

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



**Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
7 August 2023**

Overview

- While the RMM index features a reemerging MJO signal, upper-level velocity potential anomaly fields continue to reflect disorganized intraseasonal activity.
- The recent uptick in RMM amplitude may be more in response to tropical cyclone Dora tracking at a relatively low latitude in the central Pacific, and/or a low frequency atmospheric circulation developing in the equatorial Pacific.
- Dynamical model RMM forecasts generally favor weakened MJO activity during the next several weeks. Some extended range solutions point to possible reemergence over the western Pacific later in August, however ensemble spread remains very high and forecast confidence is limited.
- Even in the absence of a coherent, eastward propagating MJO, upper-level velocity potential anomaly forecasts feature a large scale environment conducive for tropical cyclone (TC) development in the eastern Pacific and Atlantic, with lowered chances of formation over the West Pacific during the period.

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

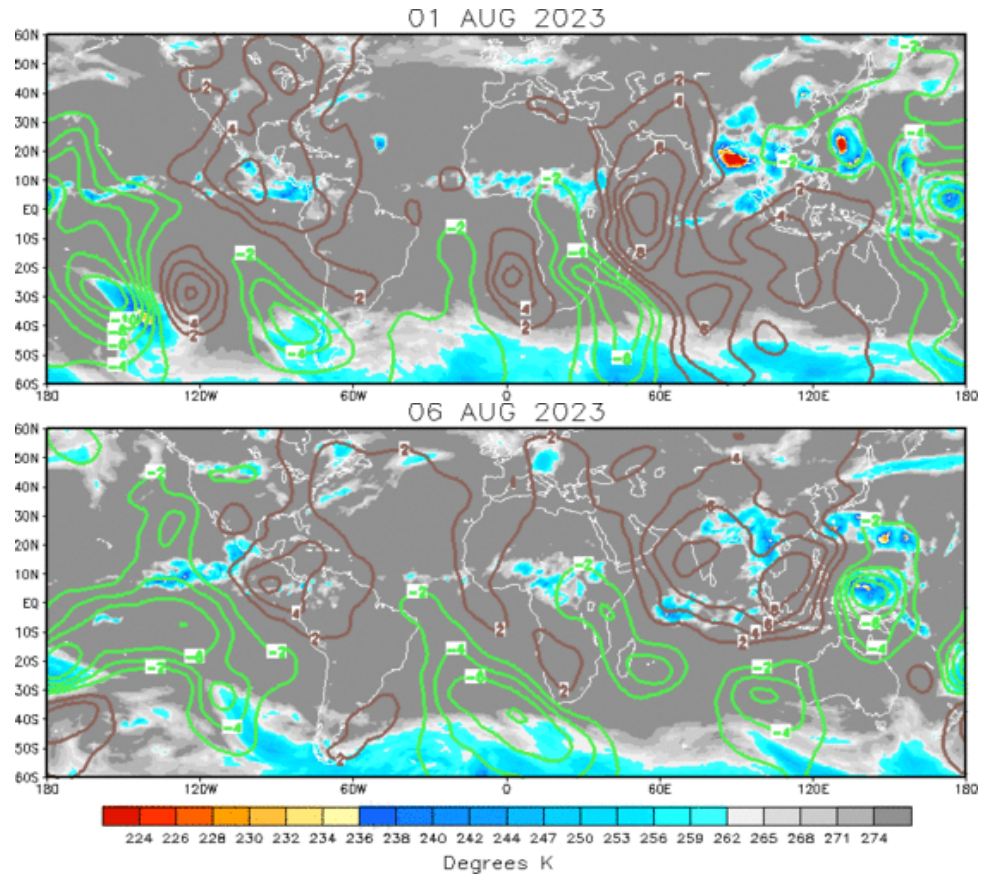
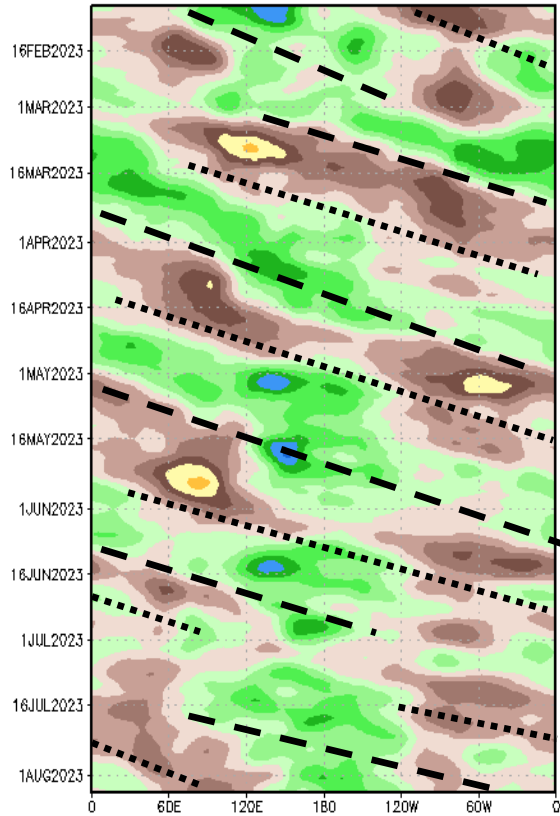
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

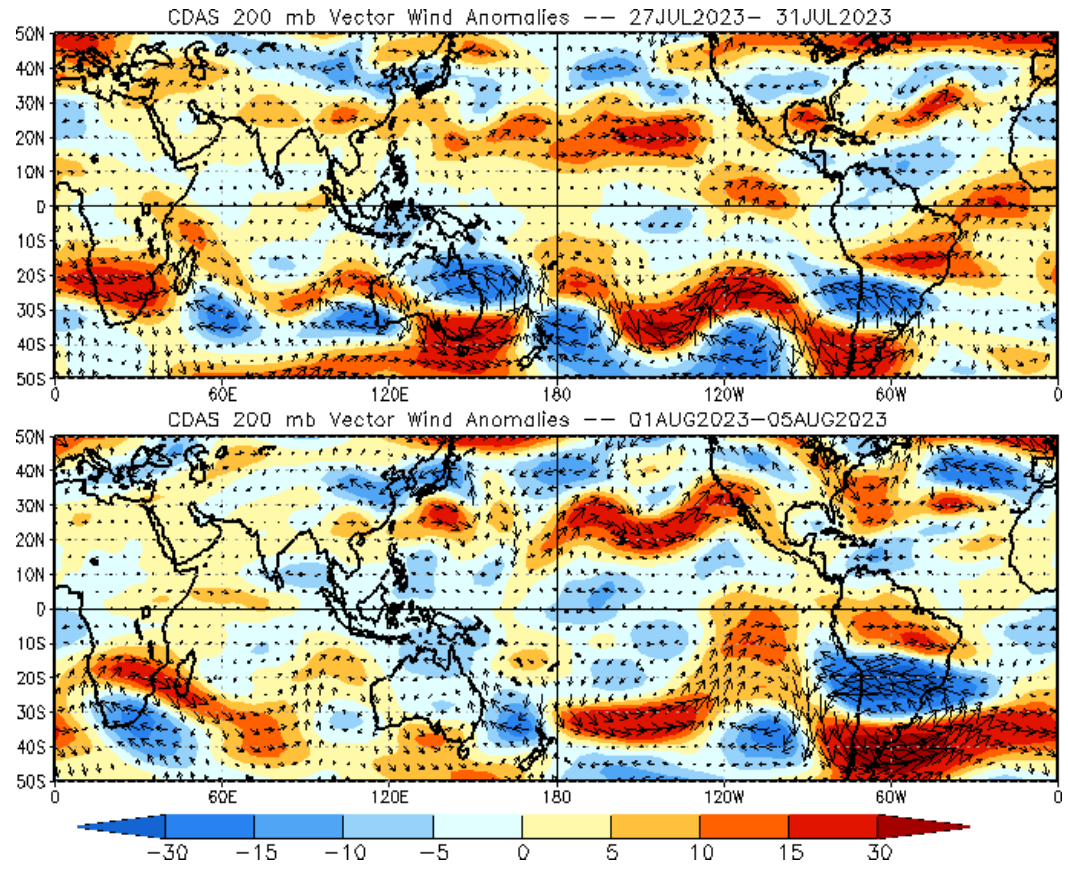
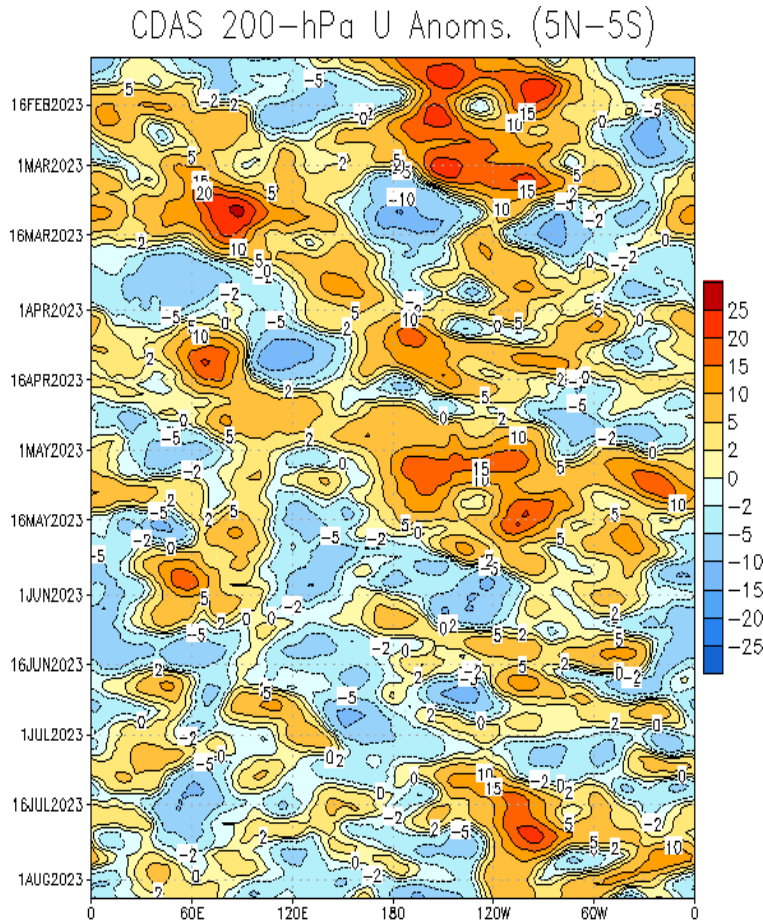
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- Since early August, multiple envelopes of enhanced divergence aloft have emerged in the global tropics, suggestive of a disorganized MJO.
- An envelope of suppressed convection shifted eastward into the Maritime Continent and West Pacific, which may begin to destructively interfere with the low frequency footprint.

200-hPa Wind Anomalies

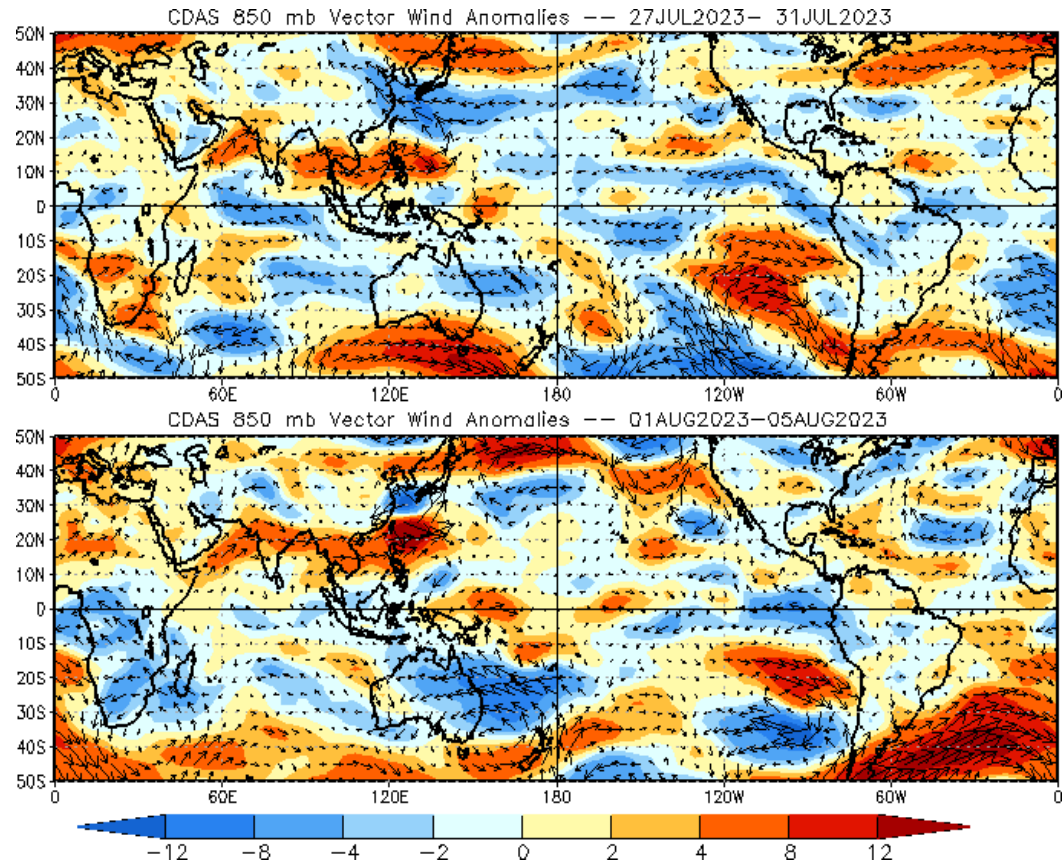
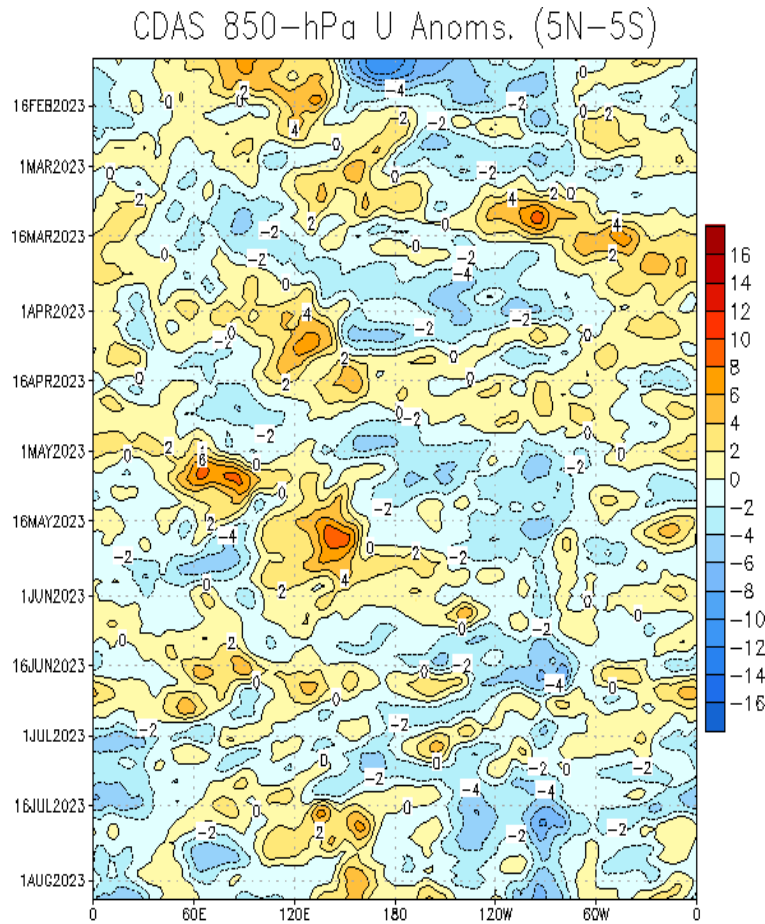
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Anomalous easterlies developed over the equatorial Pacific and becoming more consistent with a classic response to the ongoing El Nino, with little to no indication of eastward propagating features.
- Anomalous westerlies continue over much of the eastern equatorial Pacific tied to persistent wave breaking in the Southern Hemisphere.
- Strong upper-level riding remains entrenched over the southern CONUS, resulting in continued excessive heat conditions.

850-hPa Wind Anomalies

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

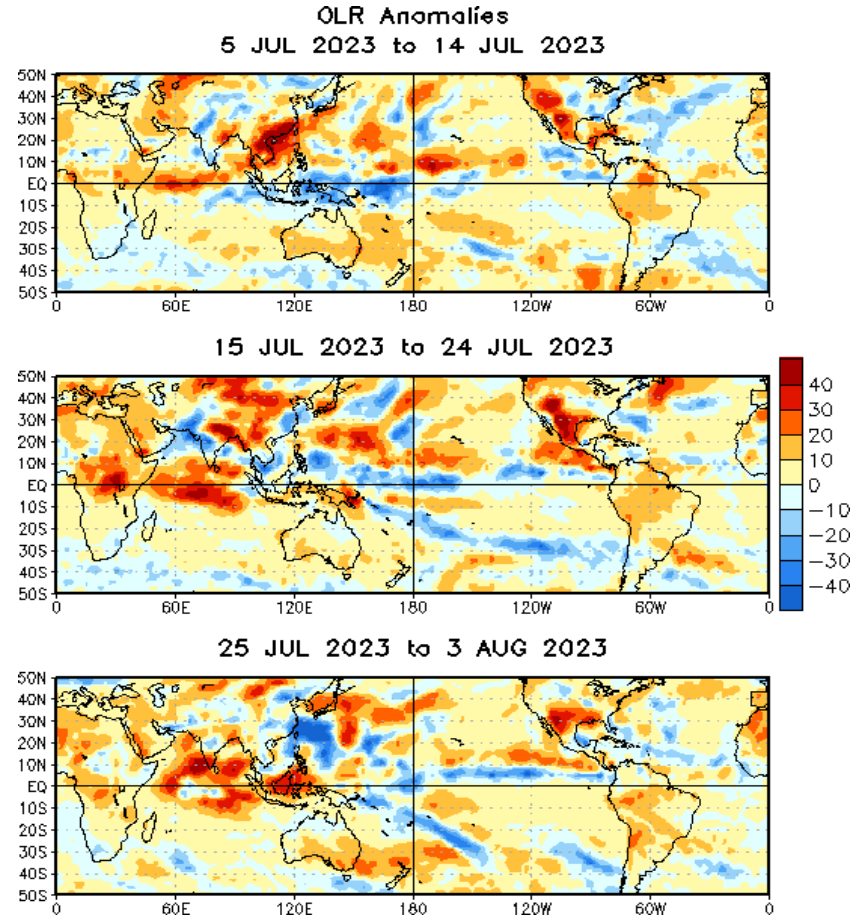
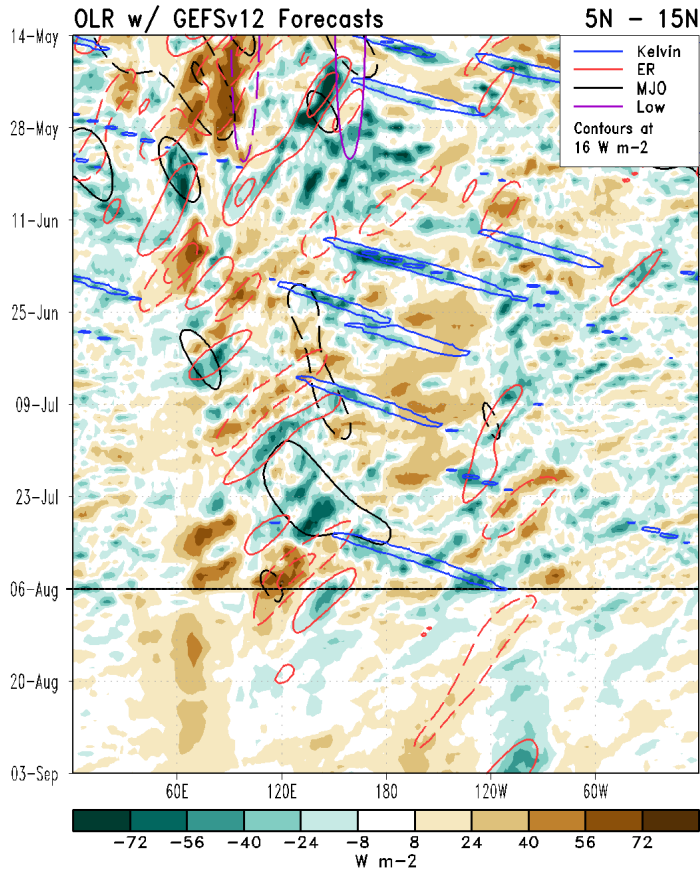


- Similar to the upper-level zonal wind response to El Niño in the equatorial Pacific, a more continuous field of anomalous lower-level westerlies developed from approximately 130°E to 150°W.
- Lower-level wind anomalies have become more mixed and weakened over the equatorial Indian Ocean.
- Anomalous westerlies have strengthened over the Main Development Region and extending westward into the Caribbean.

Outgoing Longwave Radiation (OLR) Anomalies

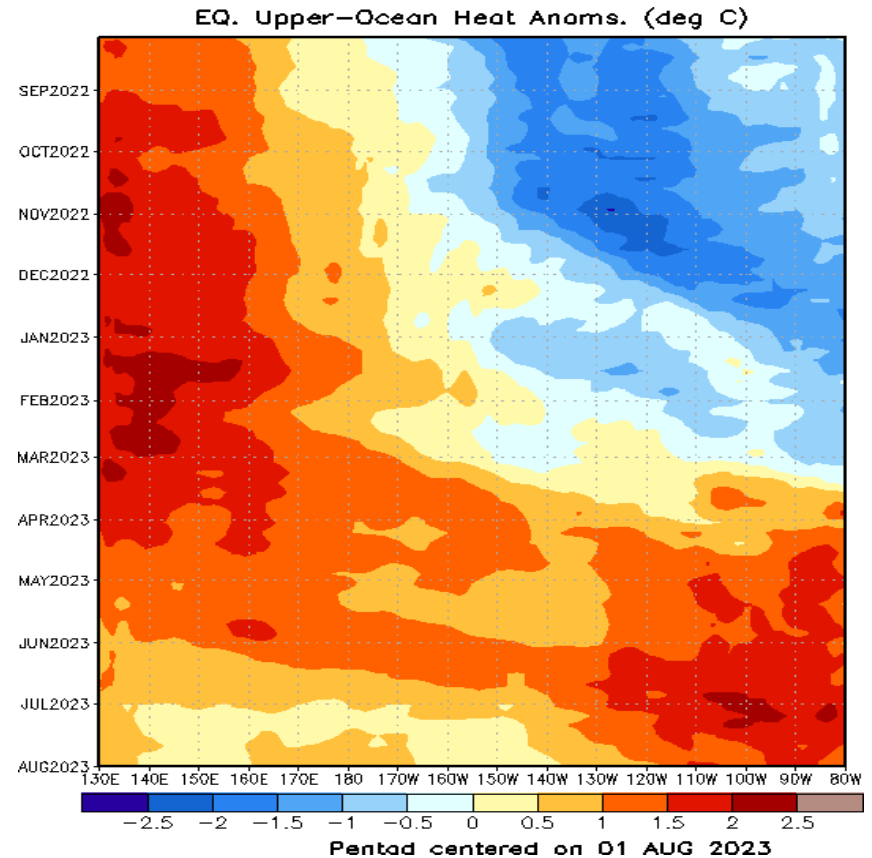
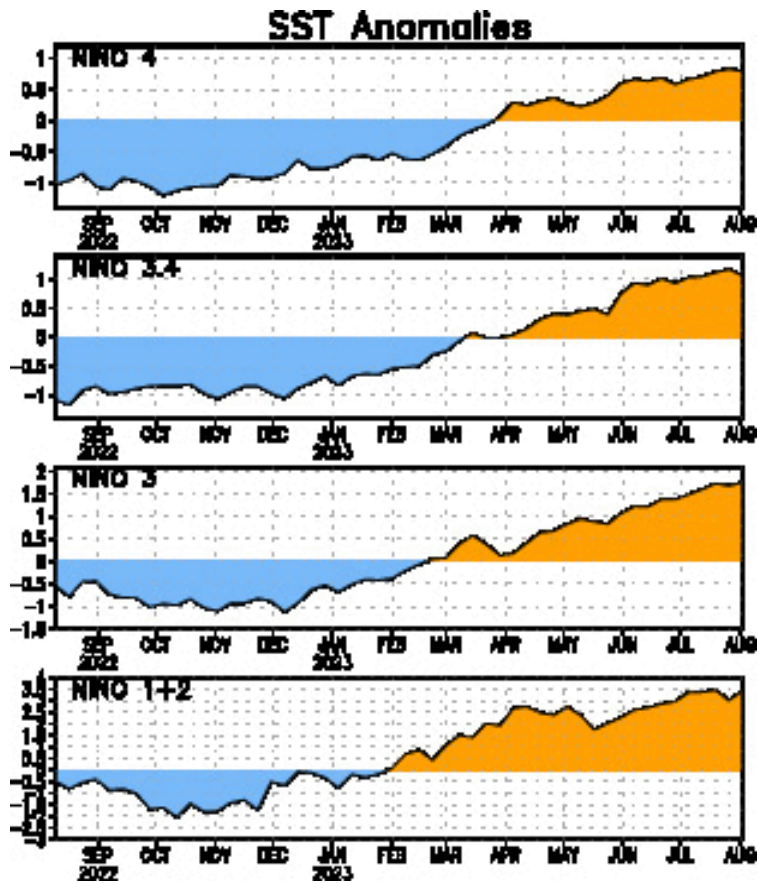
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- Since late July, enhanced convection continued across the West Pacific (tied to TC Khanun) with more suppressed convection to the south along the equator and extending westward into the Indian Ocean.
- Suppressed convection persists across the southern CONUS, aiding in the continued heat waves
- Filtered OLR forecasts show little (if any) MJO signal, as Rossby and Kelvin wave activity combined with low frequency variability are largely favored in the forecast.

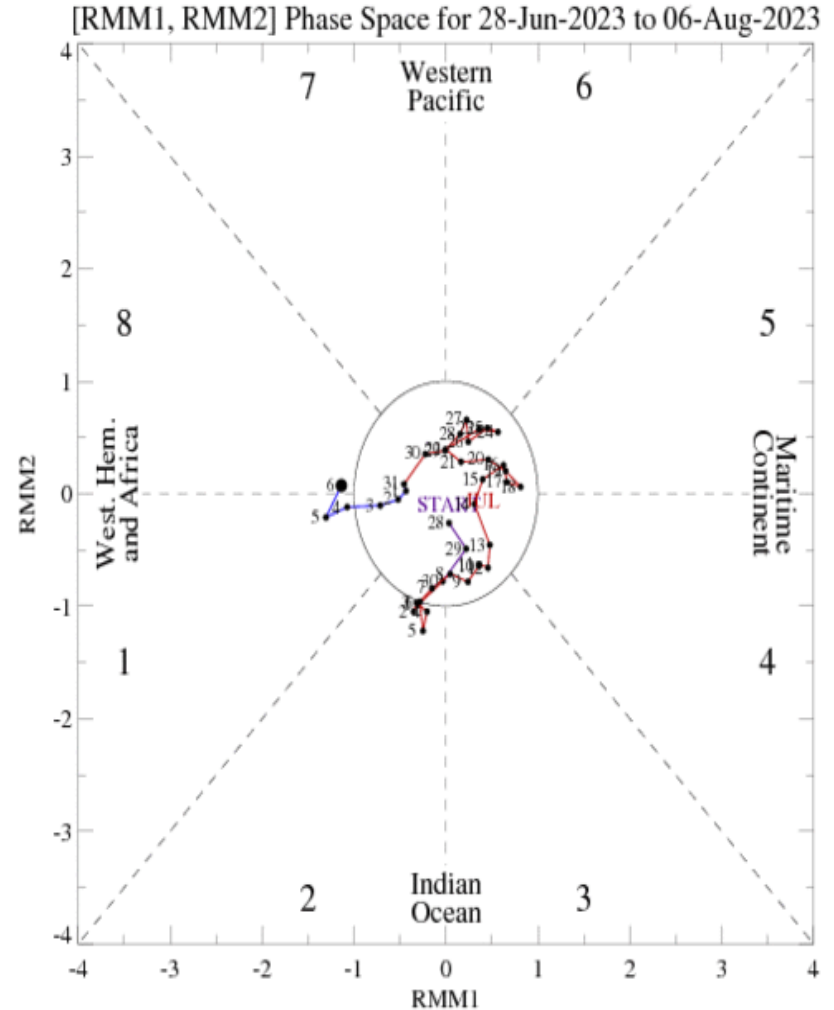
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- El Niño conditions are present across the equatorial Pacific as SST anomalies continue to climb throughout the Niño regions.
- Above-normal subsurface temperatures are present across the entire equatorial Pacific. Since early July, the warmest anomalies have weakened somewhat in the eastern Pacific, while a slight resurgence of warm waters is observed along and near the Date Line.

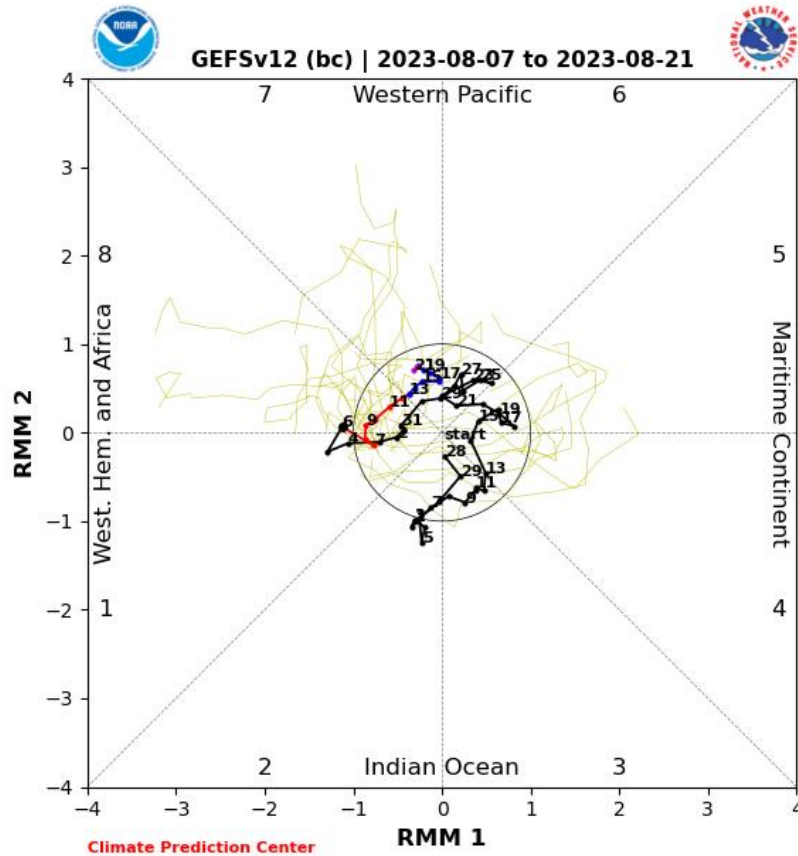
MJO Index: Recent Evolution

- More recently, the RMM index suggests renewed MJO activity over the Western Hemisphere, having being outside the unit circle for the first time since early July.

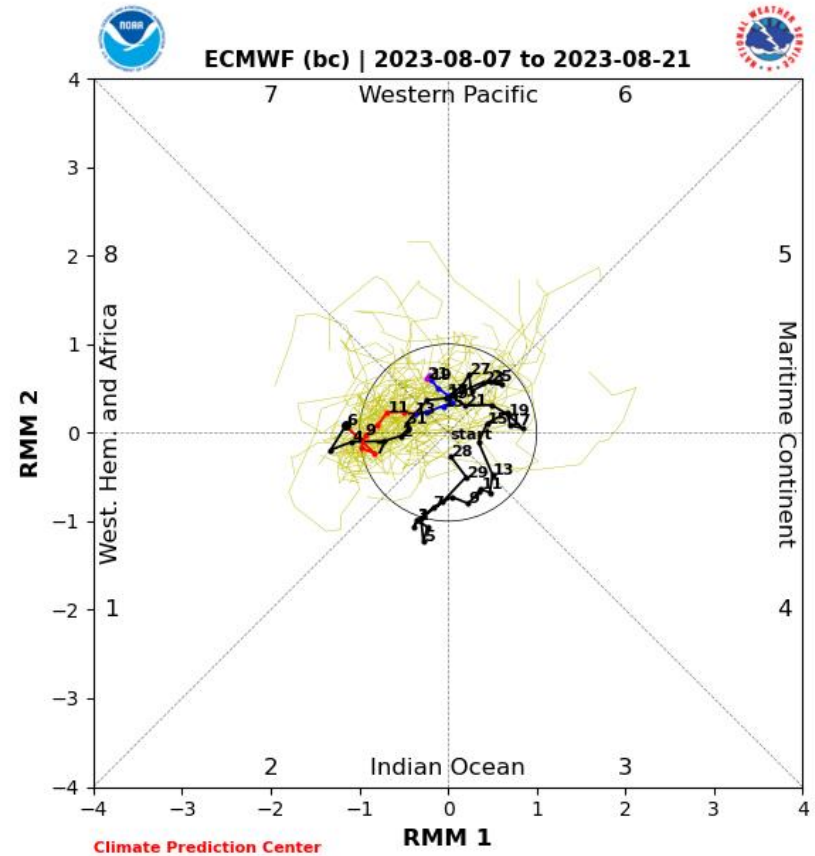


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



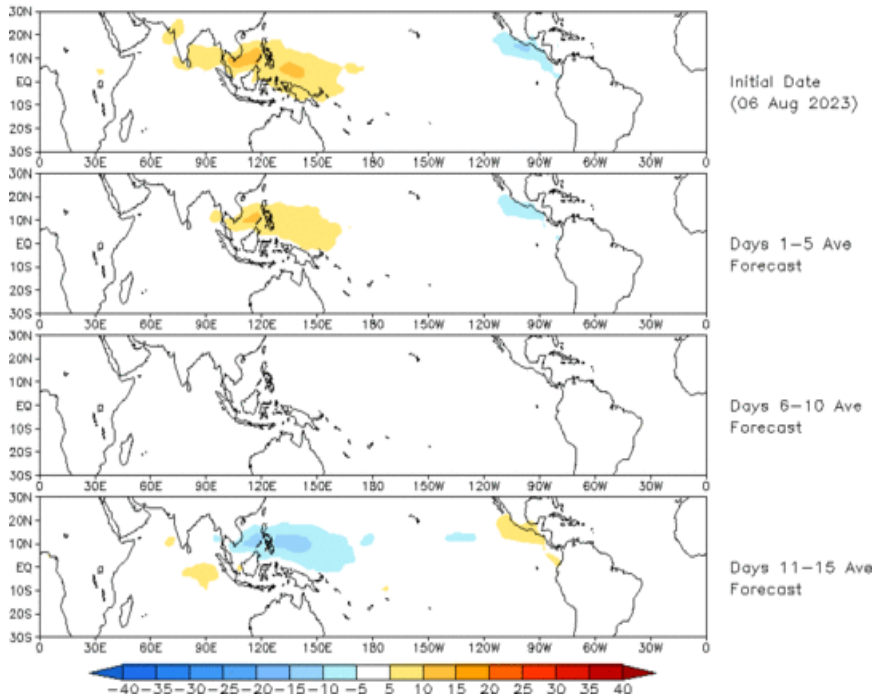
ECMWF Forecast

- RMM forecasts suggest any renewed activity to be short-lived, as nearly all dynamical models favor a weakened MJO signal during the next two weeks.
- While some extended range solutions favor some reemergence of the MJO signal, solutions greatly vary in regards to strength and location with high ensemble spread, limiting forecast confidence for any coherent intraseasonal activity later in August.

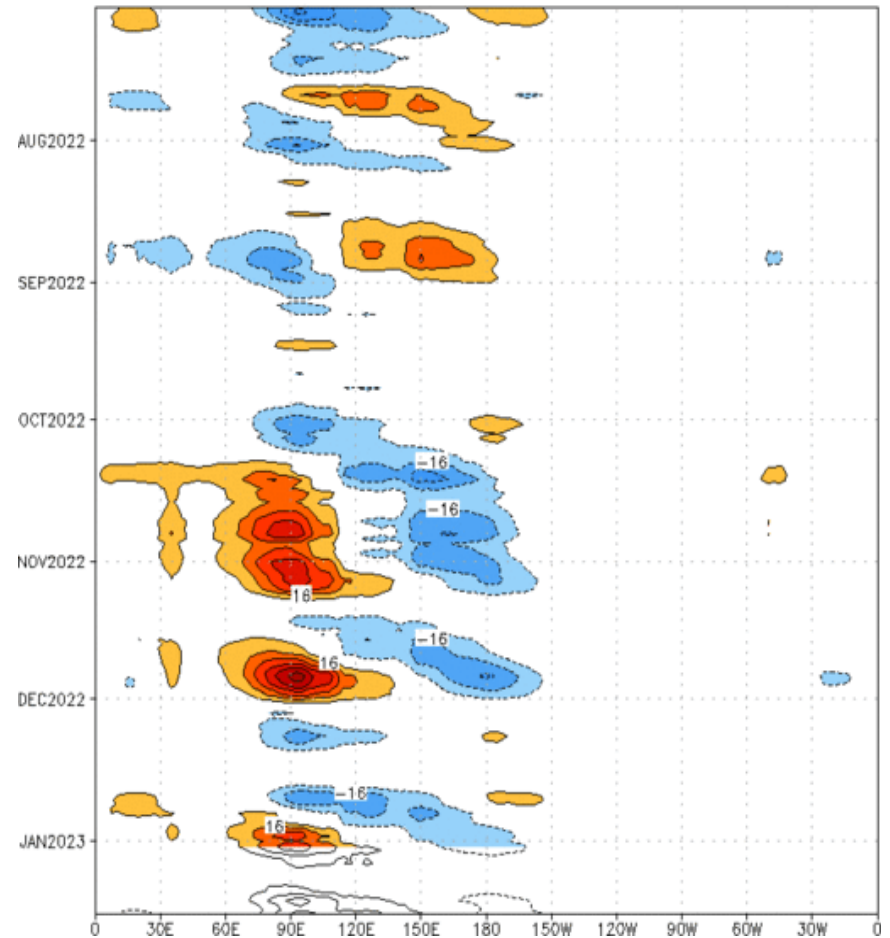
MJO: GEFS Forecast Evolution

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: 06 Aug 2023
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:03-Jul-2022 to 02-Jan-2023
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

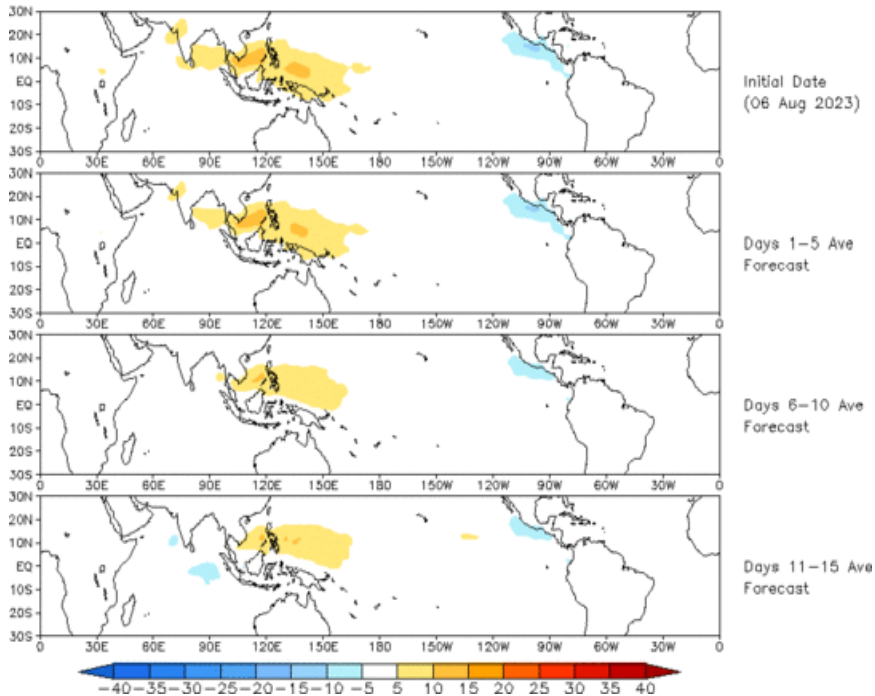


- The GEFS RMM-based OLR forecast shows suppressed (enhanced) convection weakening over the western (eastern) Pacific followed by a rapid flip in the convective pattern.

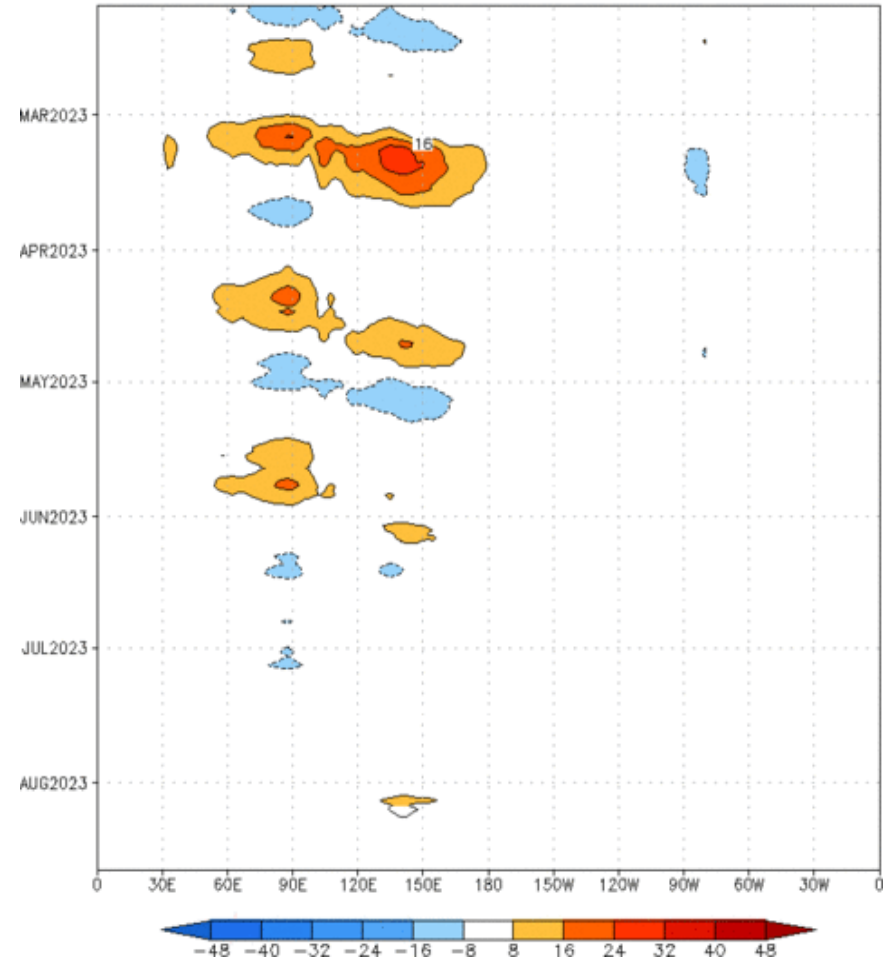
MJO: Constructed Analog Forecast Evolution

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 (06 Aug 2023)



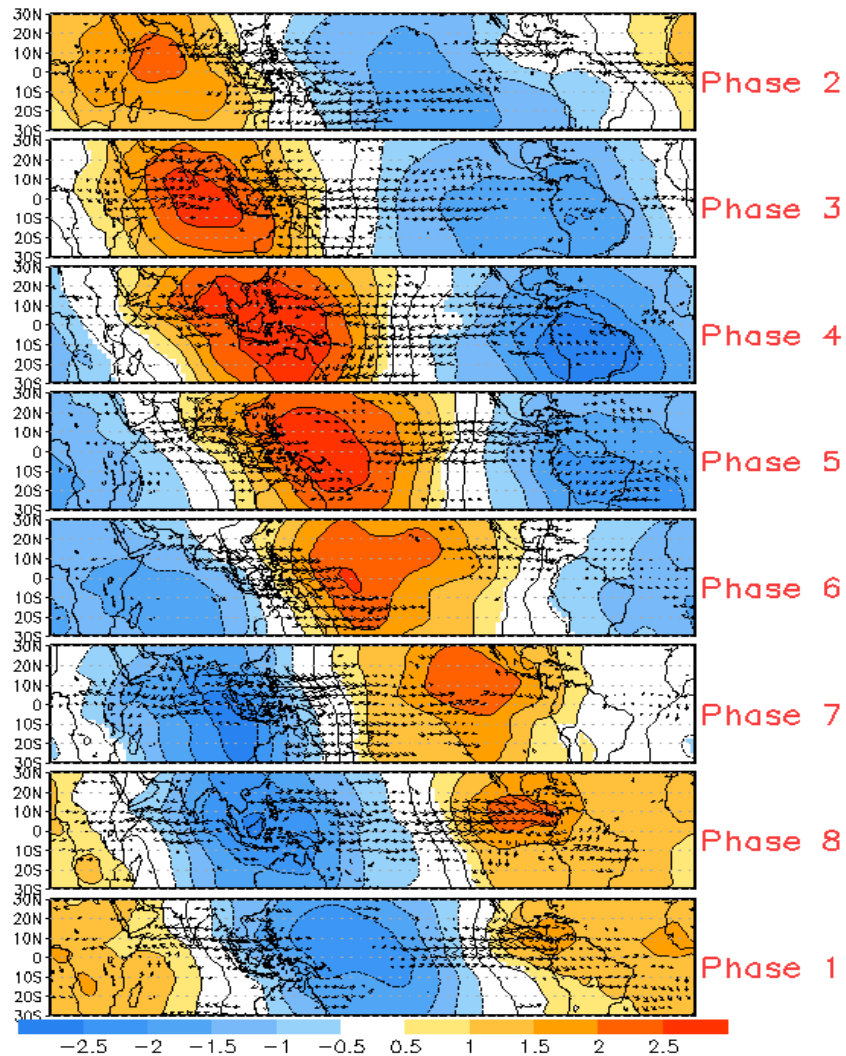
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:04-Feb-2023 to 06-Aug-2023
The unfilled contours are CA forecast reconstructed anomaly for 15 days



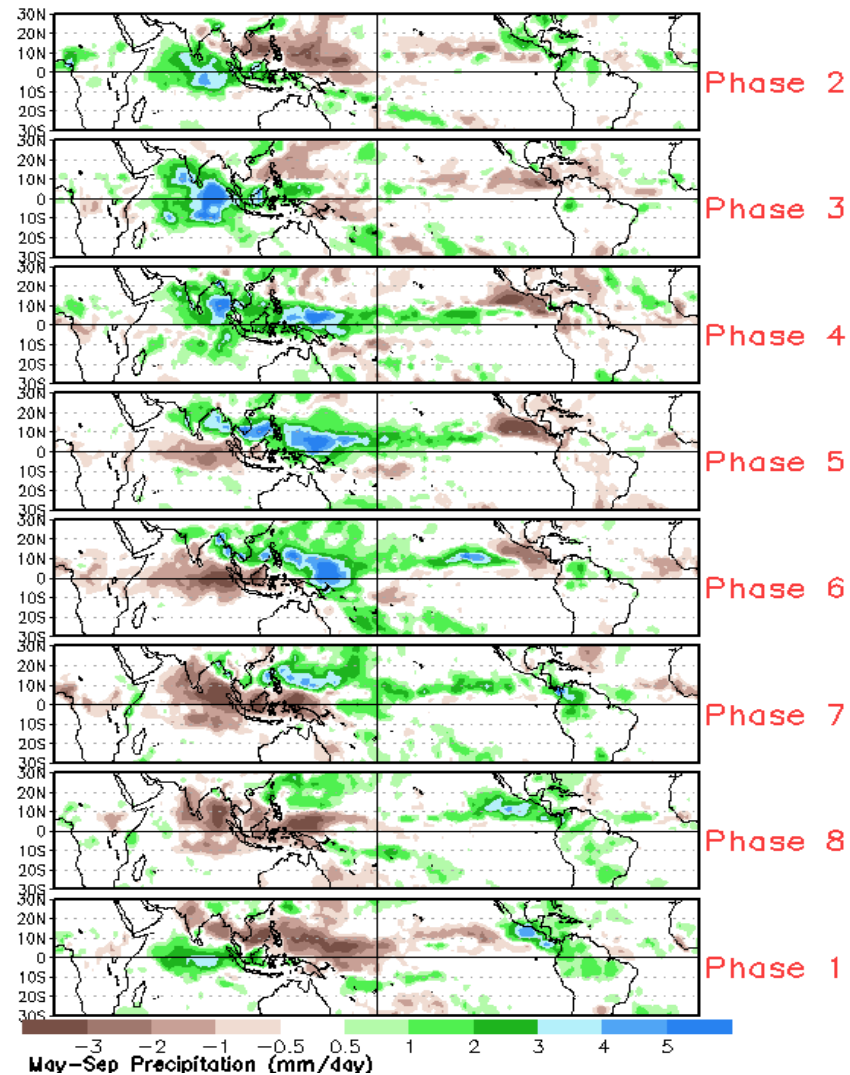
- The constructed analog RMM-based forecast favors more of a persistence of the convective pattern, with a slight tilt towards enhanced convection developing in the Indian Ocean later in week-2.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



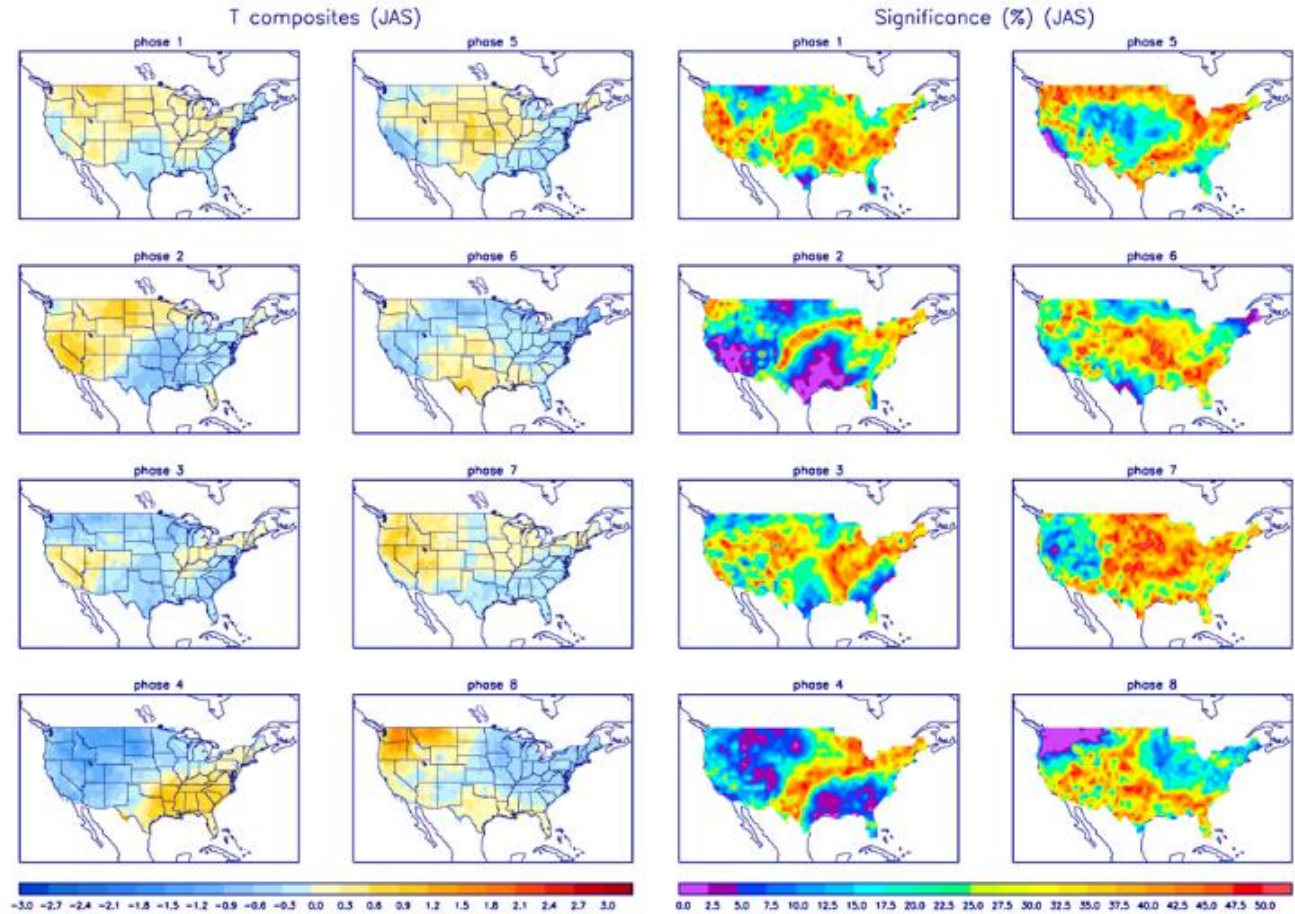
Precipitation Anomalies



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.

