

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



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

Overview

- Since late August, RMM index observations show the MJO signal has struggled to fully propagate out of the Maritime Continent. The signal has regained amplitude in the past week, but still has shown little sign of eastward propagation.
- Dynamical models have come into better agreement favoring an eastward propagating Western Pacific MJO event during the next few weeks, with several ensemble members maintaining the signal with a moderate to high amplitude as it enters the Western Hemisphere.
- Upper-level velocity potential forecasts from the models remain somewhat mixed in regards to the evolution and strength of the MJO, with the ECMWF favoring more robust activity heading into October.
- Despite some the uncertainties, conditions are expected to become more conducive for tropical cyclone development over the tropical Americas.
- MJO activity entering the Western Hemisphere historically favors less favorable conditions for TC genesis in the Western Pacific, however any waning potential may be offset by low-frequency variability and climatology.

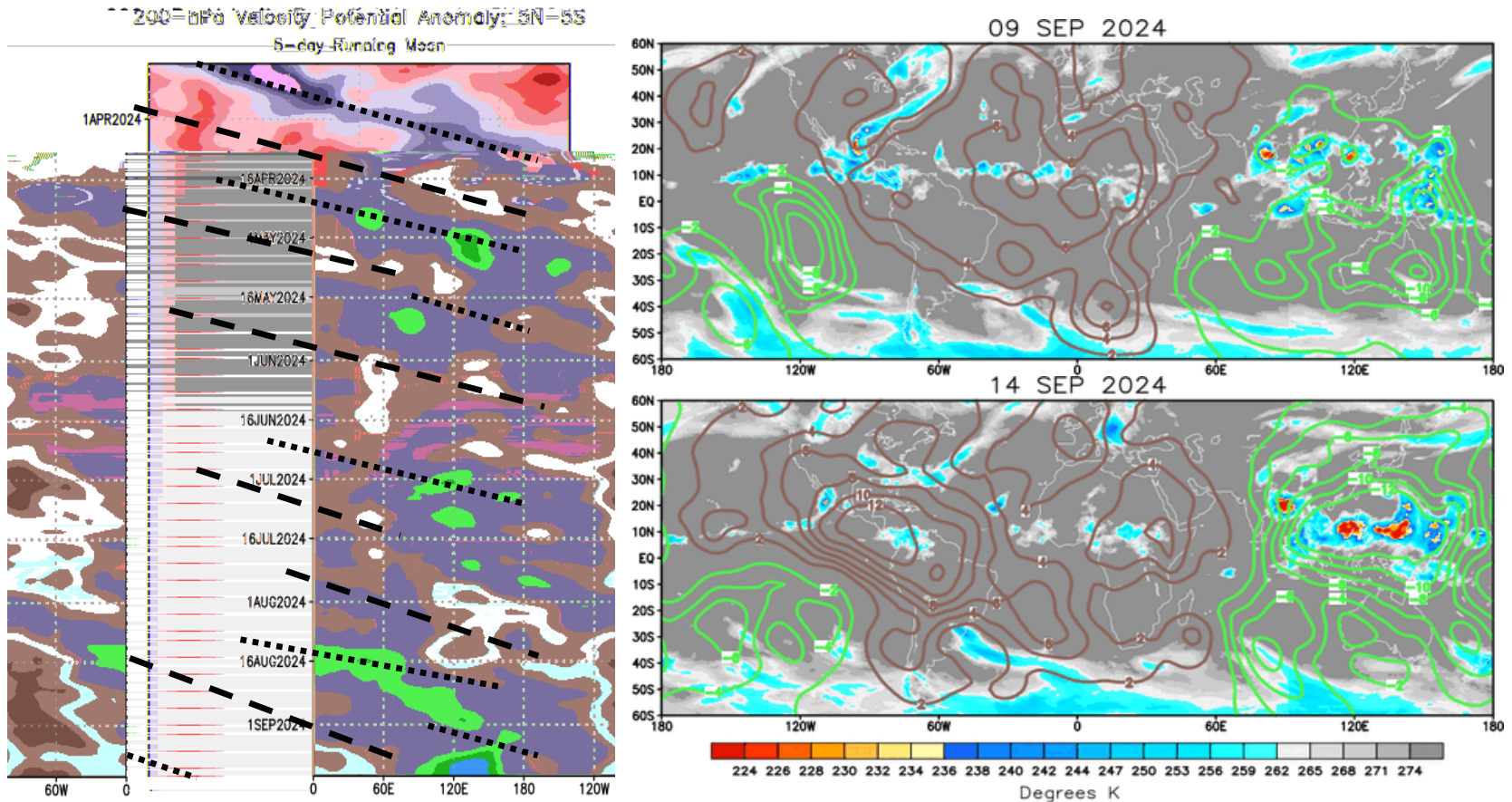
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:

<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)

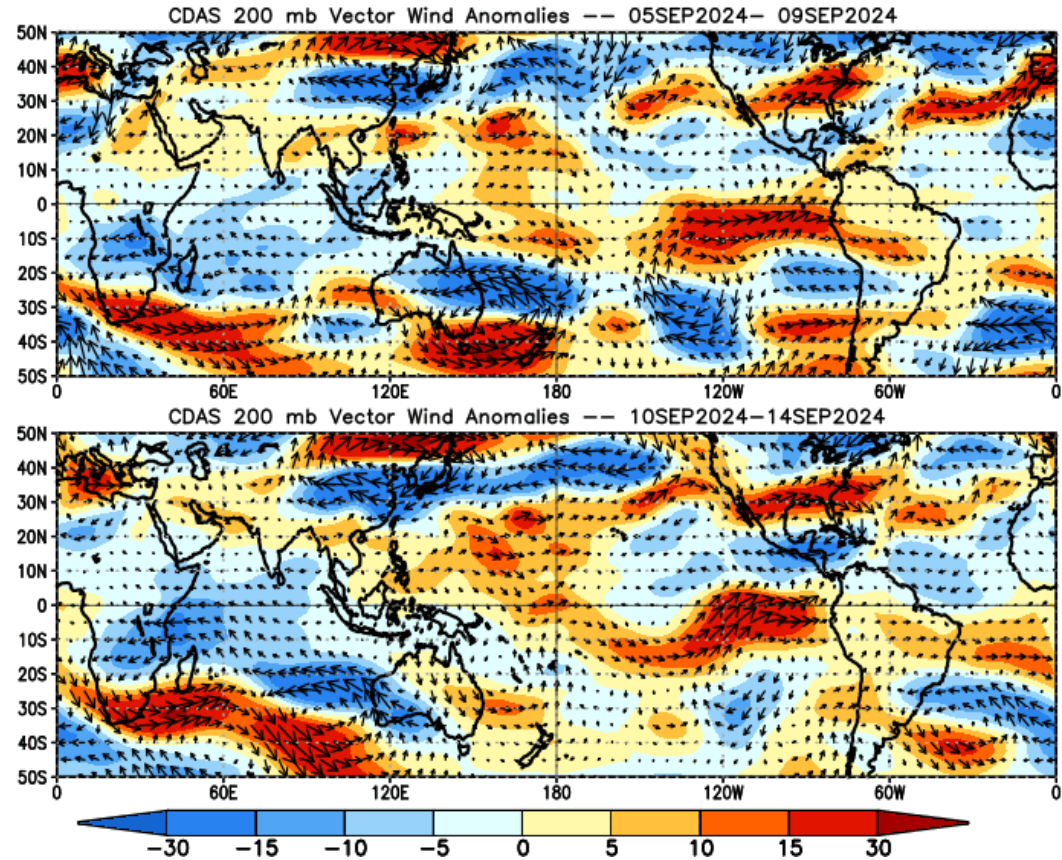
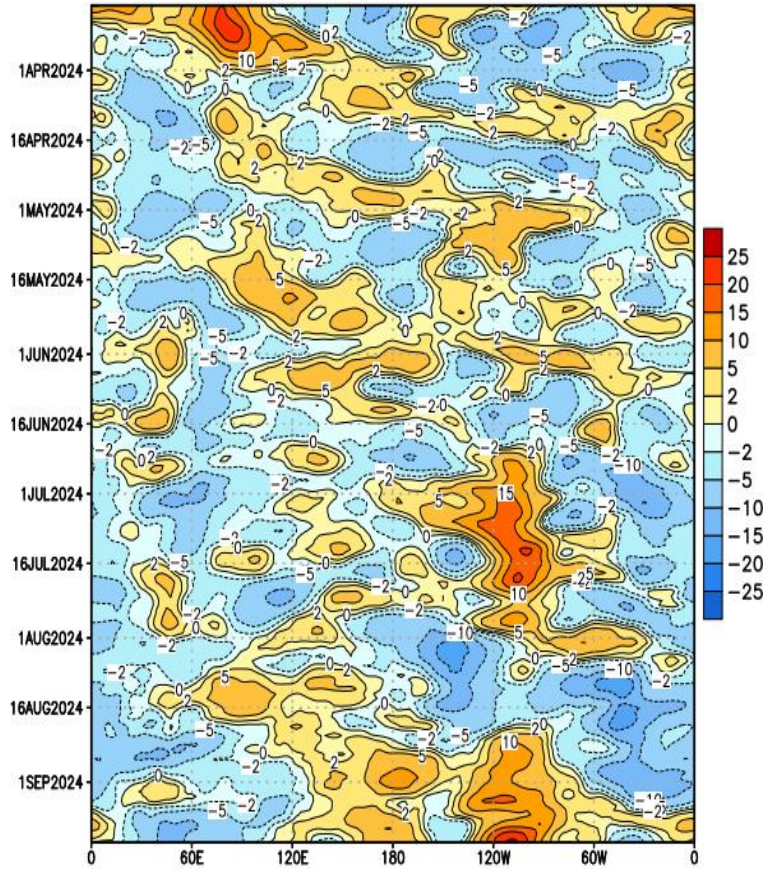


- The fairly well-defined wave-1 pattern strengthened during the past, but showed little eastward propagation, suggestive of the MJO stalling over the Maritime Continent and Western Pacific during the past week.
- Likely tied to Kelvin wave activity, the time-longitude plot shows an eastward propagating feature moving beyond the Date Line, which looks to have weakened an envelope of suppressed divergence aloft over the Americas.

200-hPa Wind Anomalies

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

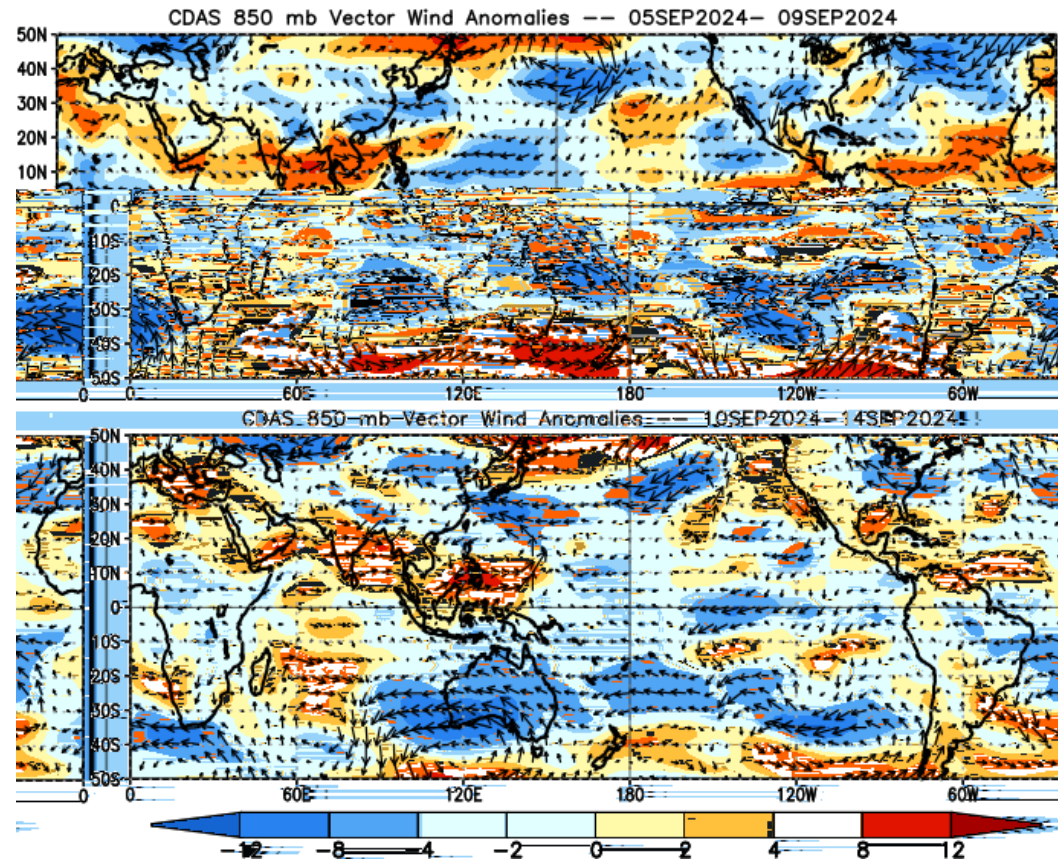
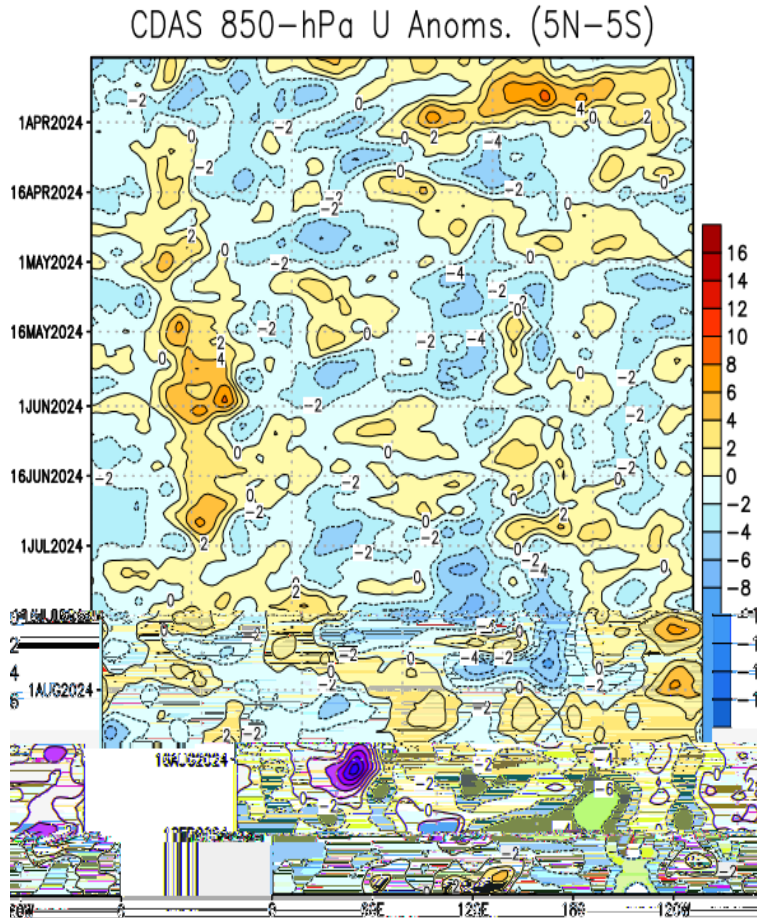
CDAS 200-hPa U Anoms. (5N-5S)



- Over the equatorial Pacific, anomalous westerlies have been generally persistent, with a noted strengthening near 120W. Closer to Central America, easterlies strengthened and helped contribute to tropical cyclone formations in the Atlantic and East Pacific.
- Over the southern Indian Ocean, the enhanced easterlies became more widespread to the north of equator.

850-hPa Wind Anomalies

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

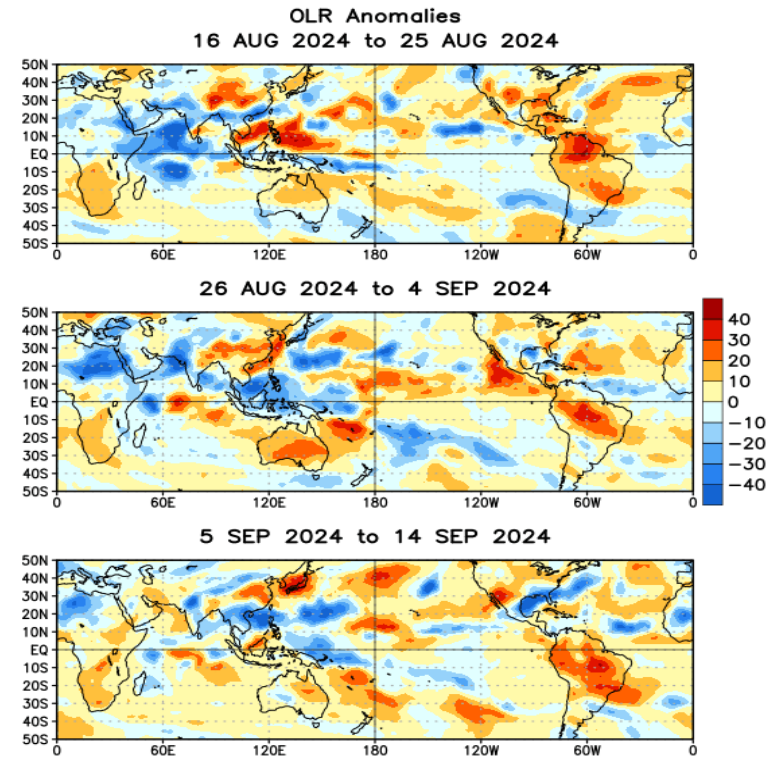
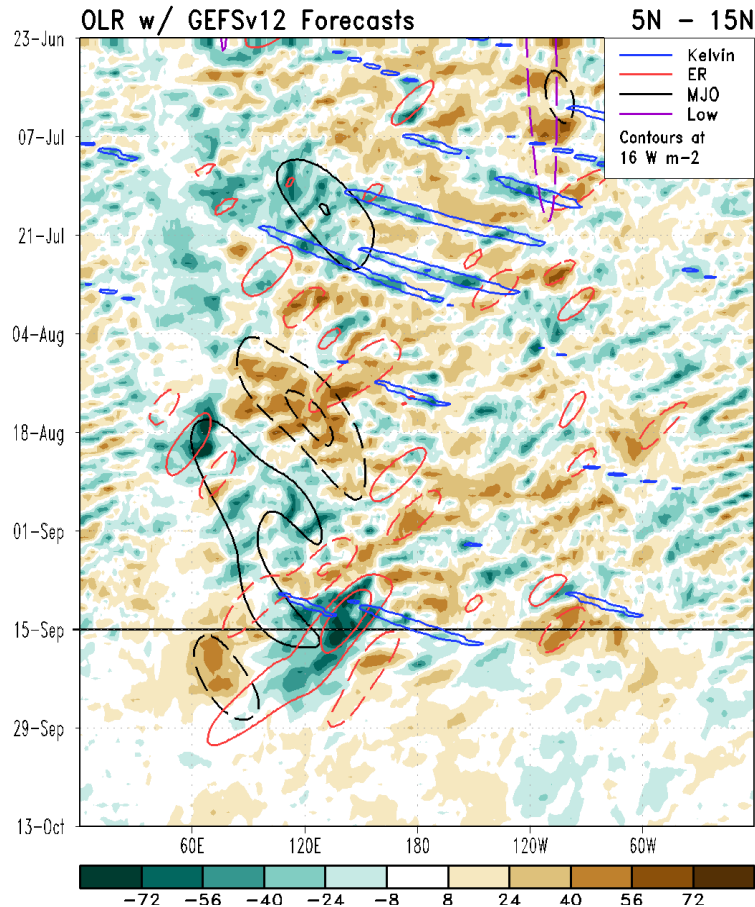


- An enhanced trade regime continues across much of the equatorial Pacific consistent with the favored transition to La Niña, however a band of anomalous westerlies is observed shifting eastward from the Maritime Continent.
- Anomalous westerlies persist over the tropical Atlantic to reduce wind shear for the Main Development Region of the Atlantic.

Outgoing Longwave Radiation (OLR) Anomalies

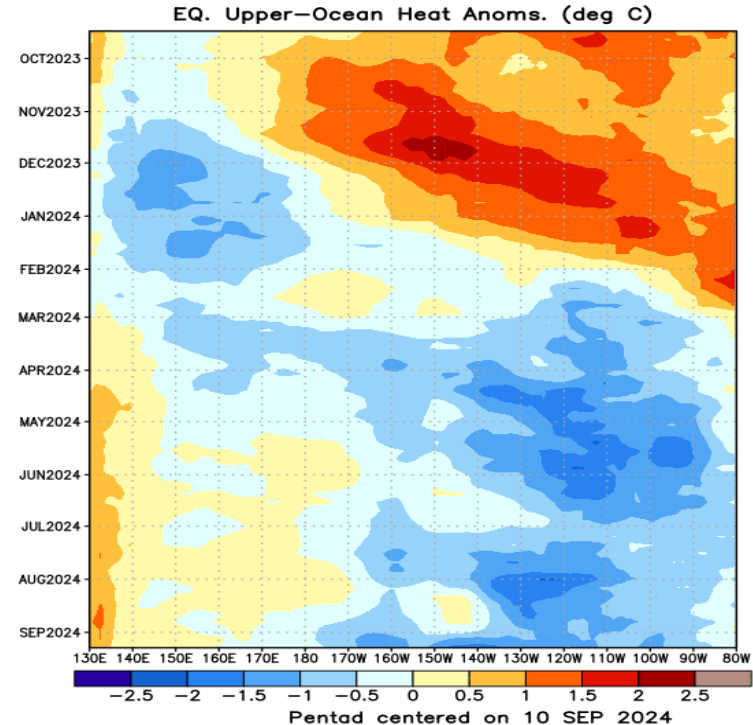
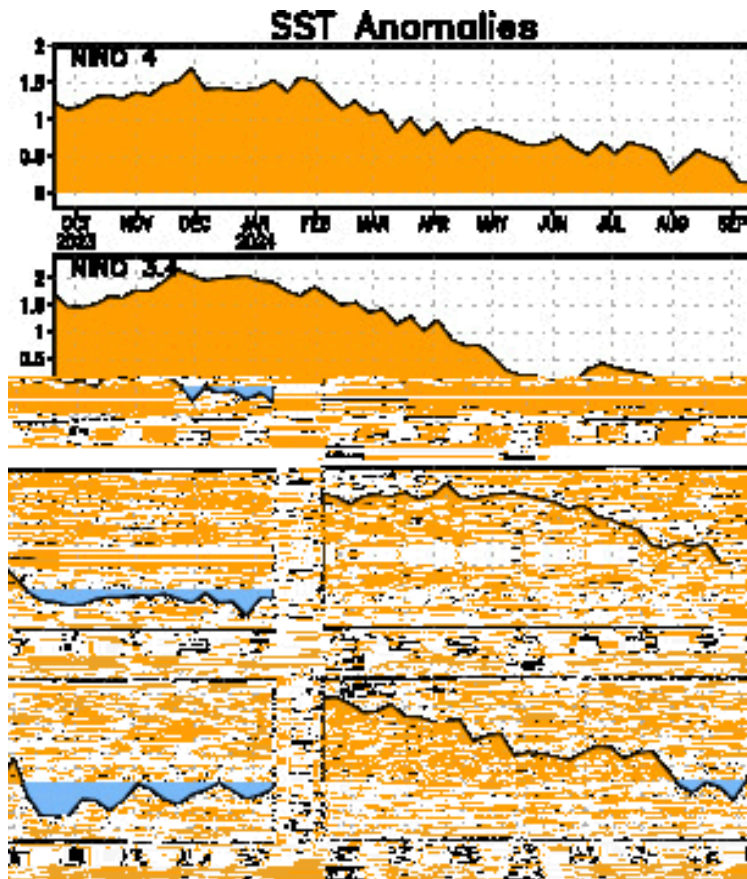
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- MJO activity is coming the OLR filtering, along with equatorial Rossby wave activity over the Maritime Continent and western Pacific. Enhanced convection to east of the Date Line appears to be tied to Kelvin wave activity
- OLR forecasts from the GEFS is rather muted with MJO activity, however the ECWMF (not pictured) features more enhanced convection shifting eastward across the equatorial Pacific consistent with renewed MJO activity.

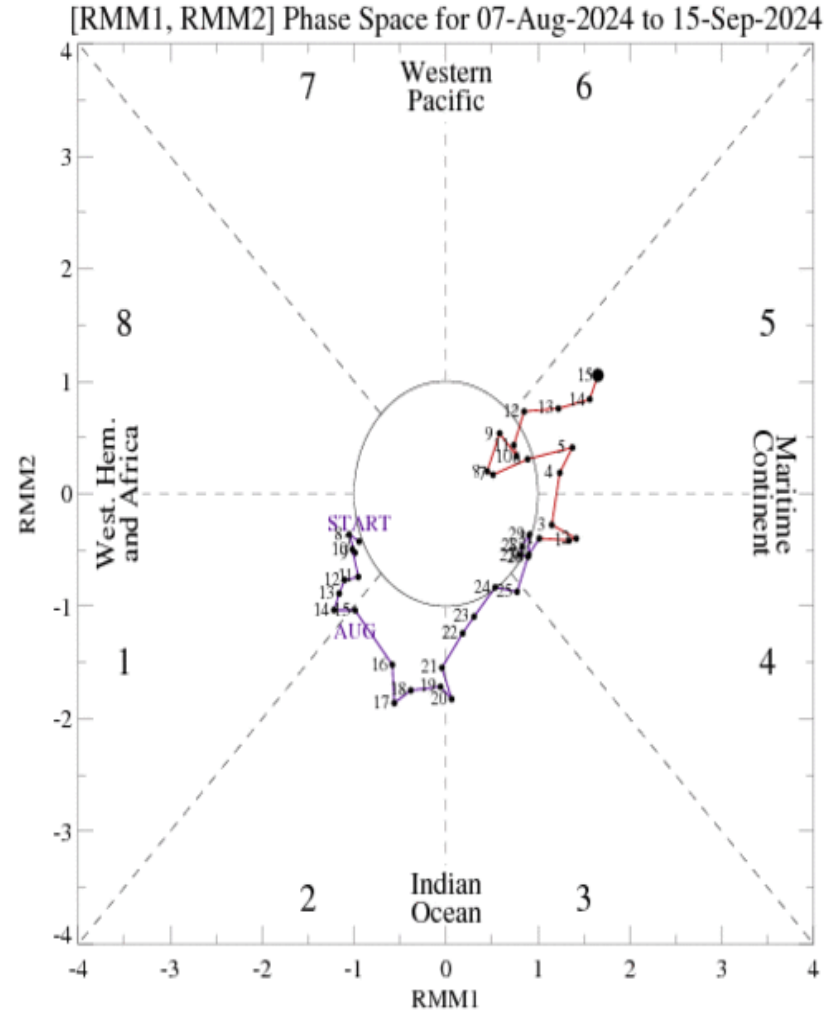
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- SSTs in all Nino regions (except Nino 4) continue to register near to below normal. Nino 4 continues to trend towards zero, and is registering its lowest positive departure from normal since last year.
- Subsurface anomalies have flipped sign west of the Date Line, with continued cooling observed throughout the equatorial Pacific.

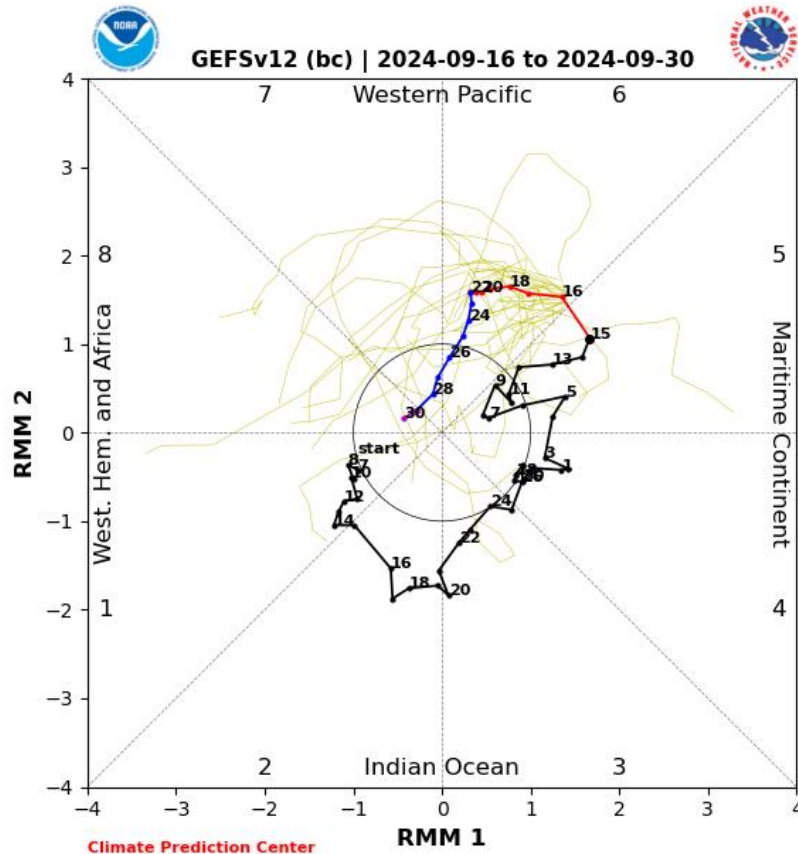
MJO Index: Recent Evolution

- The RMM index shows the MJO signal having remained over the Maritime Continent since late August, and has experienced fluctuations of amplitude most likely associated with competing modes of tropical variability.
- Since losing amplitude earlier in September, the signal has steadily gained amplitude, but with little eastward propagation during the past week.

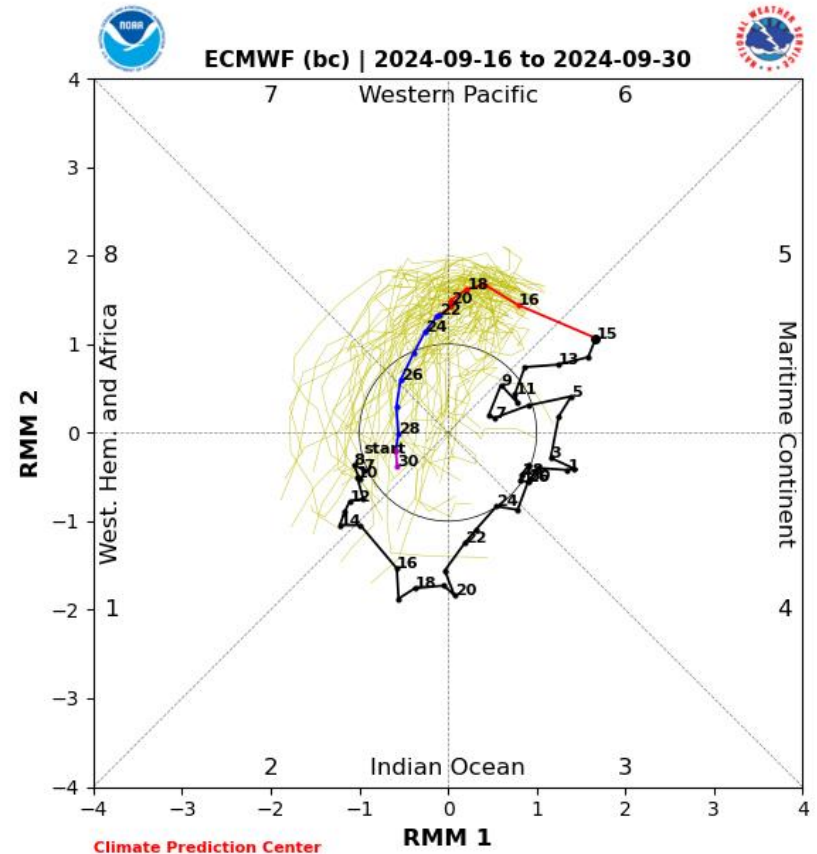


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



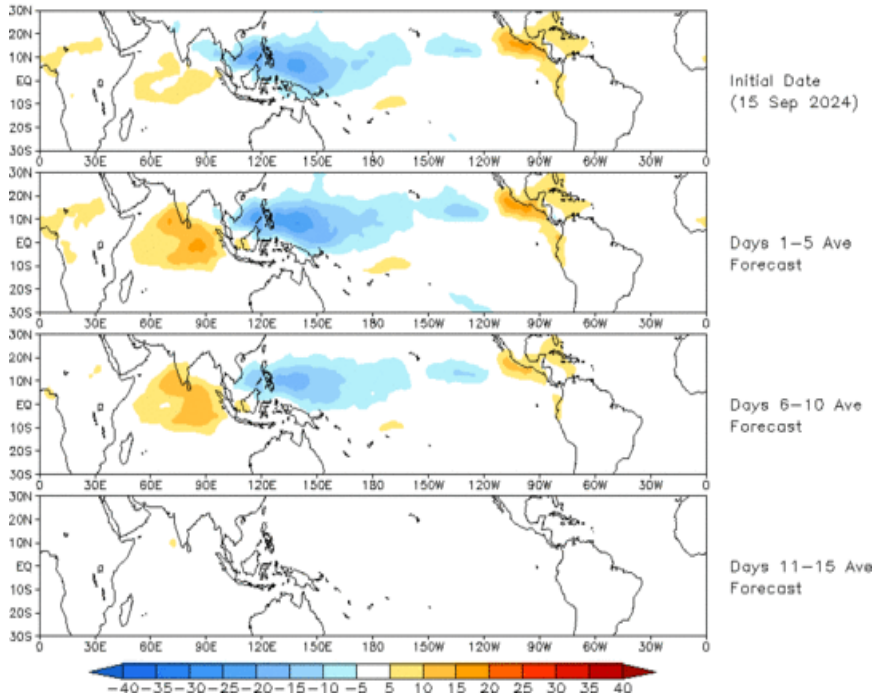
ECMWF Forecast

- Unlike previous forecasts, dynamical models have come into better agreement favoring the eastward propagation of the MJO signal across the Western Pacific during the next few weeks.
- Several ensemble members show the potential for the MJO to maintain a moderate to high amplitude as it enters the Western Hemisphere by the week-3 timeframe.

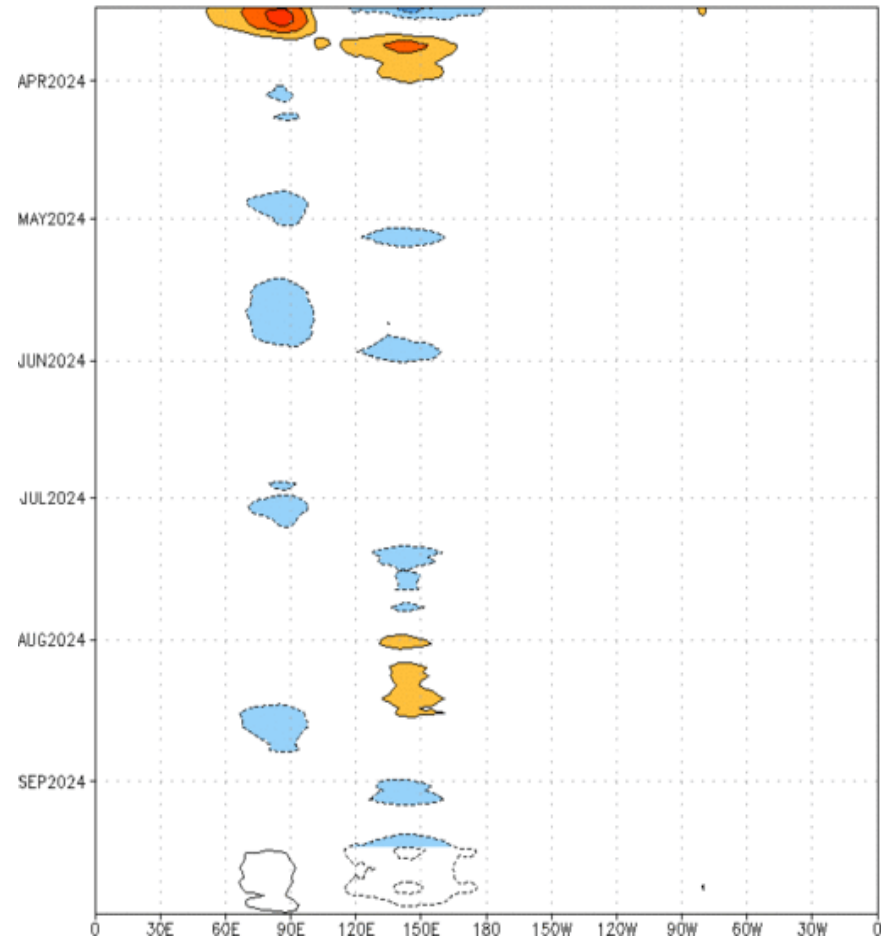
MJO: GEFS Forecast Evolution

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: 15 Sep 2024
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [$7.5^{\circ}\text{S}, 7.5^{\circ}\text{N}$] (cont: 4Wm^{-2}) Period: 16-Mar-2024 to 15-Sep-2024
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

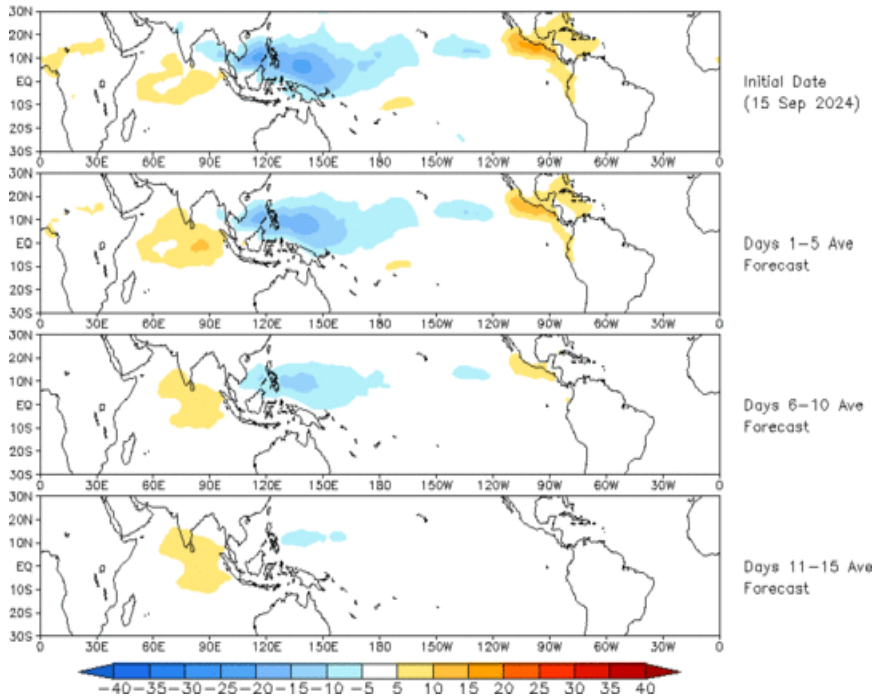


- The GEFS OLR anomaly forecast depicts a slow-moving MJO event with convective anomalies that weaken with time.

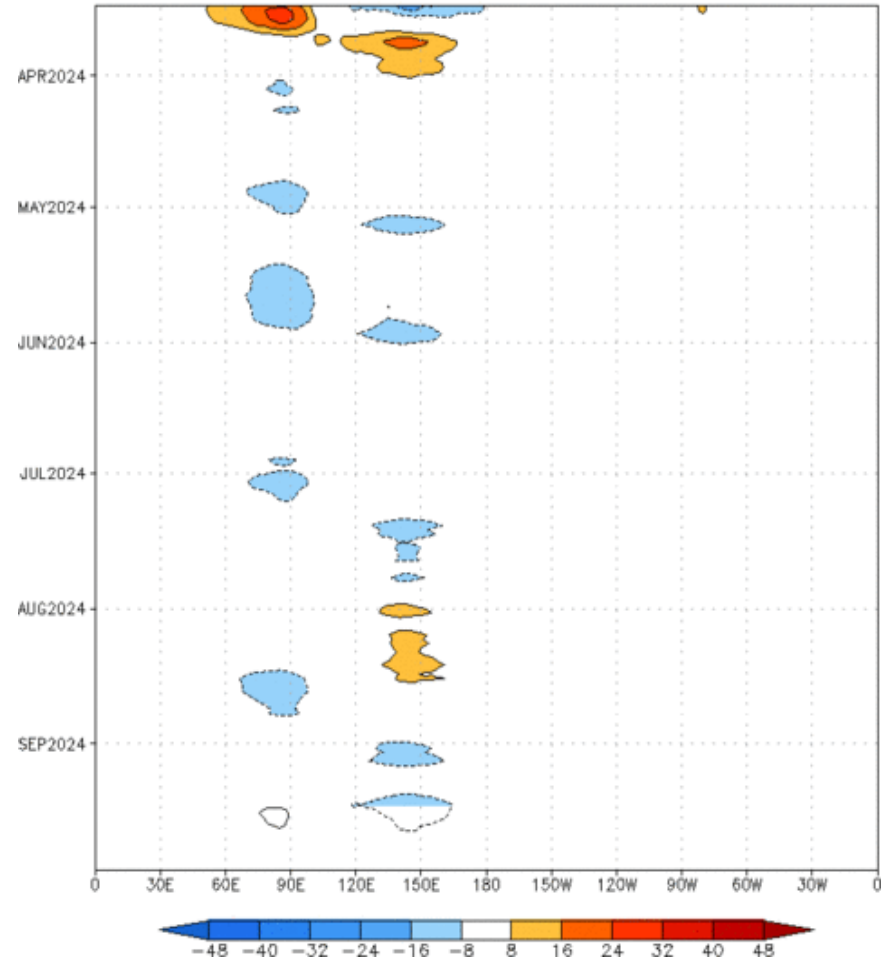
MJO: Constructed Analog Forecast Evolution

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 (15 Sep 2024)



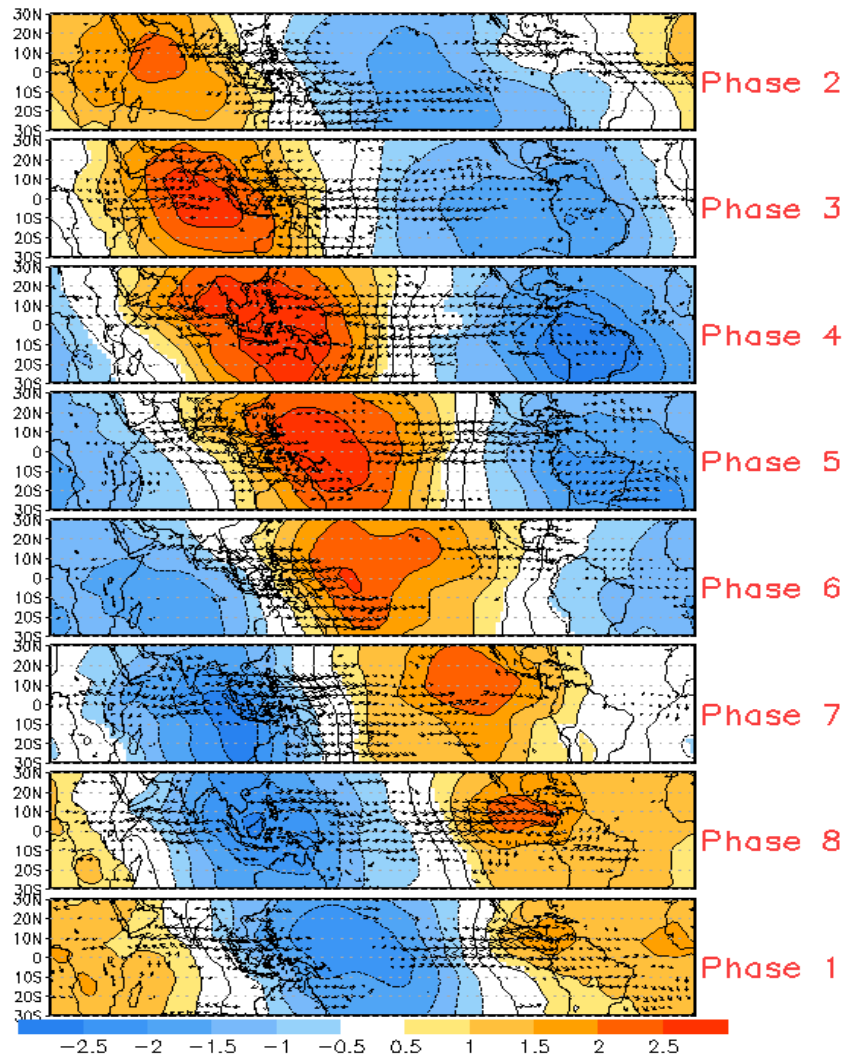
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:16-Mar-2024 to 15-Sep-2024
The unfilled contours are CA forecast reconstructed anomaly for 15 days



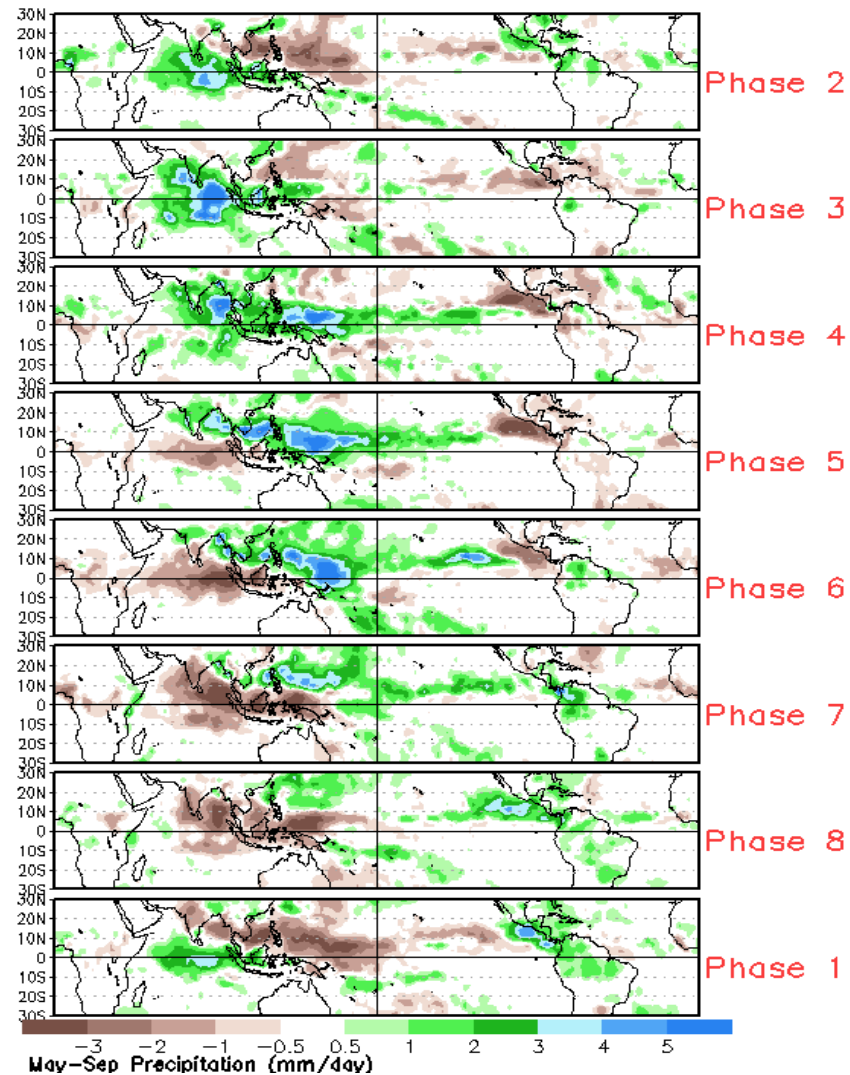
- Compared to the GEFS, the constructed analog is also slow, but weaker with the convective anomalies.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



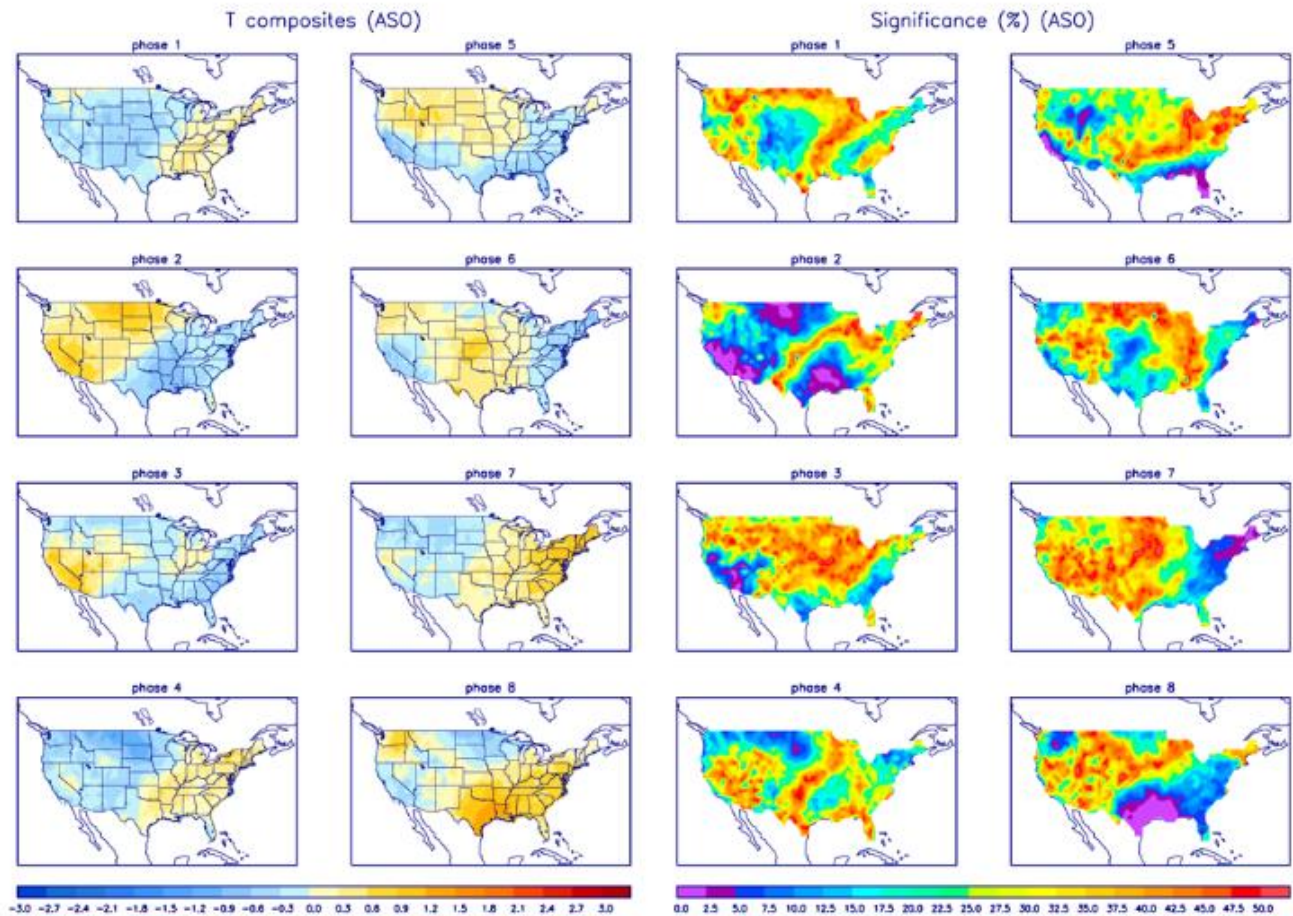
Precipitation Anomalies



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.

