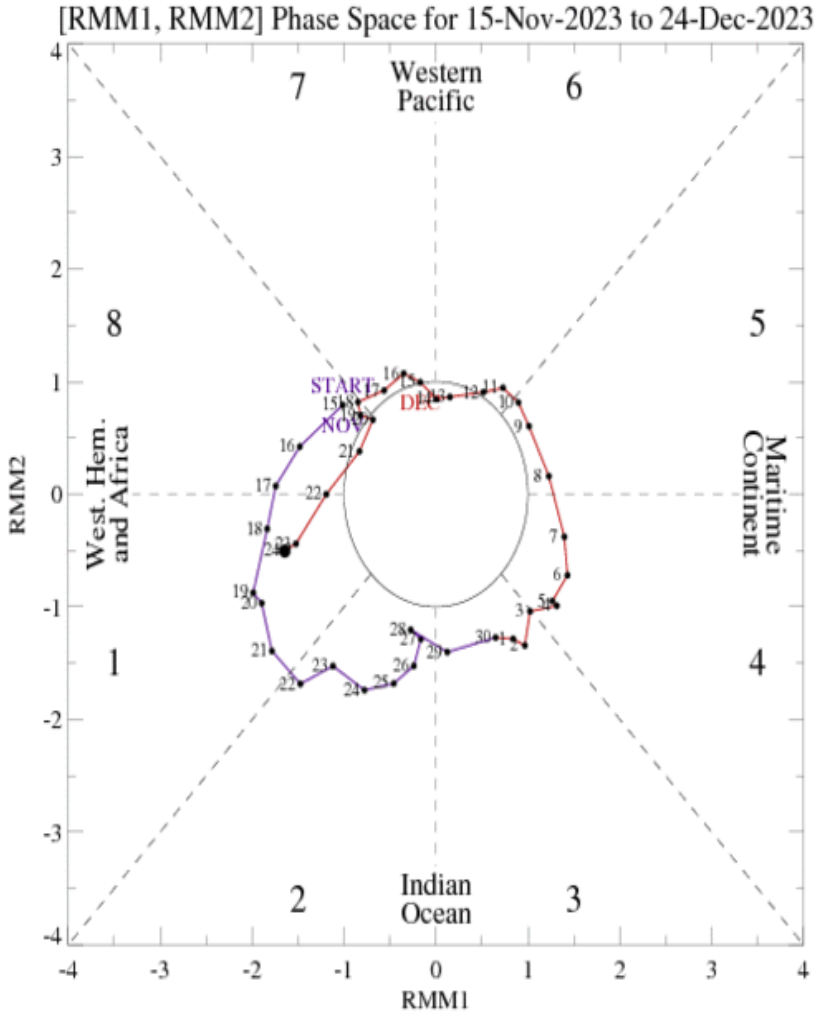



- Low-level westerly wind burst activity across the Pacific during November have resulted in rising SSTs across the Central Pacific, with the NINO 3.4 region now indicating SST anomalies greater than +2.0°C.
- Negative upper-oceanic heat anomalies expanded eastward to the Date Line associated with the upwelling phase of the oceanic Kelvin wave. SSTs across the West Pacific remain above-average, however.

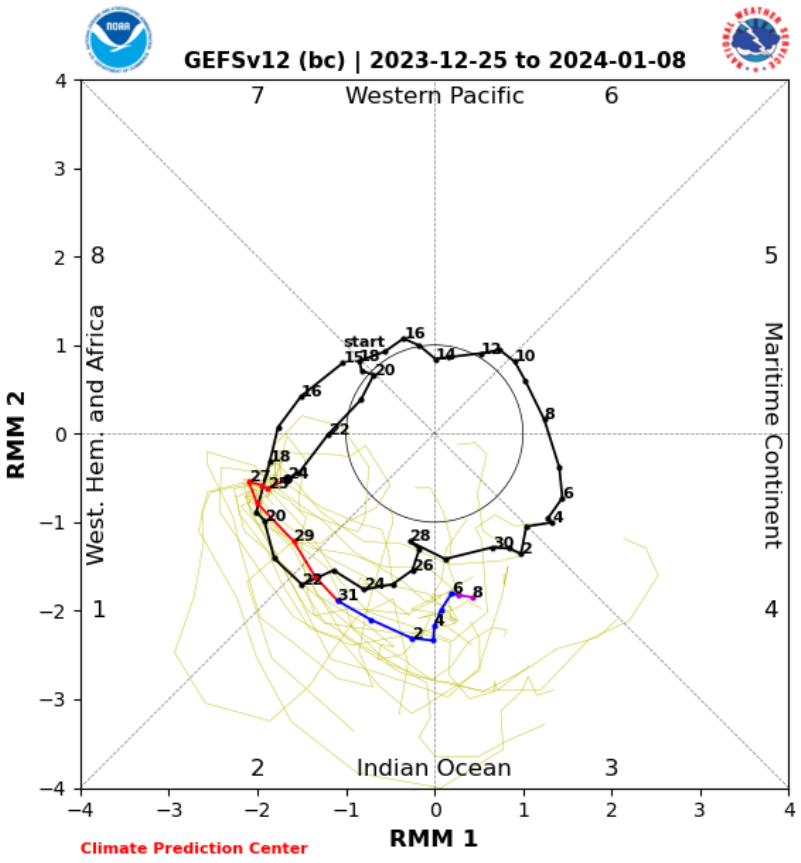
# MJO Index: Recent Evolution

- The MJO signal propagated rapidly across the Western Hemisphere over the past week.
- The index slowed over the past day or so, possibly due to destructive interference between the intraseasonal signal and ENSO.

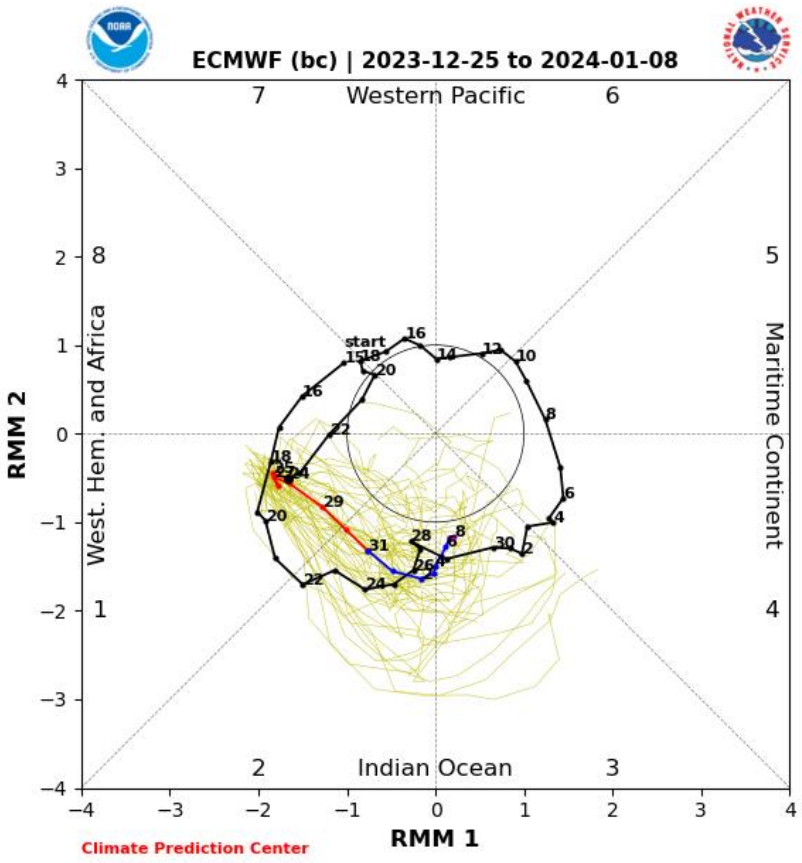



For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

# MJO Index: Forecast Evolution




GEFS Forecast

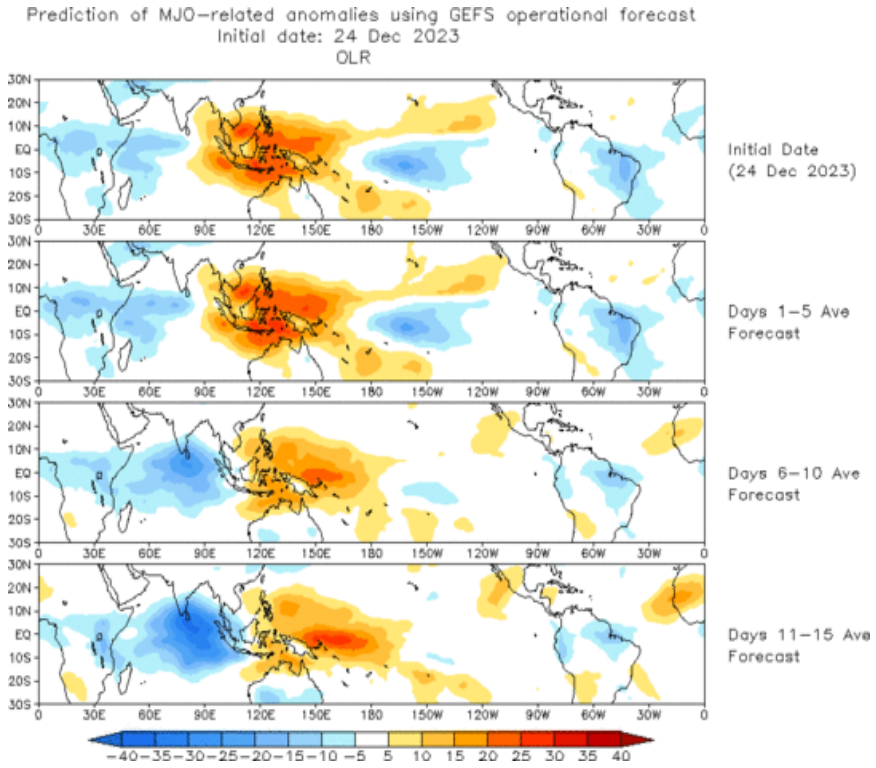


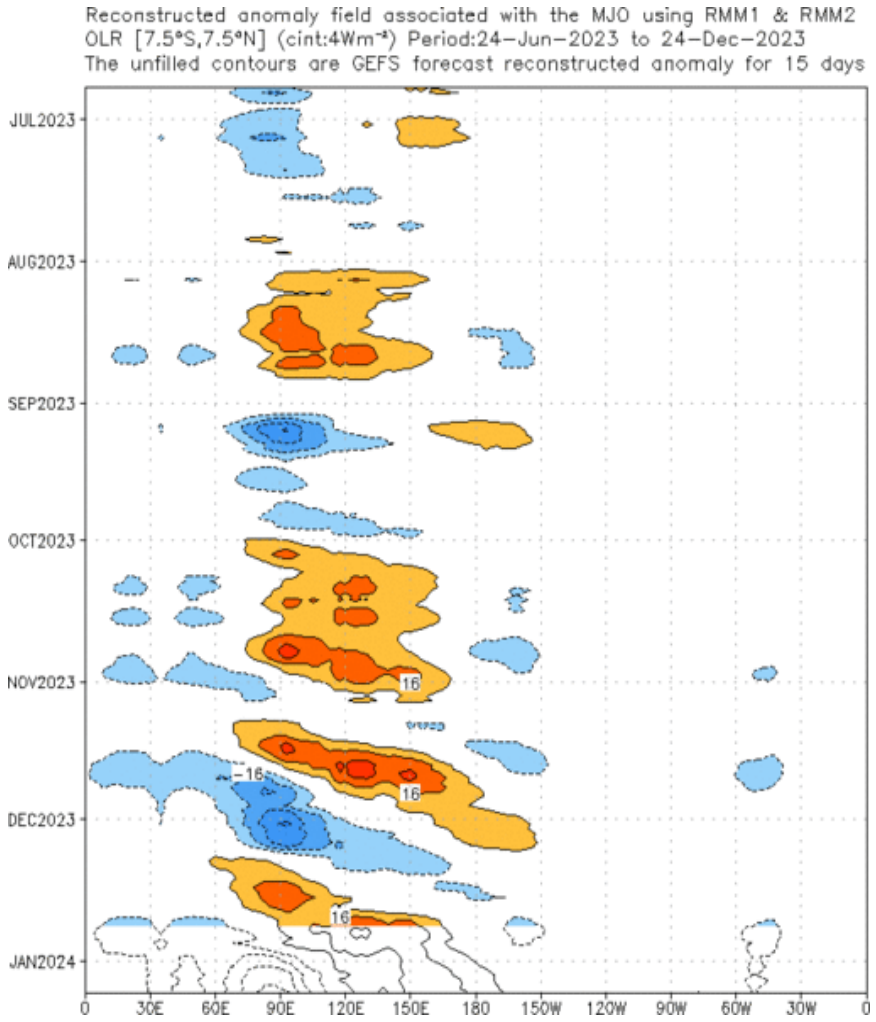

ECMWF Forecast

- Dynamical model forecasts from the GEFS and ECMWF are remarkably consistent, with both models favoring a continued robust MJO signal.
- During Week-1, the MJO is favored to continue propagating across the Western Hemisphere and Africa, entering the Indian Ocean basin during Week-2.
- Longer range dynamical model forecasts are generally supportive of continued MJO activity crossing the Maritime Continent during 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.)

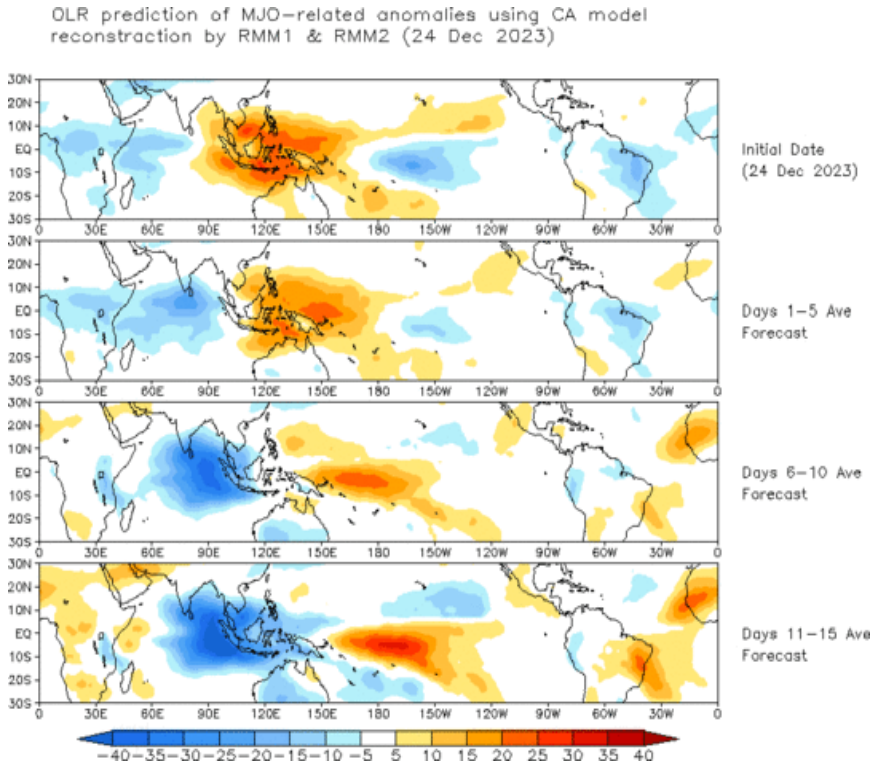


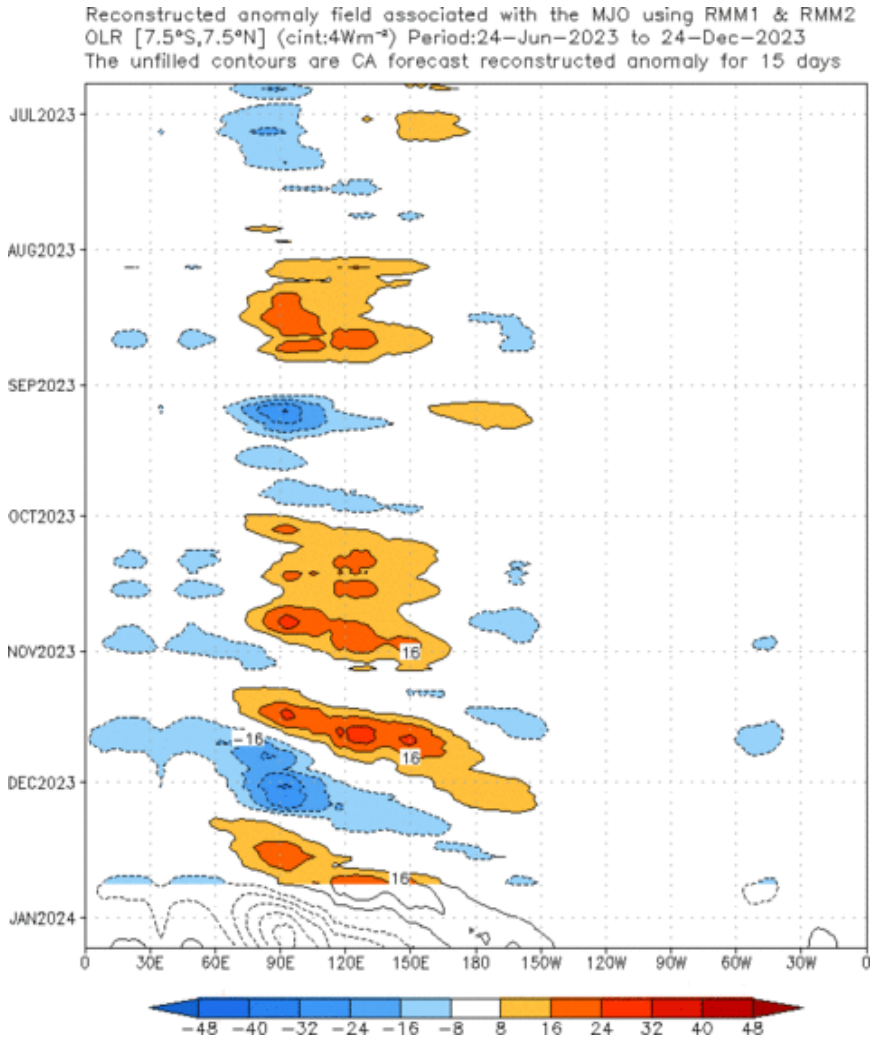




- The GEFS RMM-based OLR forecast depicts a robust MJO-related Wave-1 pattern that propagates across the Indian Ocean over the next two weeks. The amplitude of the signal increases during the forecast period.

# 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.)

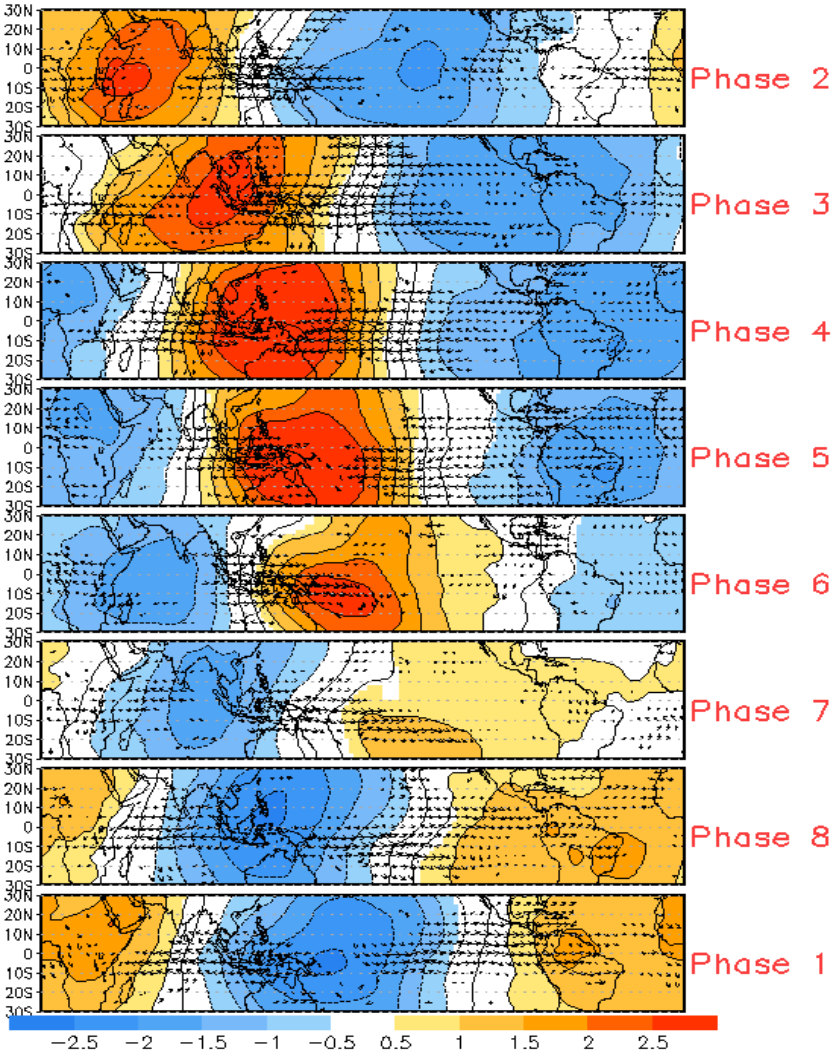


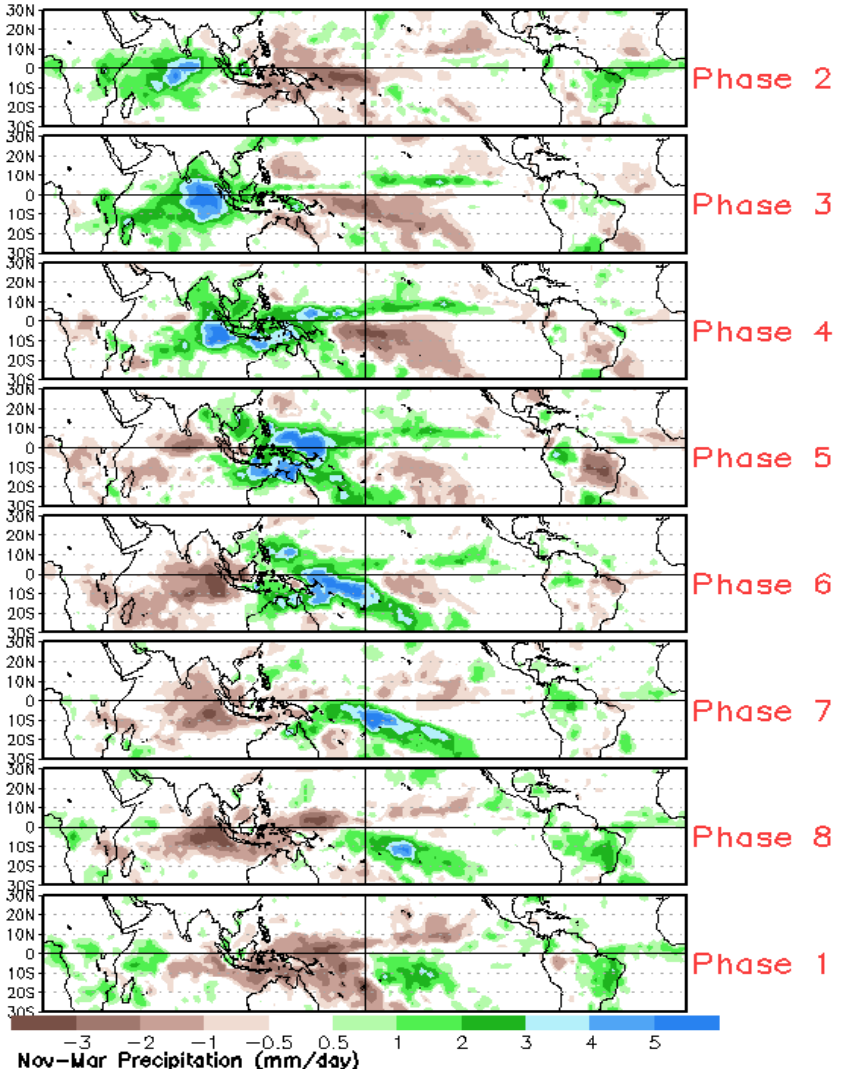

- The constructed analog (CA) RMM-based forecast is remarkably amplified, with a faster propagation phase speed than the GEFS. The CA forecast shows the enhanced convective phase reaching the Maritime Continent by the end of Week-2.

# MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



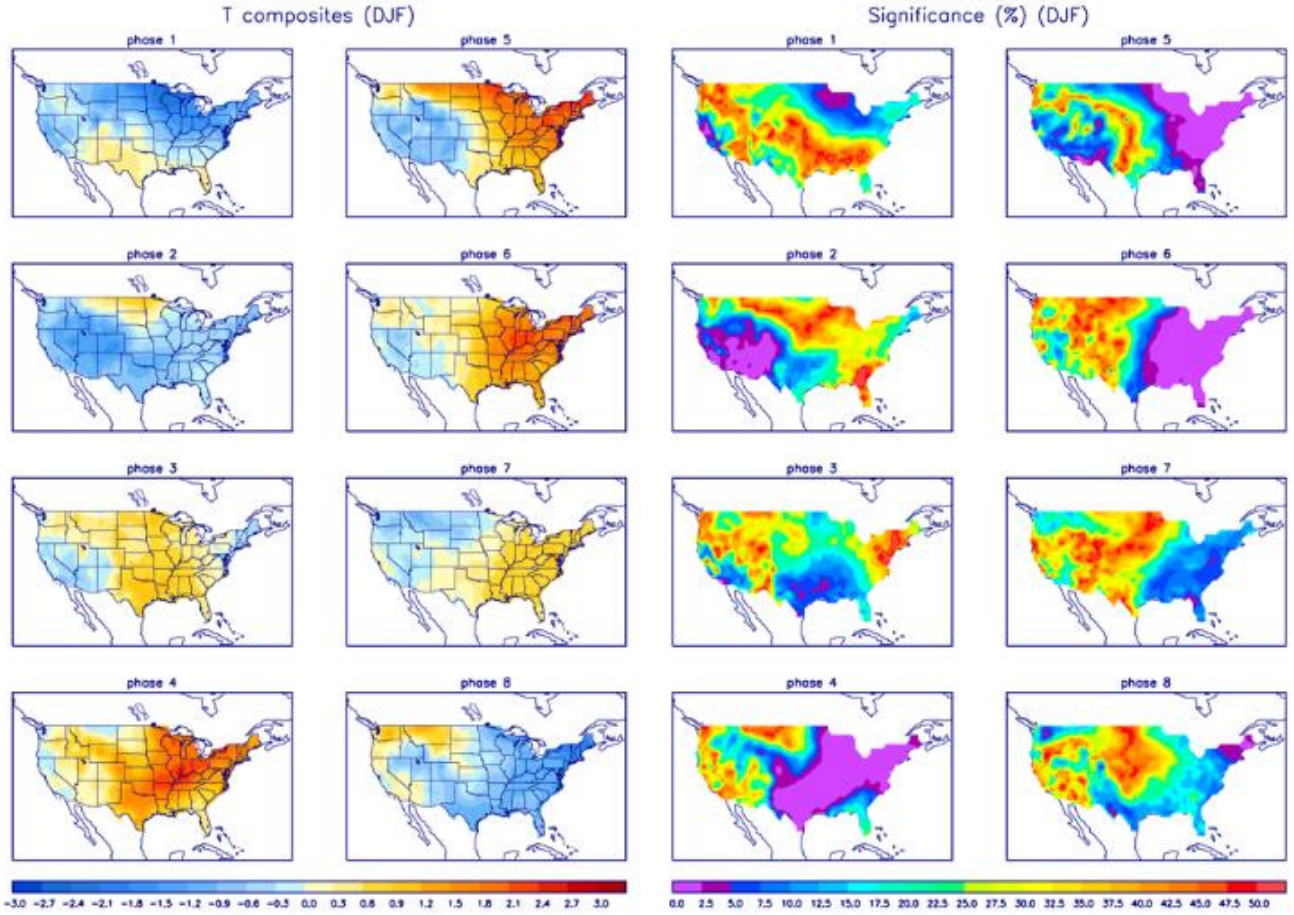

Precipitation Anomalies



# 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.

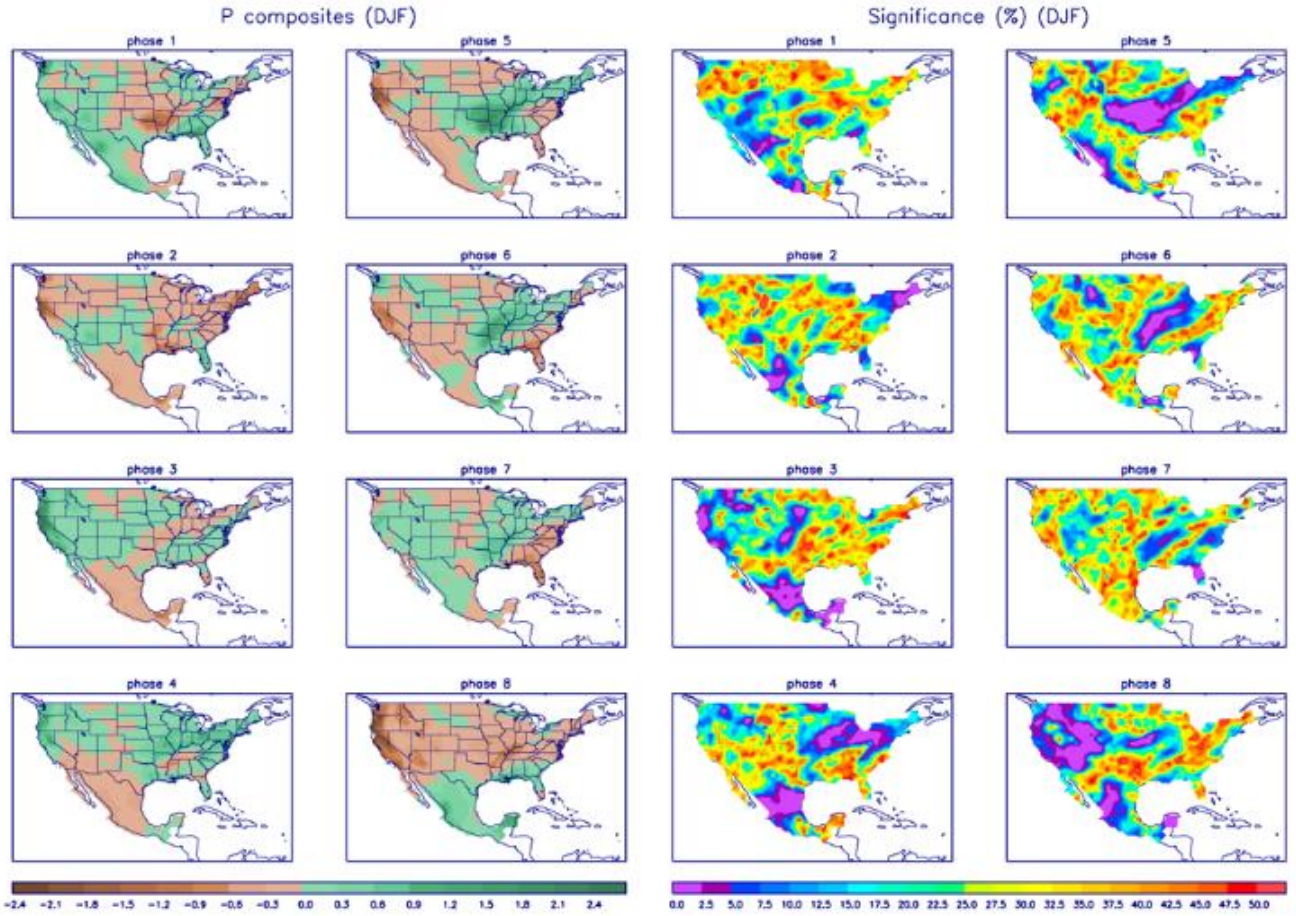



More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

# 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.




More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml