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

**Update prepared by the Climate Prediction Center**
**NWS / NCEP / CPC**
**11 September 2023**

# Overview

- The ongoing El Niño and its atmospheric response are the dominant drivers of the global tropical convective anomaly pattern.

- The intraseasonal signal remains somewhat active, with the enhanced convective phase currently crossing the Maritime Continent, where it is destructively interfering with the ENSO base state.

- Interference from Rossby waves, Kelvin waves, and the ENSO base state have resulted in a weakened presentation of the MJO signal.

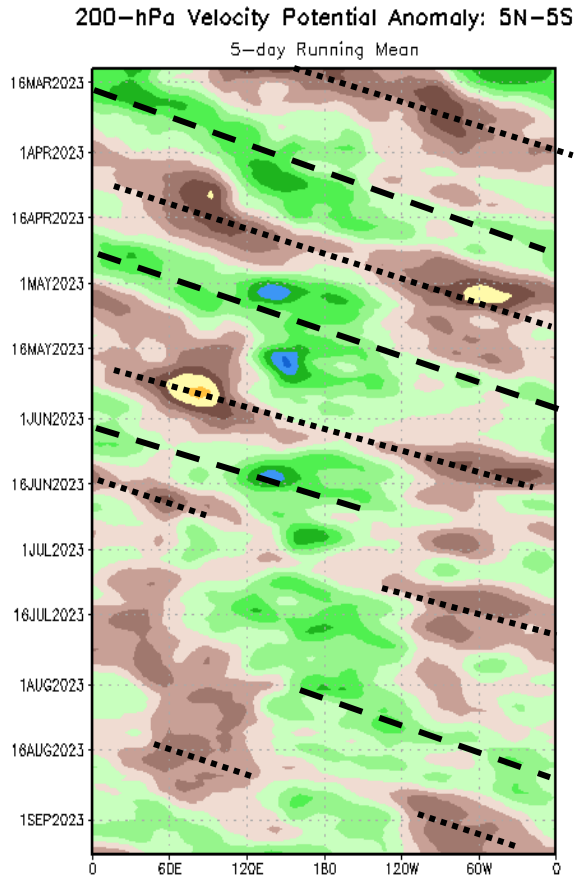
- Dynamical model MJO index forecasts depict continued interference and a weak MJO footprint over the next two weeks. There is some model support, particularly from the ECMWF, for an increase in MJO activity by Week-3, with the enhanced phase crossing the Pacific.

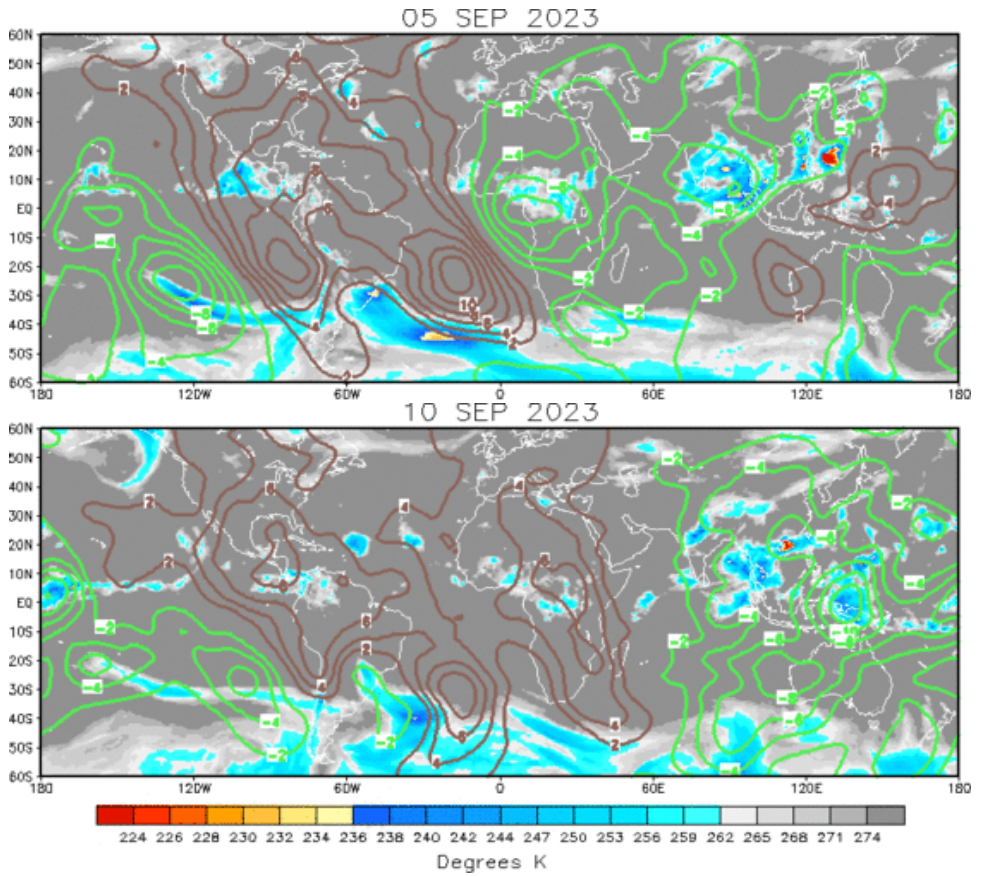
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

# 200-hPa Velocity Potential Anomalies

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

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



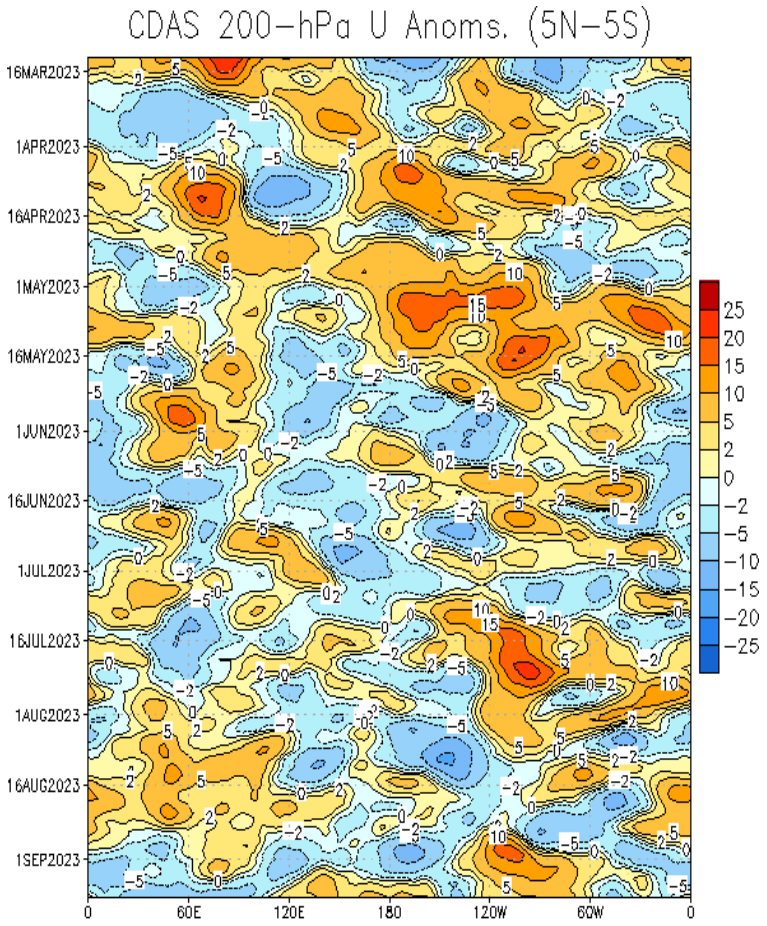



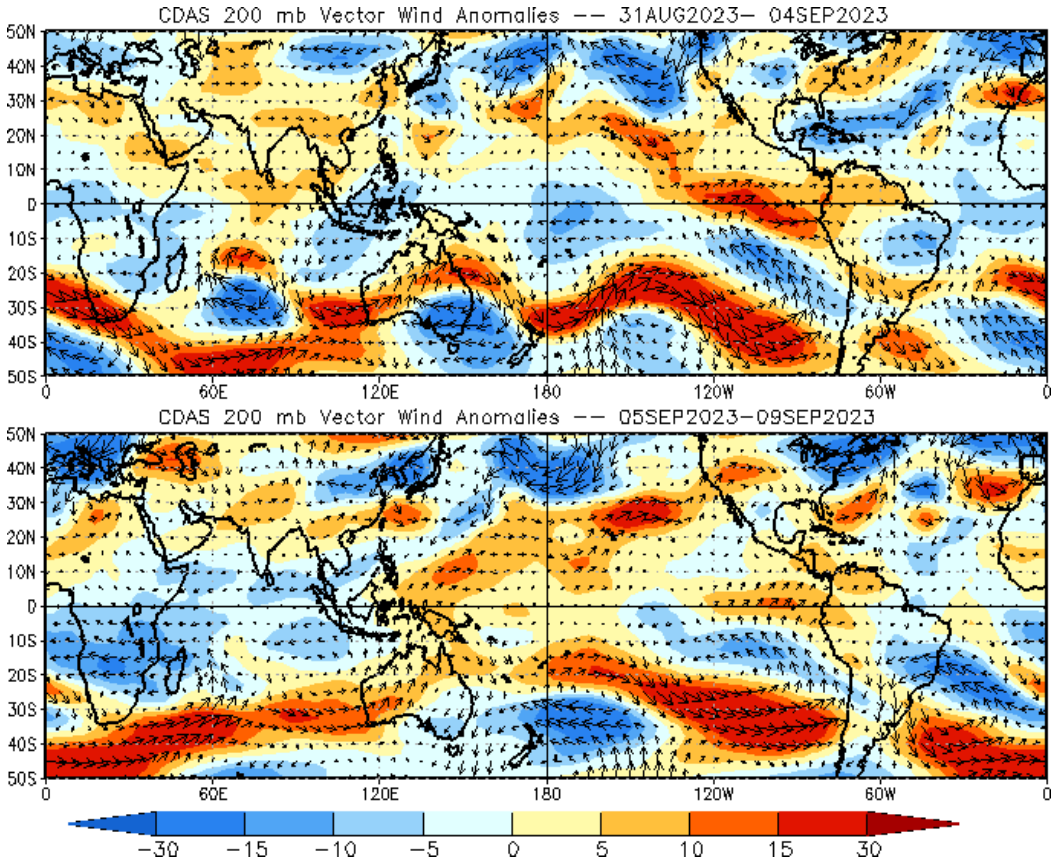

- Since mid-July, El Niño was the primary driver of broad-scale global tropical convective anomalies, with a quasi-stationary pattern of increased divergence (convergence) aloft over the Pacific (eastern Indian Ocean). The atmospheric response to El Niño was further west than typical, due in part to continued abnormal warmth over the West Pacific Warm Pool.

- The MJO was increasingly active during August, destructively interfering with the ENSO base state in late August and early September.

# 200-hPa Wind Anomalies

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

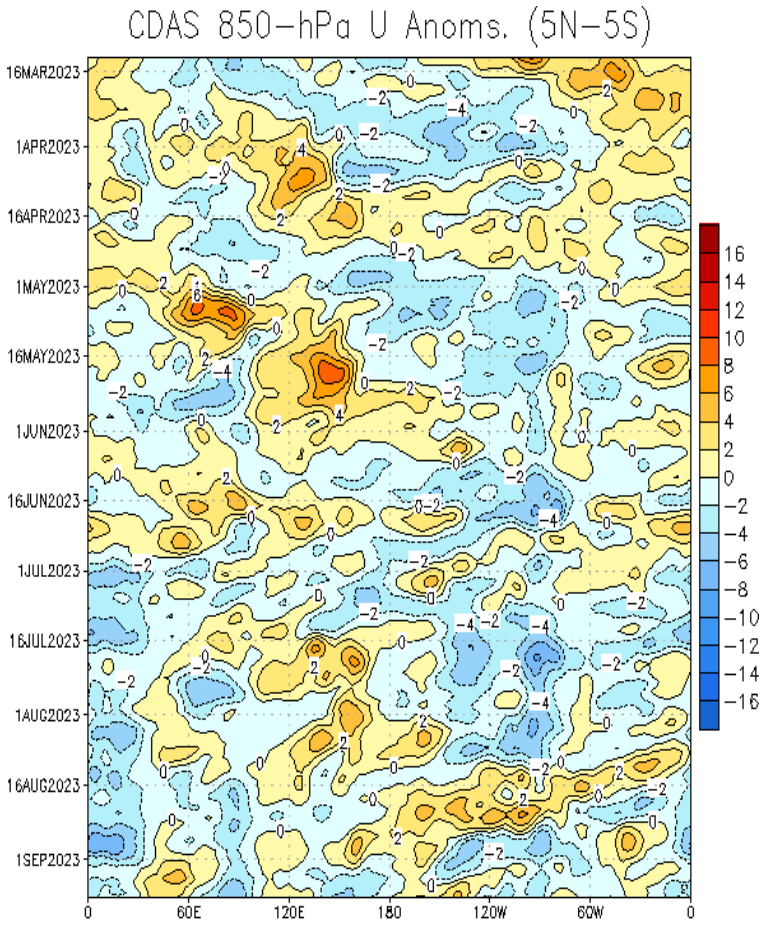


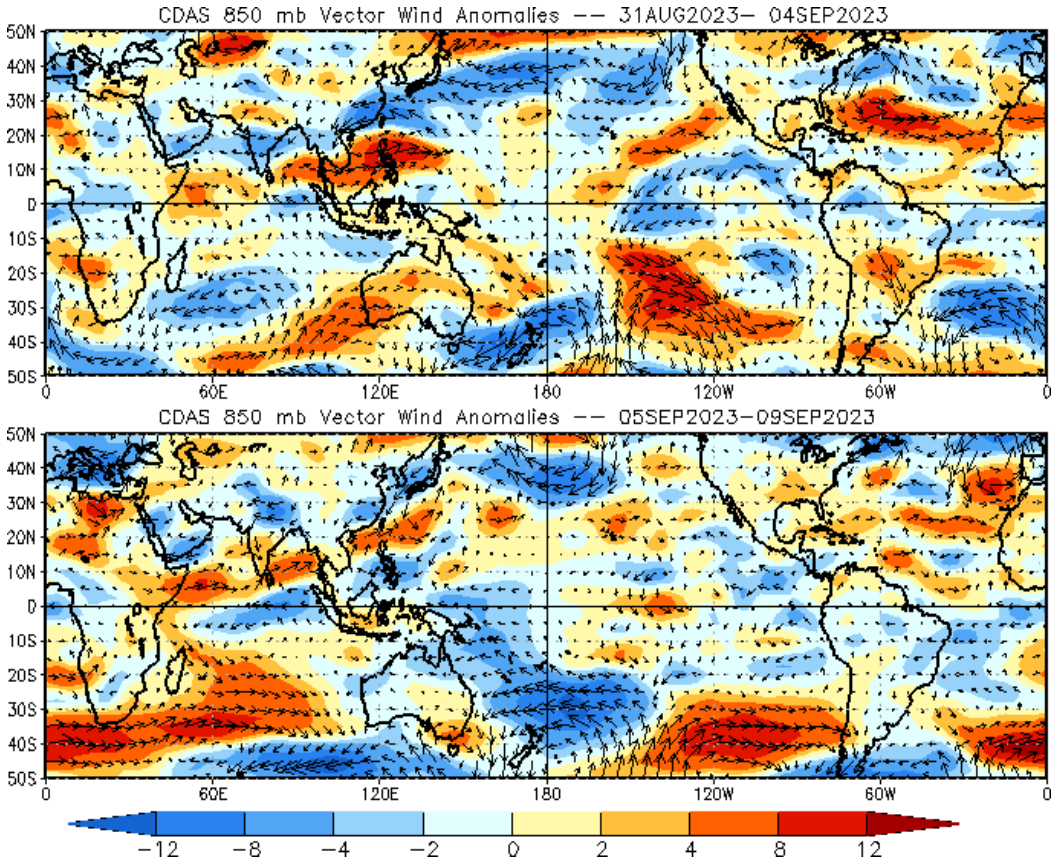




- A rapid moving transient pattern appears to be in place, with upper-level westerlies overspreading the Pacific.
- The Southern Hemisphere jet stream remains active, injecting Rossby wave energy into the tropics periodically, such as what is occurring over the Eastern Pacific and northeast Australia.

# 850-hPa Wind Anomalies

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



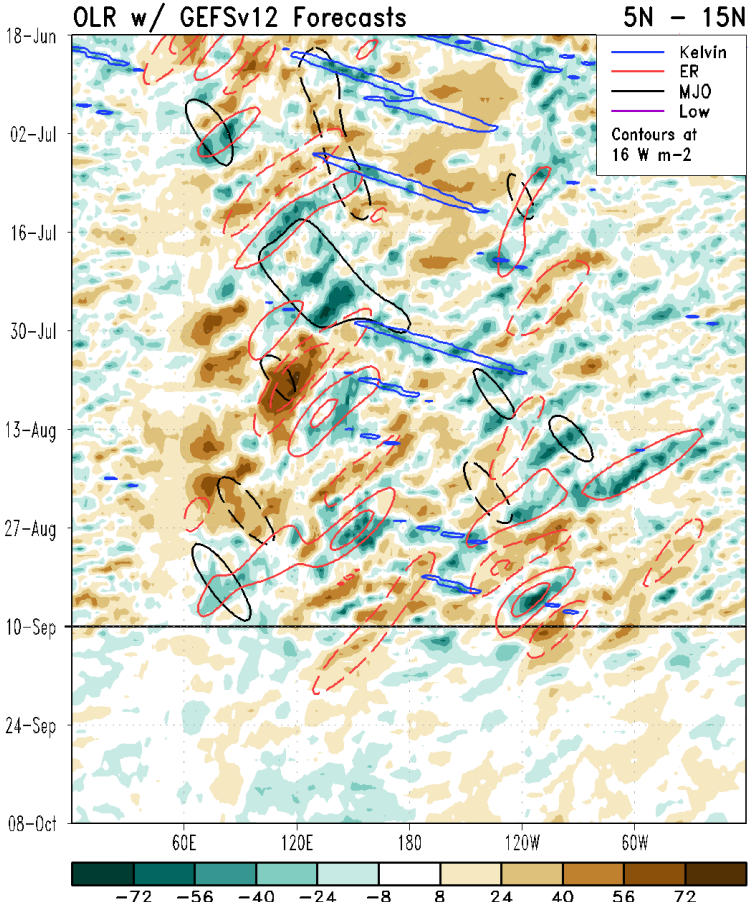



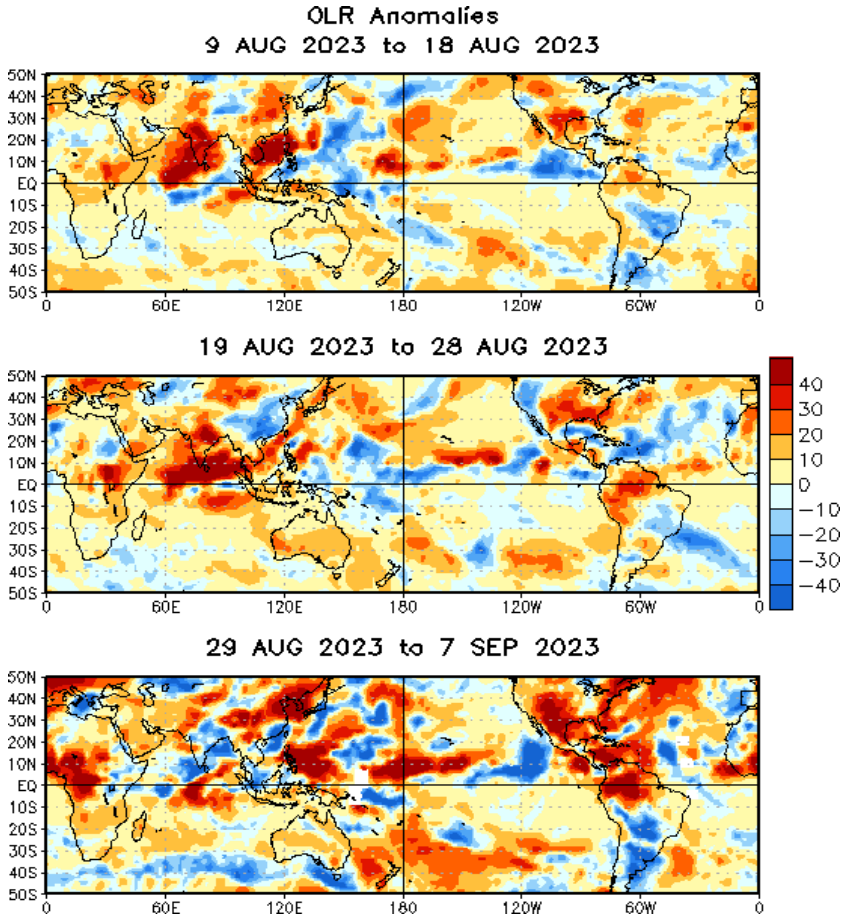

- The low-level wind field is broadly chaotic, though some eastward propagation of westerly anomalies is evident, most recently reaching the Indian Ocean.

- Easterly anomalies over the West Pacific may be due in part to destructive interference between ENSO and the remnant intraseasonal signal.

# Outgoing Longwave Radiation (OLR) Anomalies

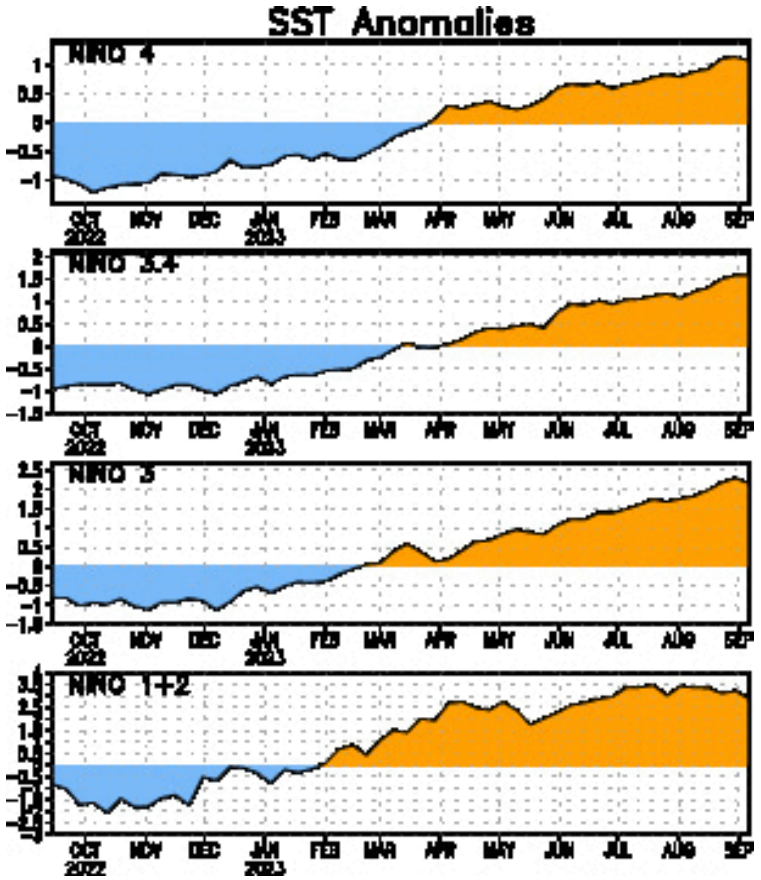
**Green shades: Anomalous convection (wetness)**
**Brown shades: Anomalous subsidence (dryness)**

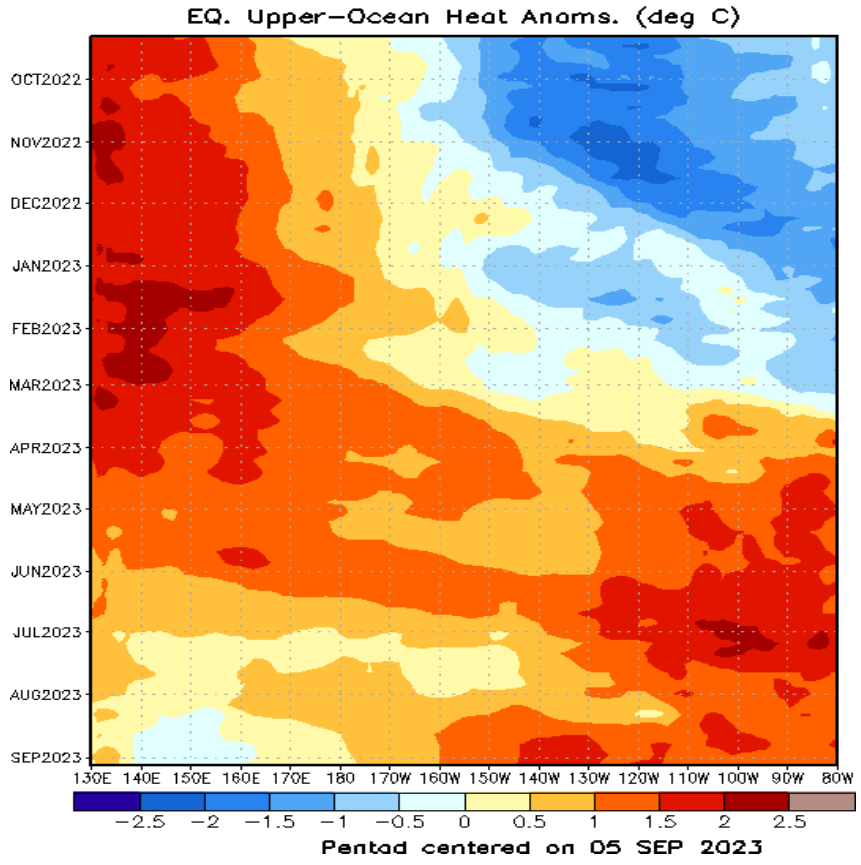



- A slightly more active monsoon pattern set up over South Asia in early September.
- Widespread suppressed convection over the Americas is consistent both with recent intraseasonal activity and El Niño.
- Suppressed convection near the Date Line was not consistent with the El Niño response, and may reflect destructive interference with the remnant MJO activity.

# SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

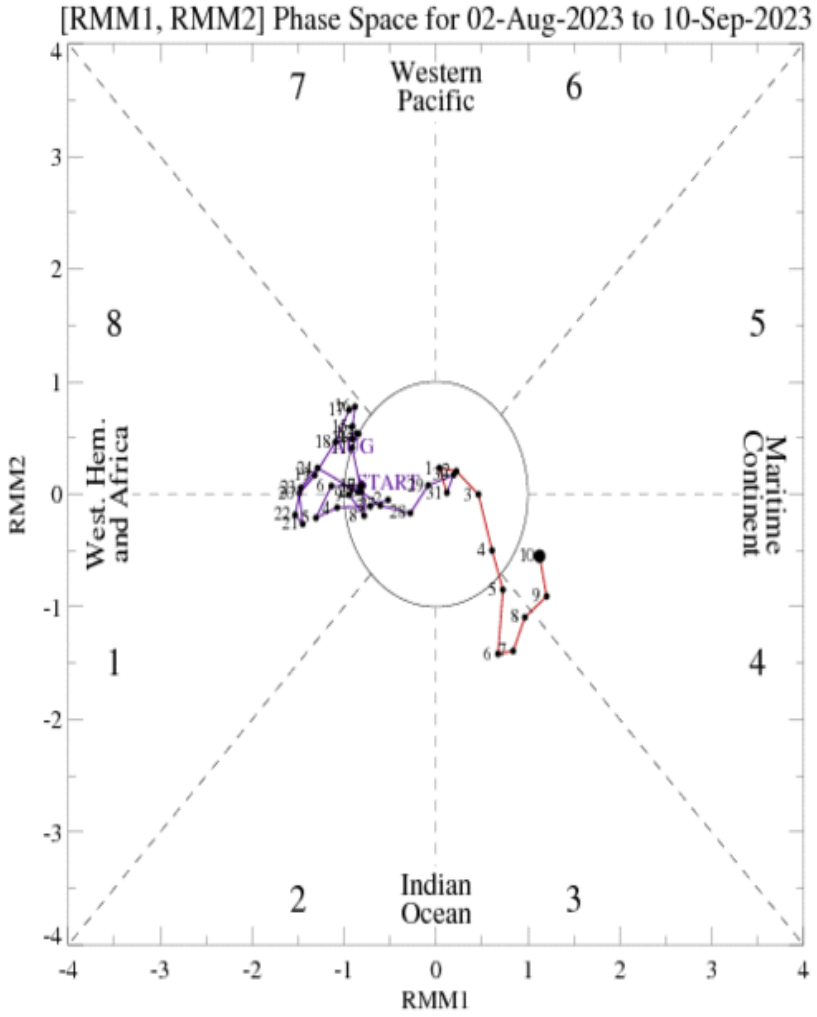



- El Niño conditions are present across the equatorial Pacific as SST anomalies remain strongly positive in all of the Niño basins.
- Following some attenuation during July, a downwelling oceanic Kelvin wave brought warmer subsurface ocean water eastward across the central Pacific. Negative heat content anomalies are now appearing in the West Pacific Warm Pool.

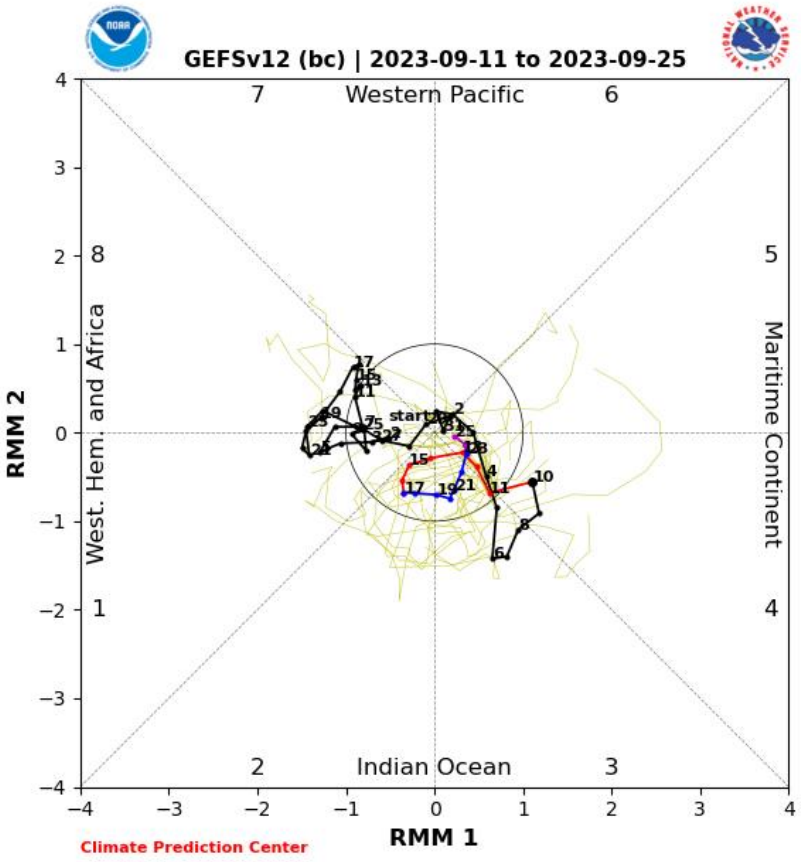
# MJO Index: Recent Evolution

- Following a period of weak presentation on the RMM index, increased amplitude over the Maritime Continent was observed, which is consistent with the other observational fields.
- Some eastward propagation has occurred over the last several days.

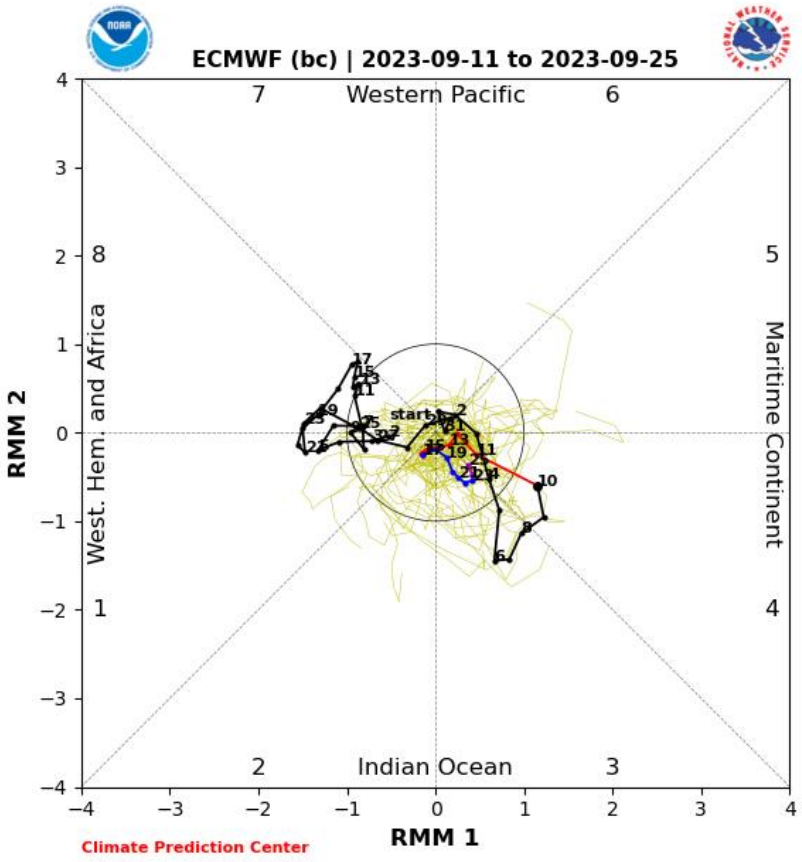



For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

# MJO Index: Forecast Evolution




GEFS Forecast

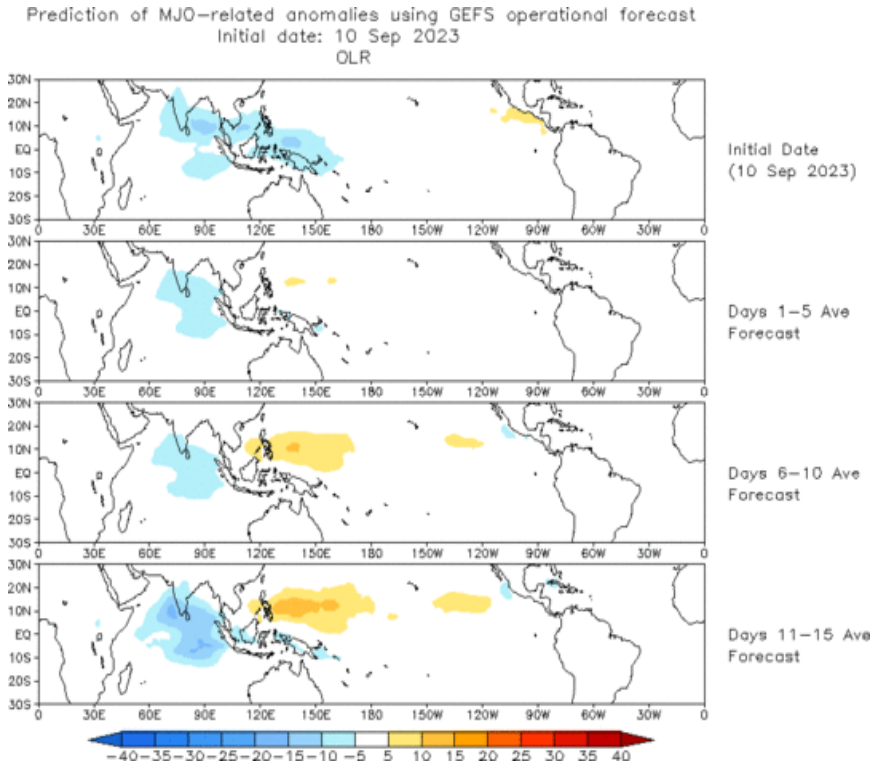


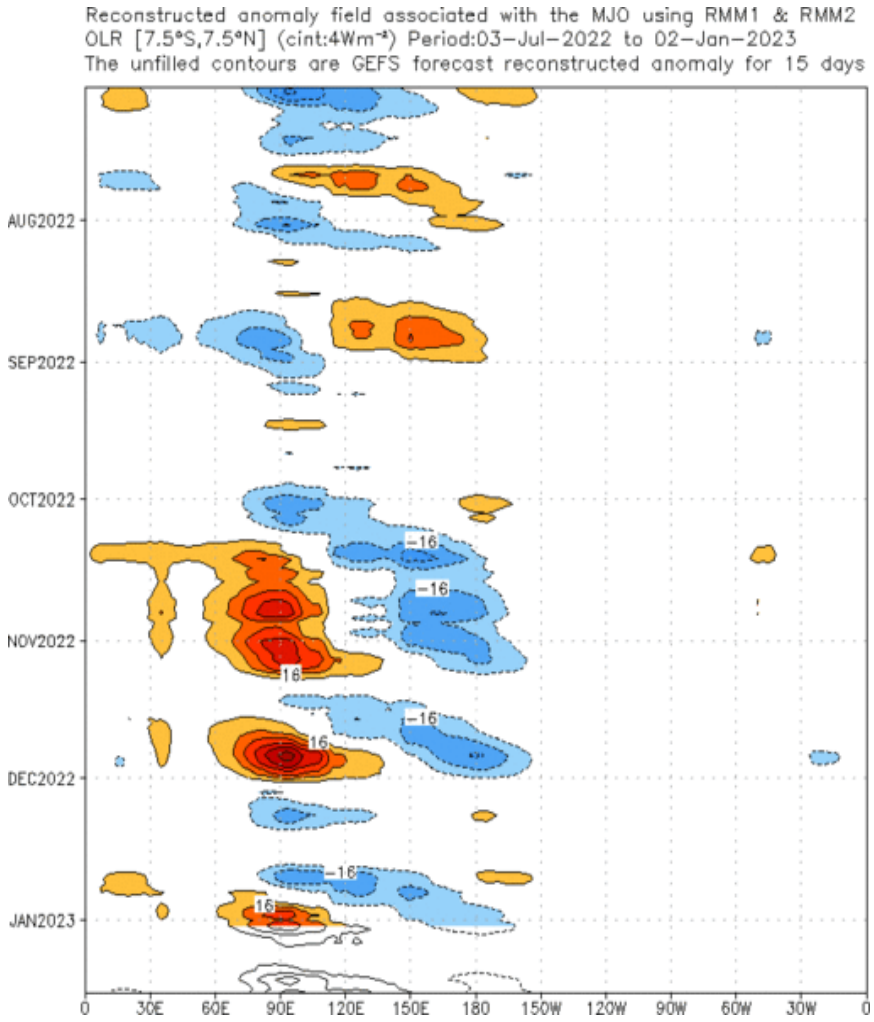

ECMWF Forecast

- Both the GEFS and ECMWF predict a sharp “left turn” of the RMM index back inside the unit circle, which is consistent with Rossby wave interference. Forecasts over the next two weeks show generally weak activity, with greater spread present in longer-range outlooks.

# 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.)

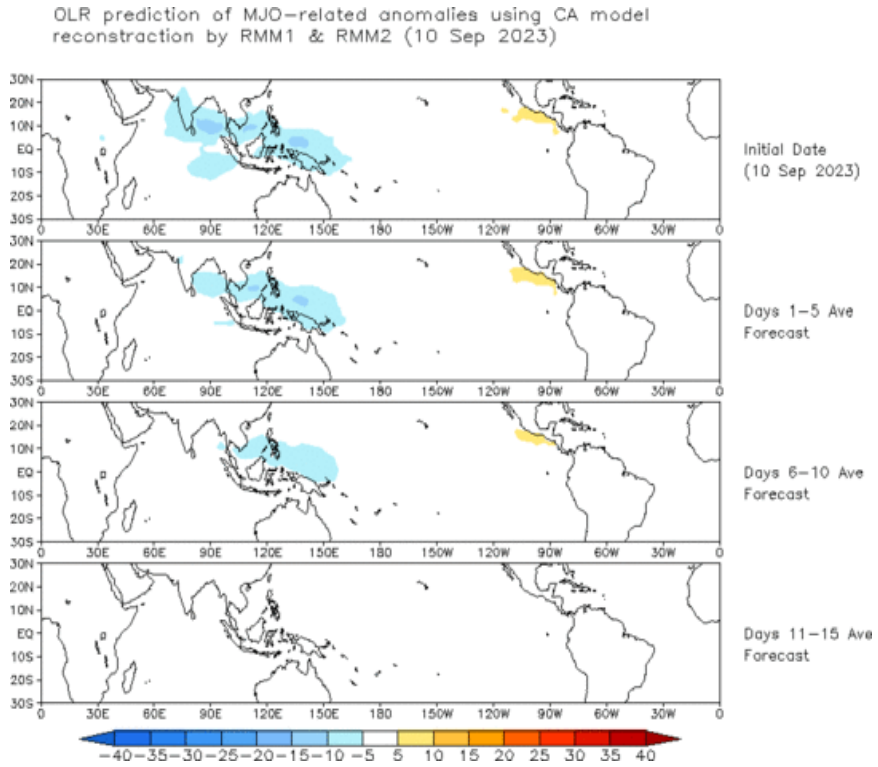


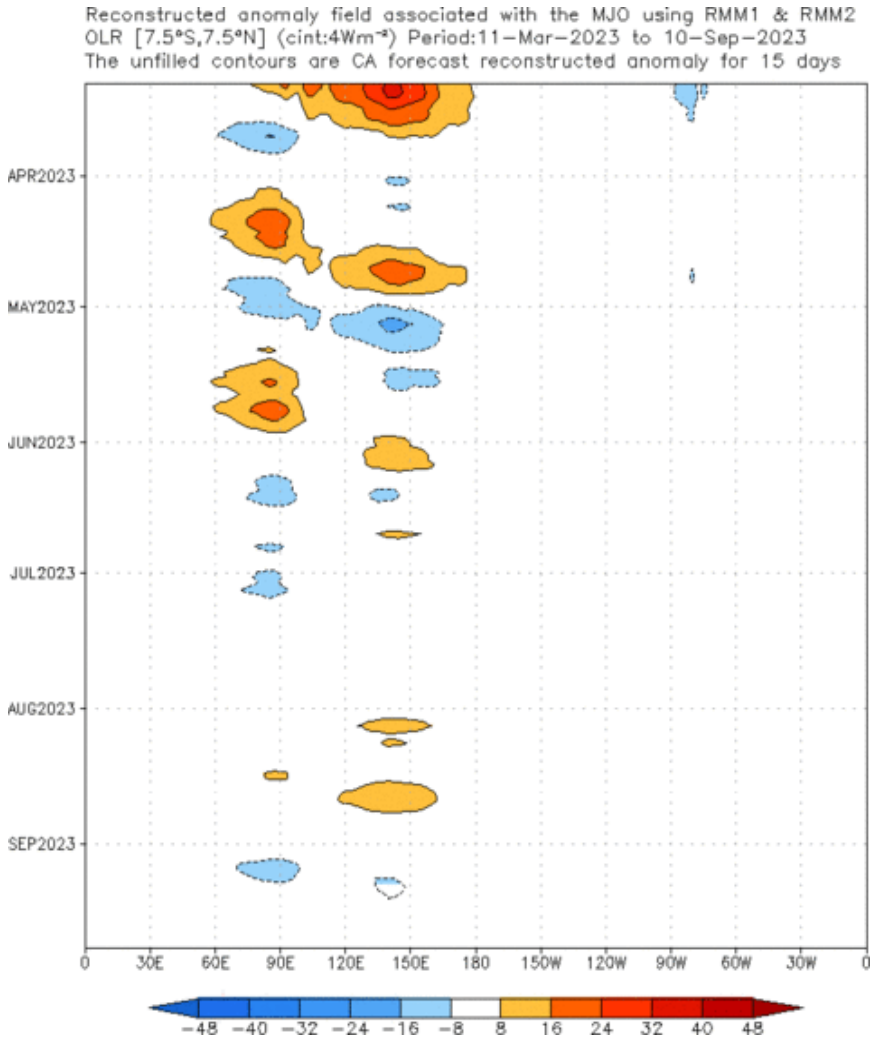




- The GEFS RMM-based OLR forecast depicts a stationary pattern with an enhanced convective envelope over the Indian Ocean.

# 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.)

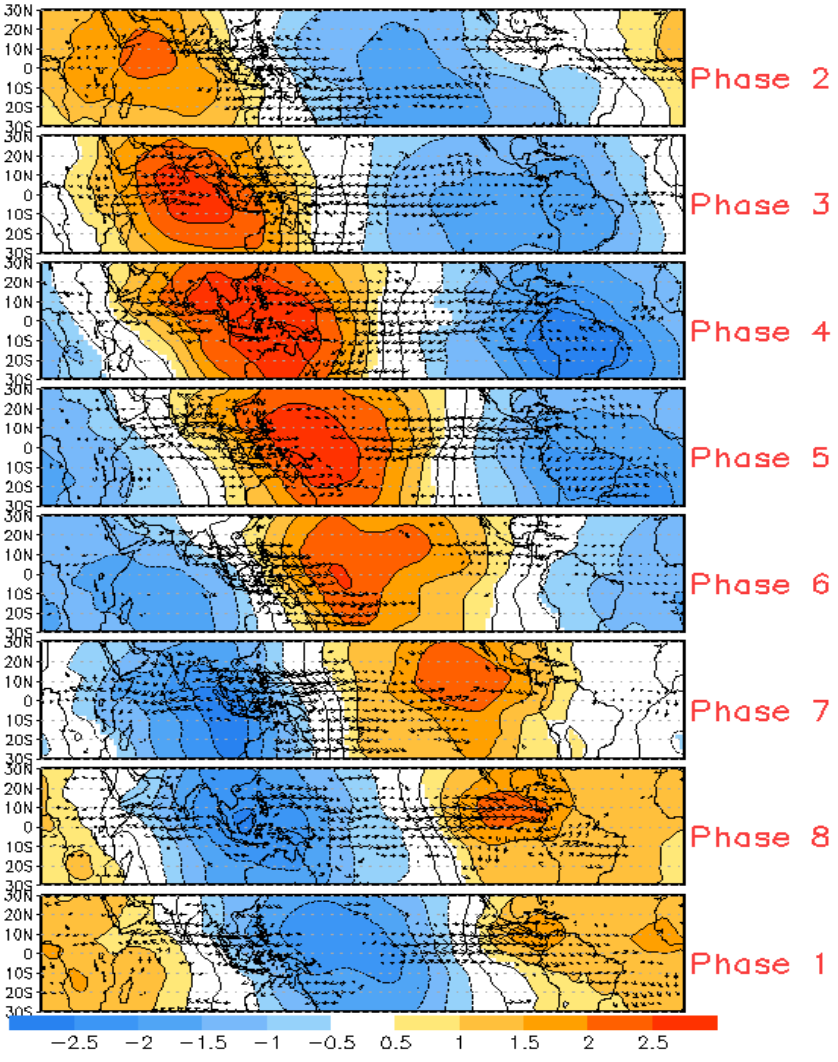


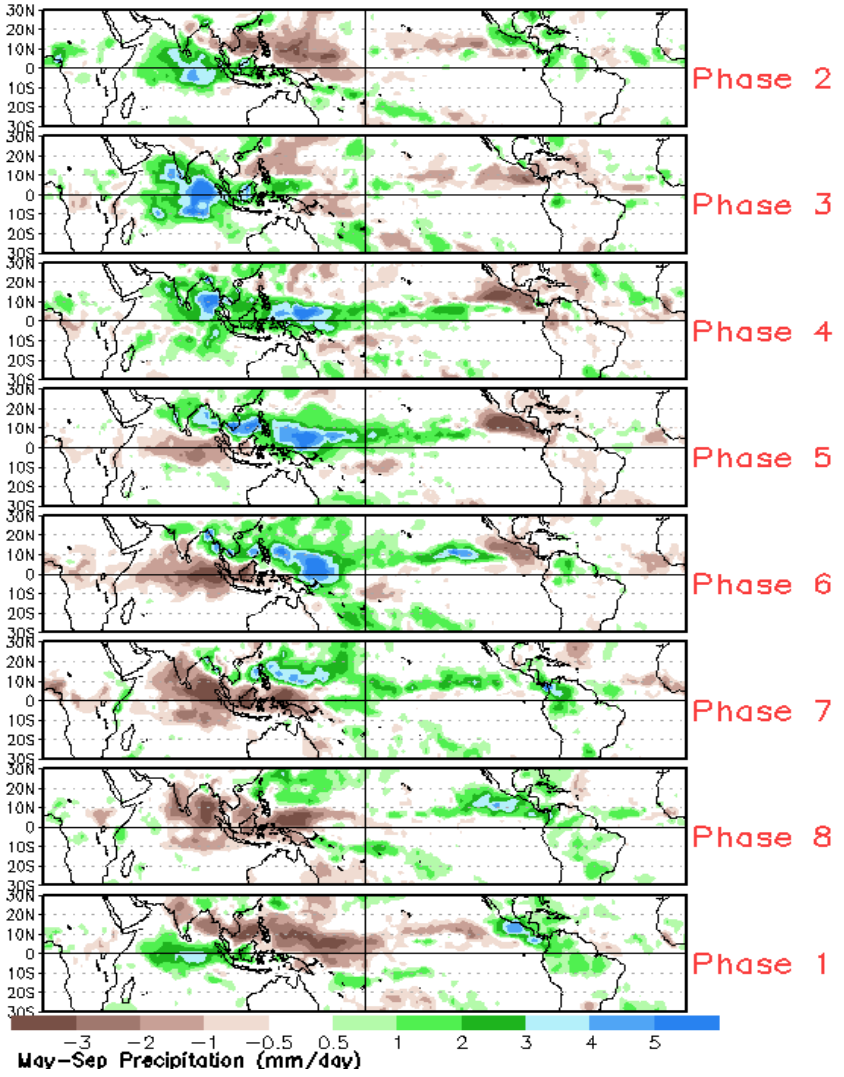

- The constructed analog RMM-based forecast shows weak activity over the next two weeks.

# MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



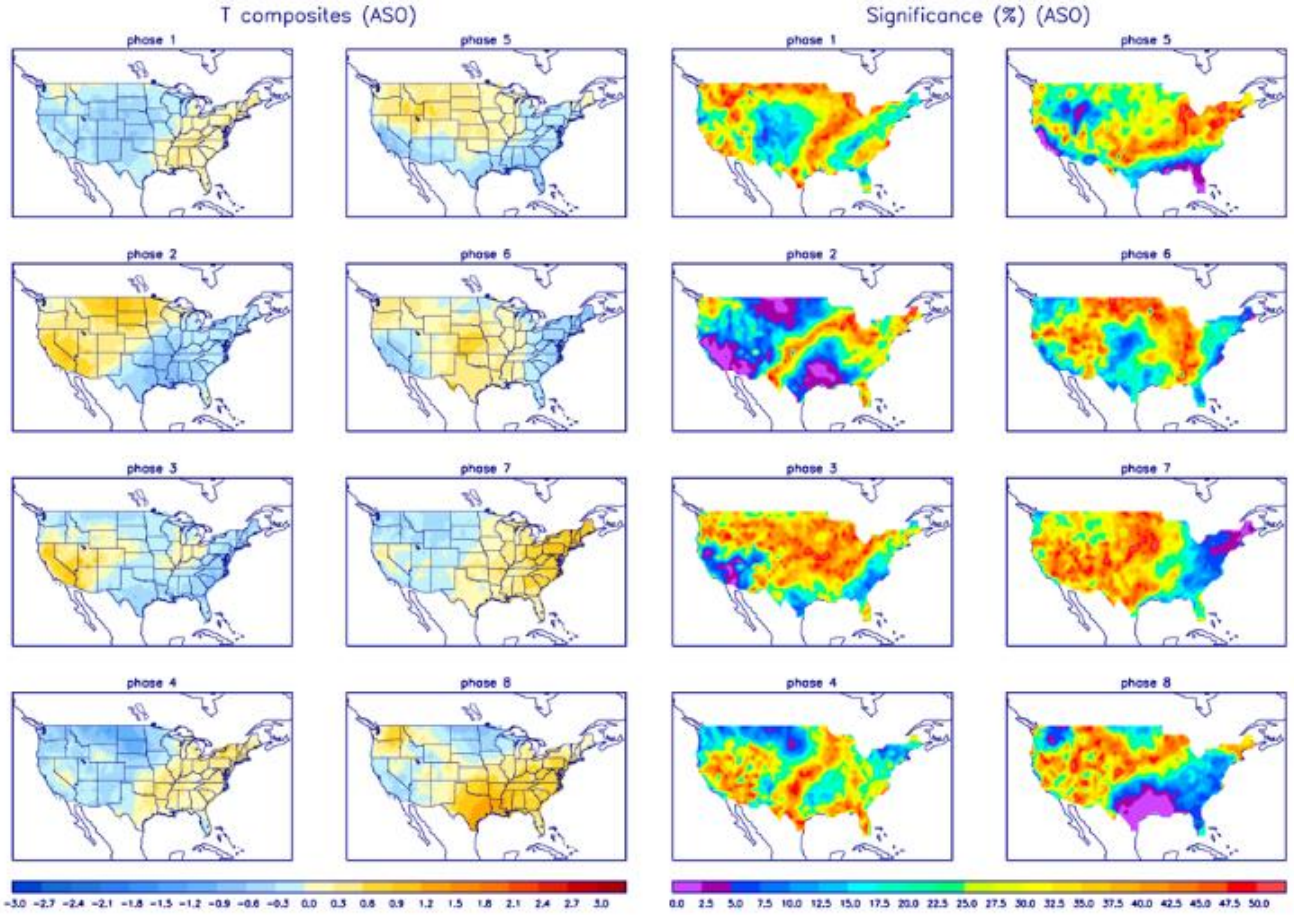

Precipitation Anomalies



# 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.

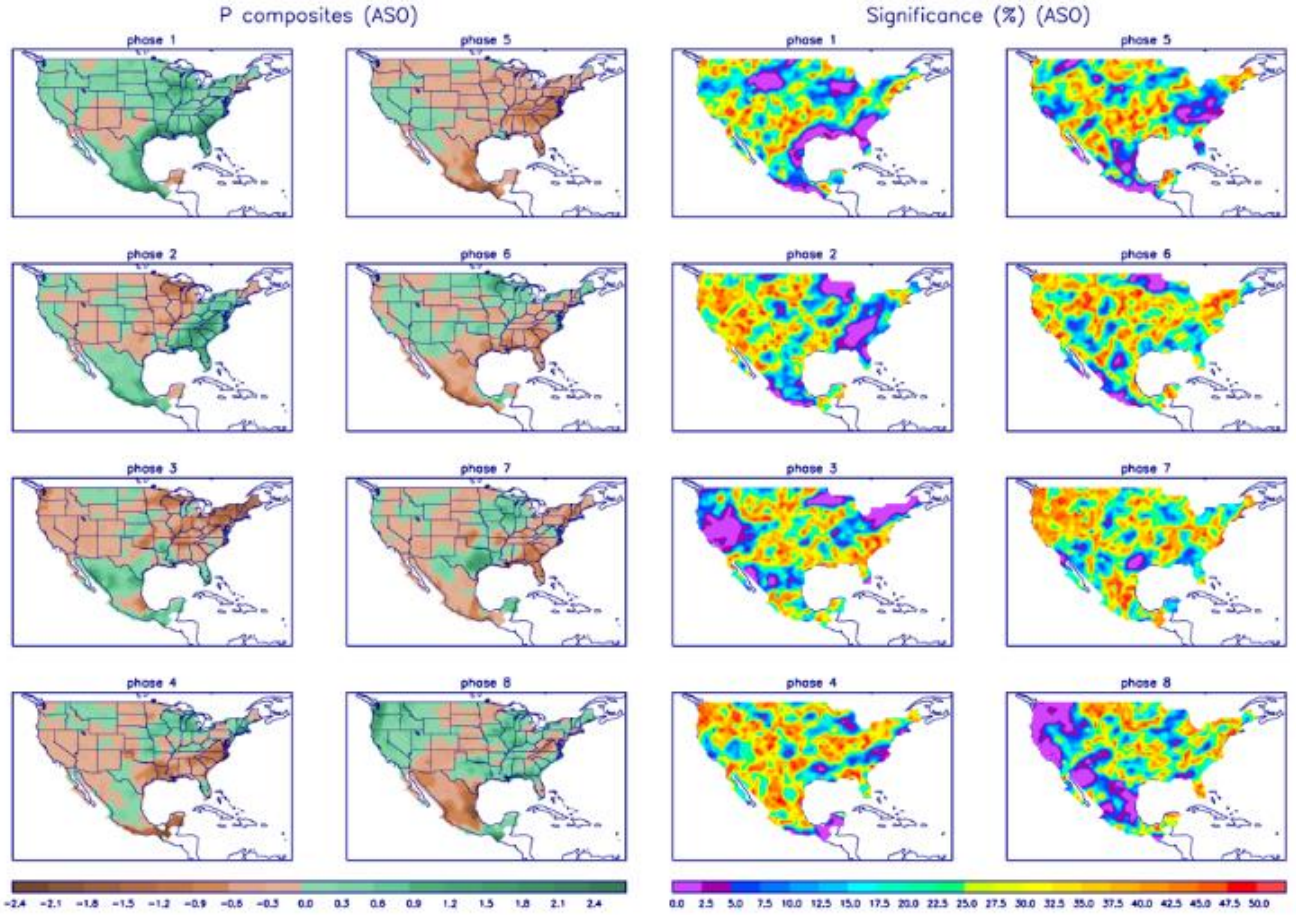



More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

# 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