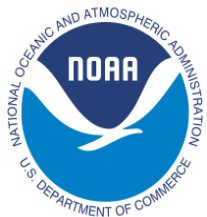


Madden-Julian Oscillation: Recent Evolution, Current Status and Predictions



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

Overview

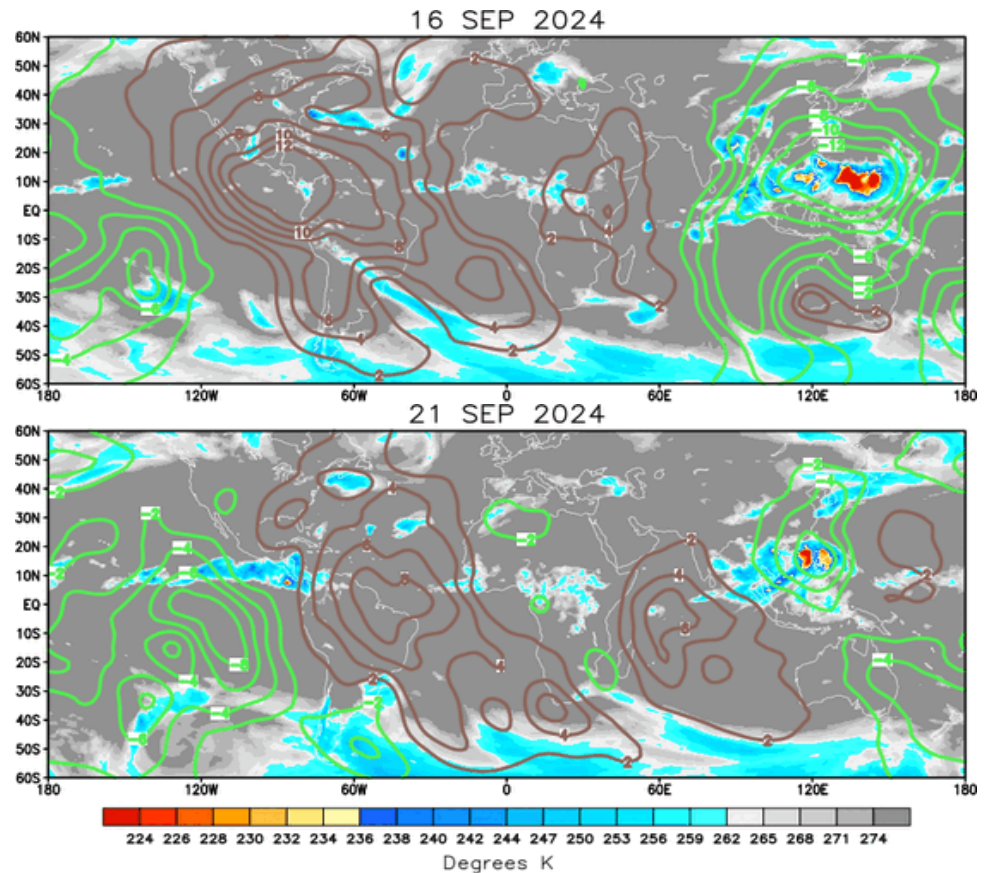
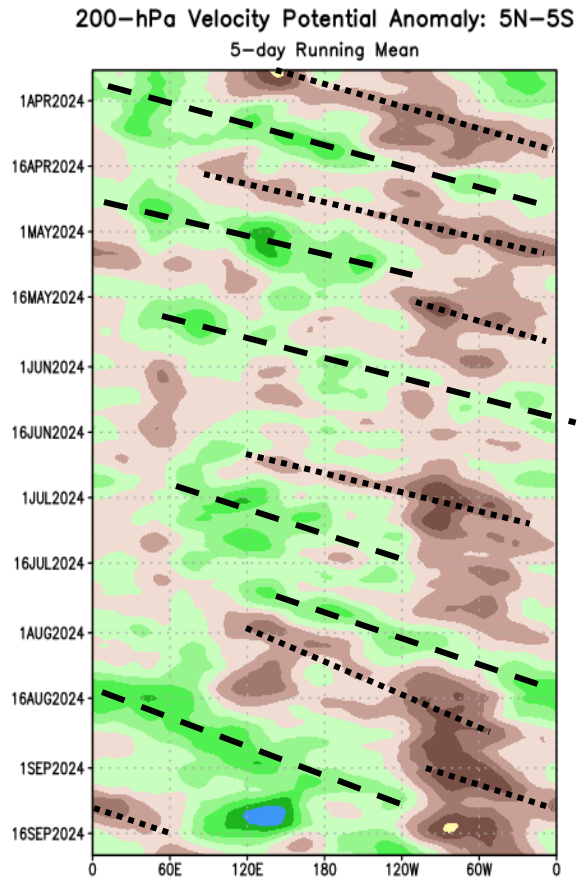
- Following a period of destructive interference with strong equatorial Rossby wave activity over the Maritime Continent, some diagnostics depict a more coherent MJO signal beginning to emerge over the Pacific.
- Dynamical model MJO index forecasts show a coherent evolution of the signal, with the enhanced convective phase crossing the Western Hemisphere and entering the Indian Ocean basin during Weeks 1-2, with some weakening possible but continued eastward propagation during Week-3.
- During the next several weeks, enhanced precipitation and low-level westerly wind anomalies associated with the Central American Gyre (CAG) will provide an environment conducive for tropical cyclone development across the western Caribbean, southern Gulf of Mexico, and far eastern Pacific.
- The MJO may also contribute to a window of favorability for tropical cyclogenesis across the Atlantic Main Development Region (MDR) during both Weeks 2 and 3.

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)

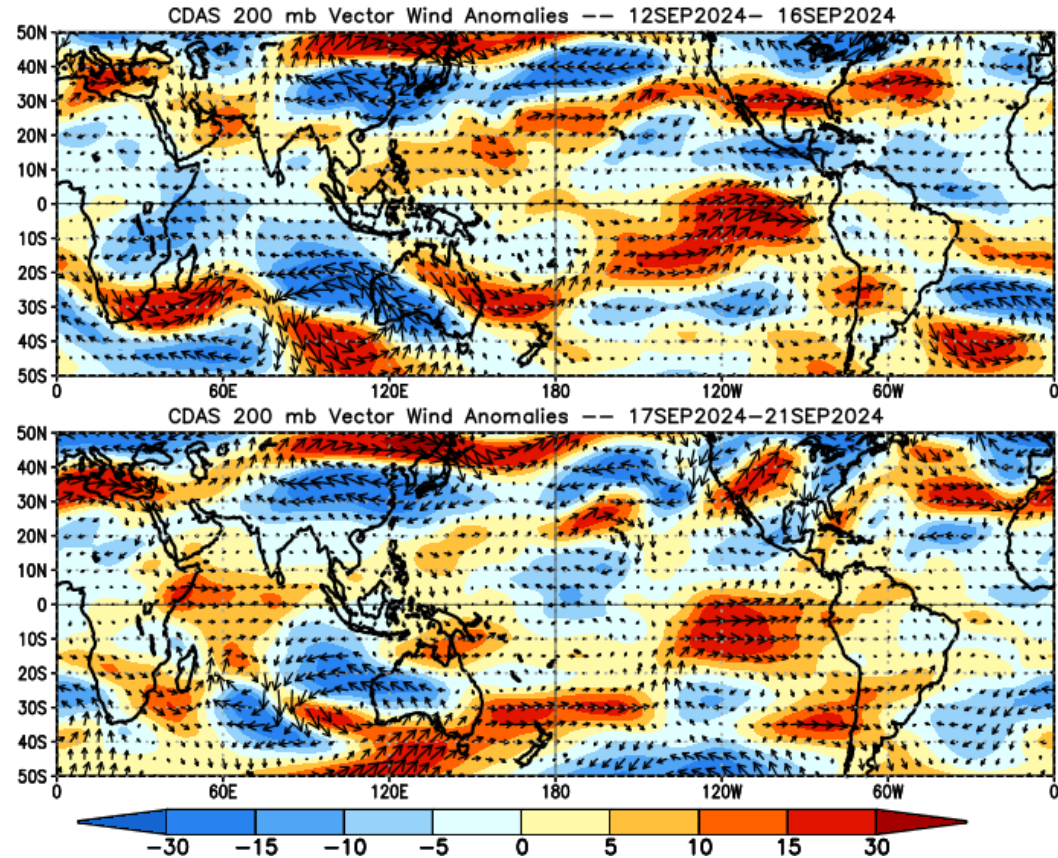
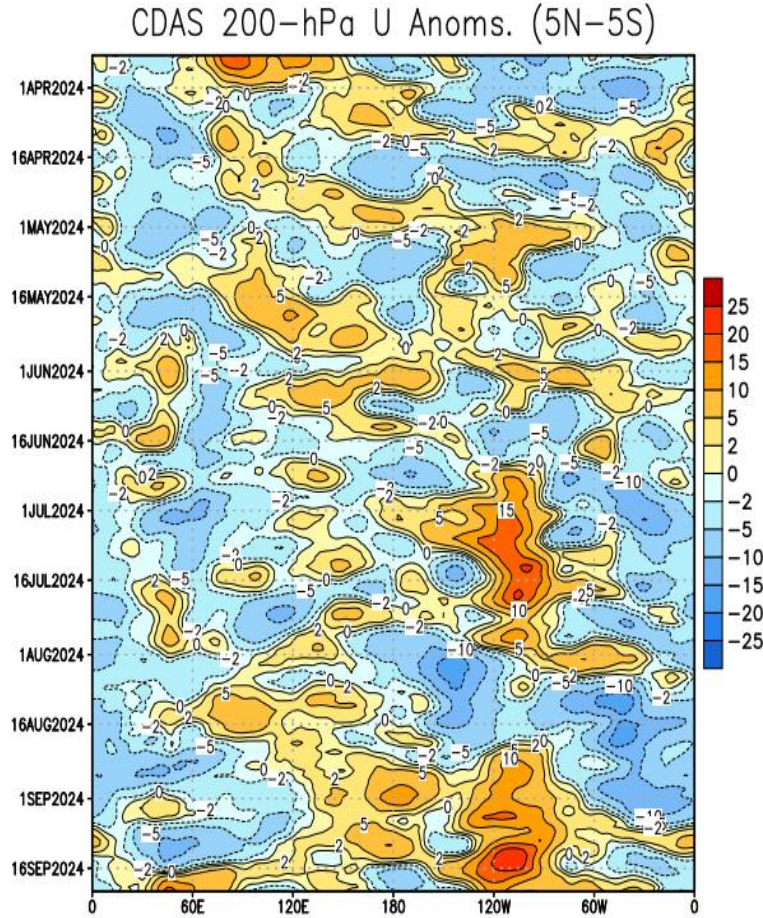
Brown shades: Anomalous convergence (unfavorable for precipitation)



- The upper-level velocity potential pattern became increasingly disorganized during late September as other modes, such as tropical cyclone activity over the far western Pacific, interfered with the intraseasonal signal.
- Suppressed convection over the eastern Pacific may be tied to the evolving base state.
- More recently, an eastward propagating envelope of enhanced divergence aloft is crossing the eastern Pacific.

200-hPa Wind Anomalies

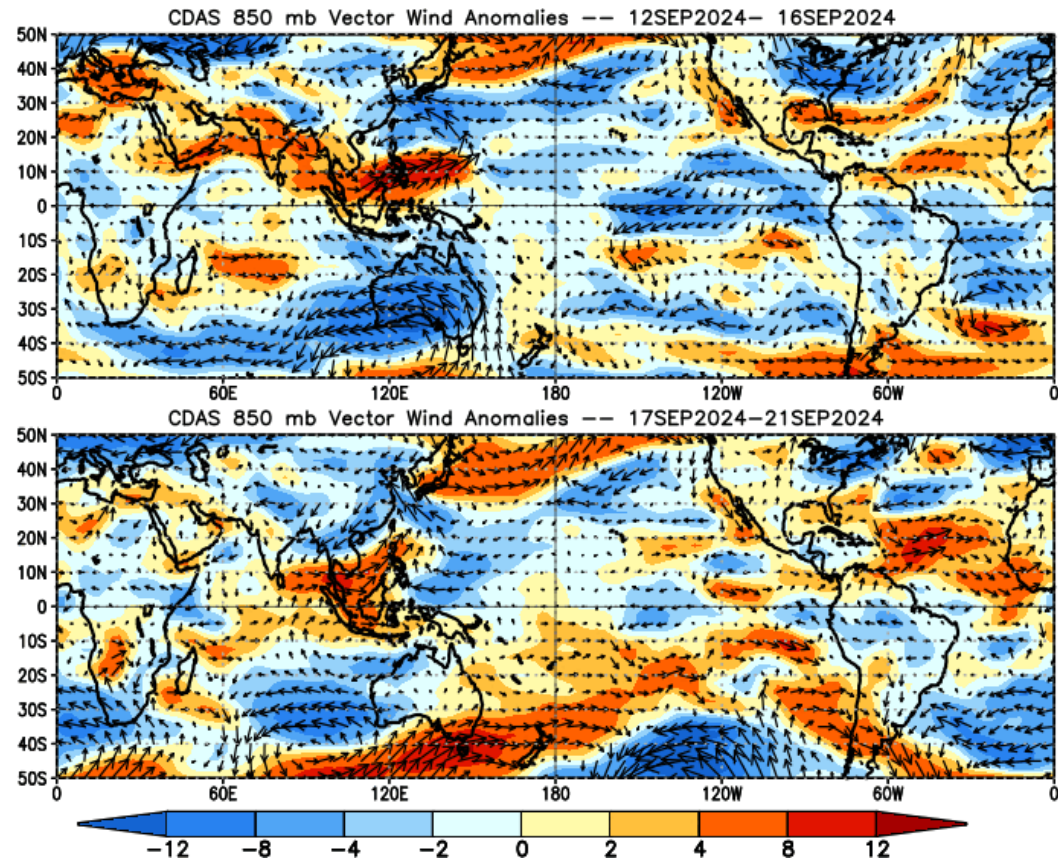
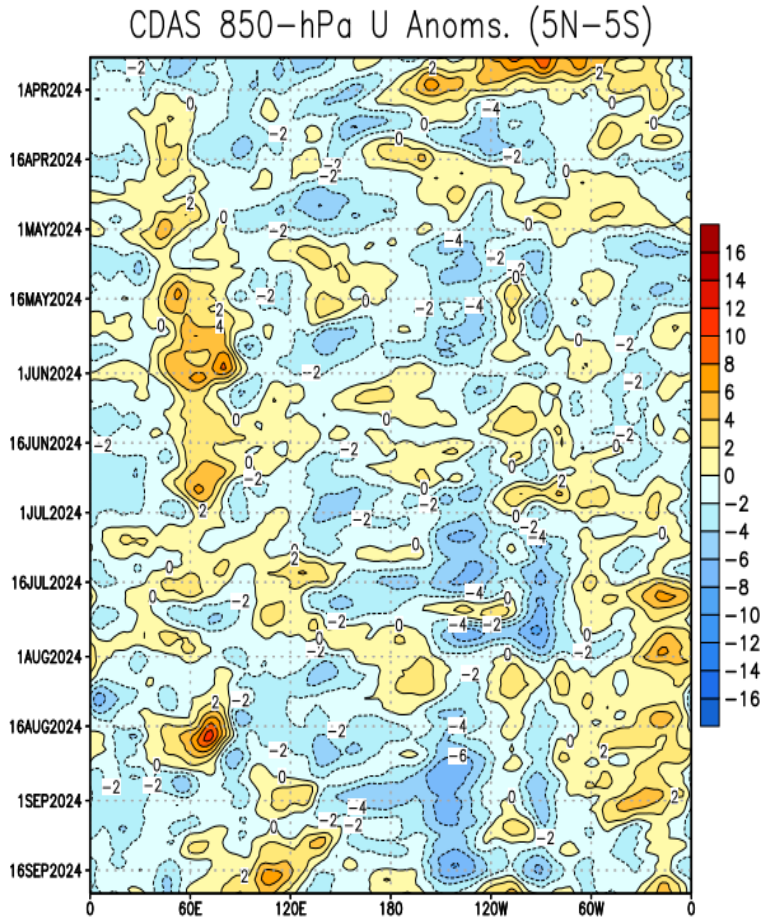
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Westerly anomalies have been present over the eastern Pacific near 120W since late August.
- Easterly anomalies near the Date Line are helping to increase divergence aloft over the eastern Pacific.
- Westerly anomalies have emerged over the western and central Indian Ocean.

850-hPa Wind Anomalies

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

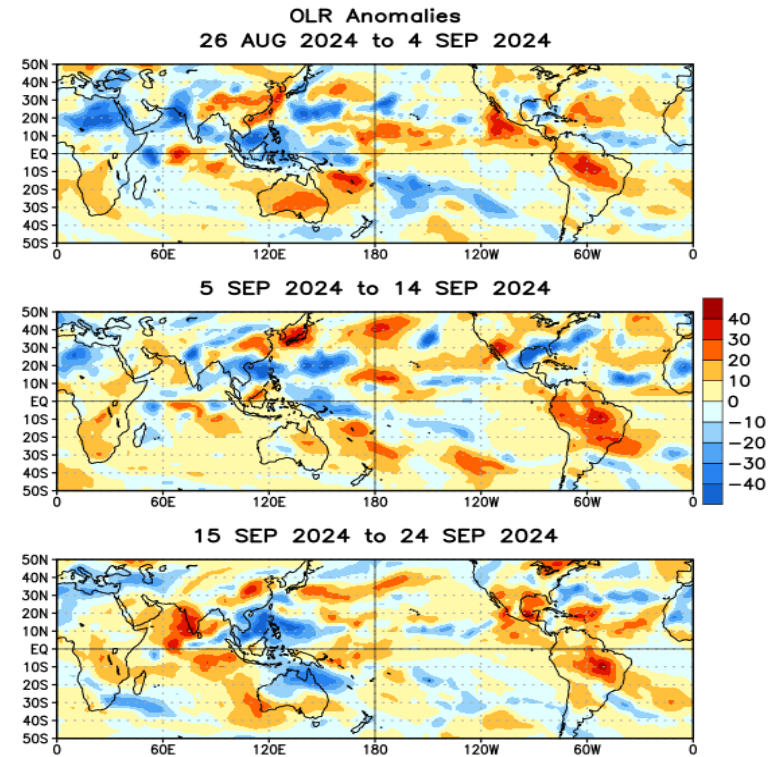
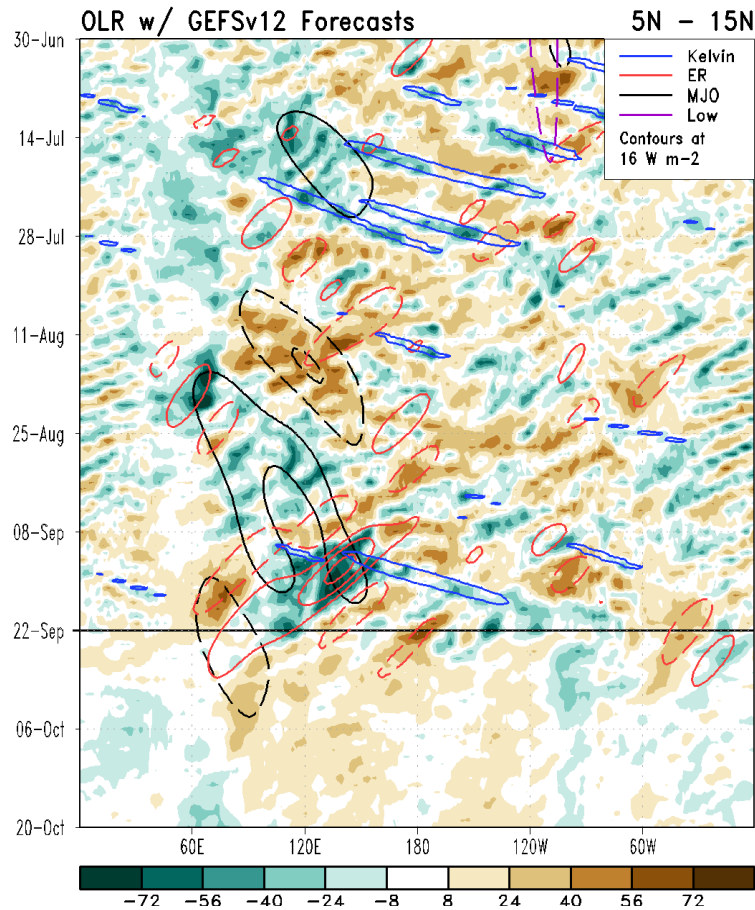


- The enhanced trade wind regime over the east-central Pacific weakened over the past few days, though enhanced trades remain in place near 140W.
- Westerly anomalies remain present across much of the tropical North Atlantic.
- Westerly anomalies across the Indian Ocean appear tied to equatorial Rossby wave activity.

Outgoing Longwave Radiation (OLR) Anomalies

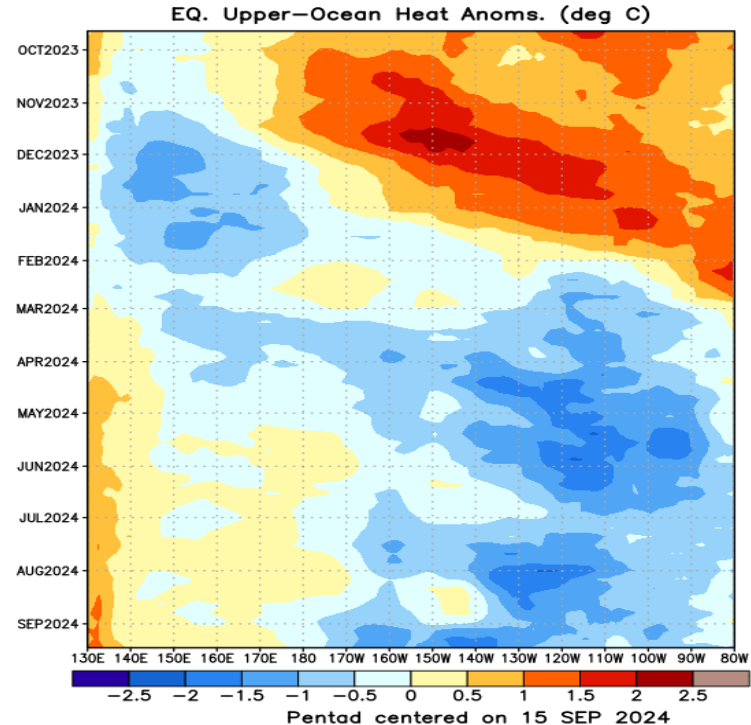
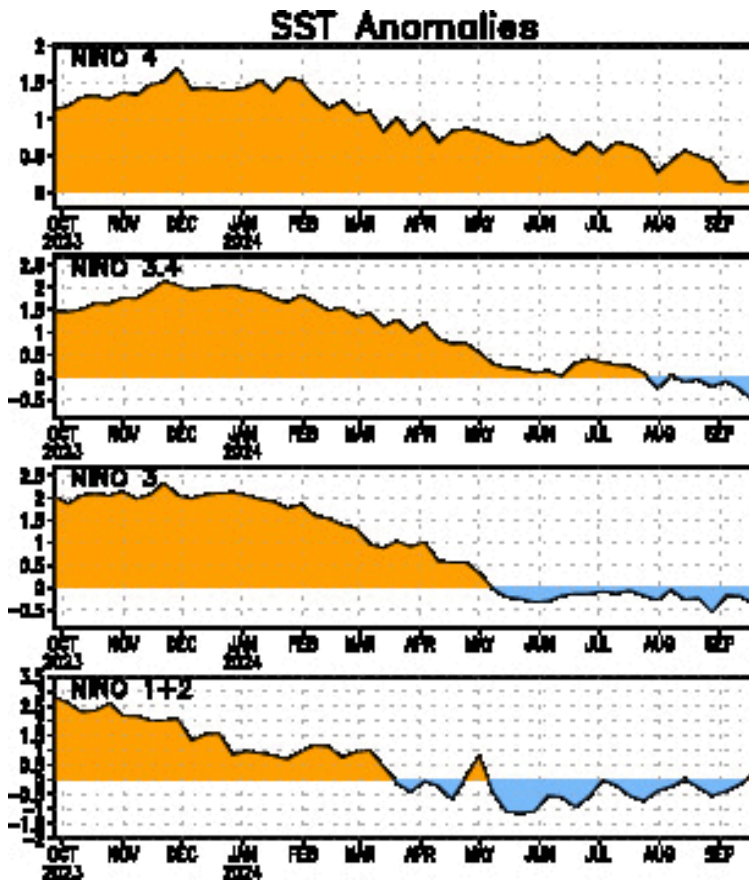
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- Strong equatorial Rossby wave activity crossing the Maritime Continent and eastern Indian Ocean interfered with the MJO signal crossing the basin in early September.
- Kelvin wave activity crossed the Pacific during mid-September, and may help touch off a period of increased Central American Gyre (CAG) activity moving into October.

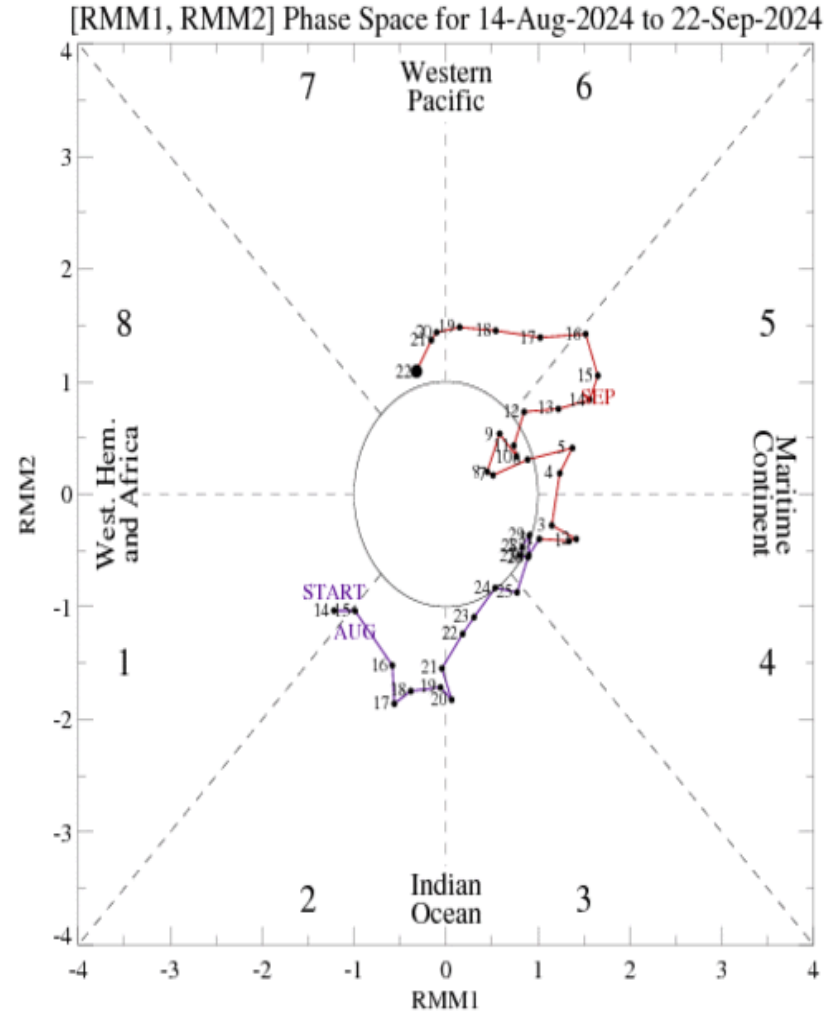
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- SSTs in Niño 3.4 and 4 continue to register below normal, while the easternmost Niño 1+2 region has seen a slight temperature increase. Niño 4 continues to trend towards zero, and is registering its lowest positive departure from normal since last year.
- Subsurface anomalies have continued to cool throughout the equatorial Pacific.

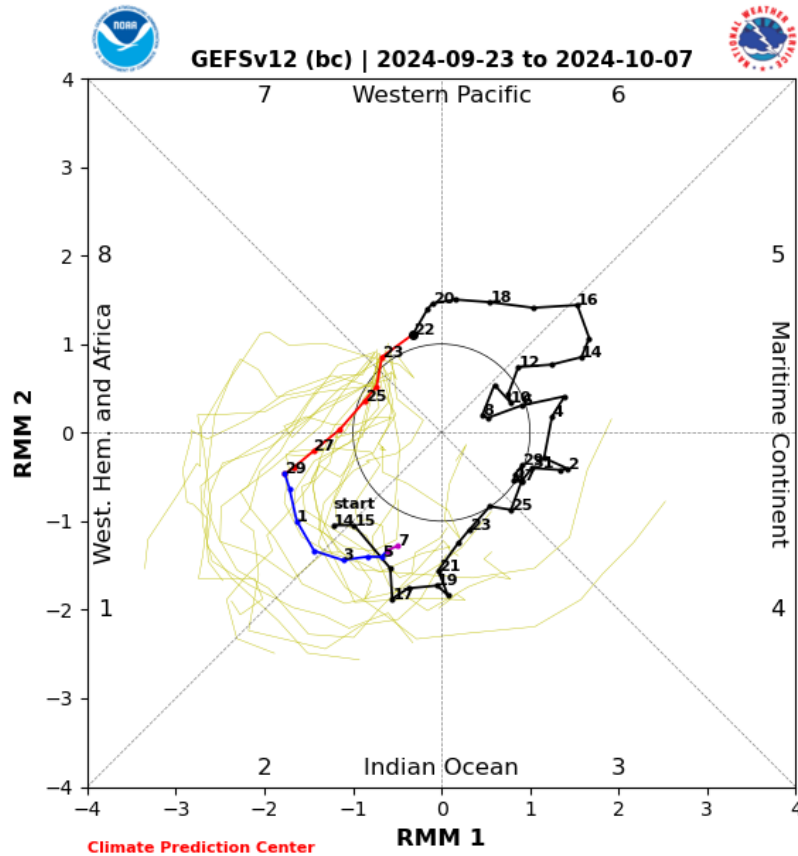
MJO Index: Recent Evolution

- Following a period of rapid weakening and amplification over the Maritime Continent during early and mid-September, possibly tied to strong equatorial Rossby wave influences, the RMM index has shown re-established eastward propagation across the Pacific.

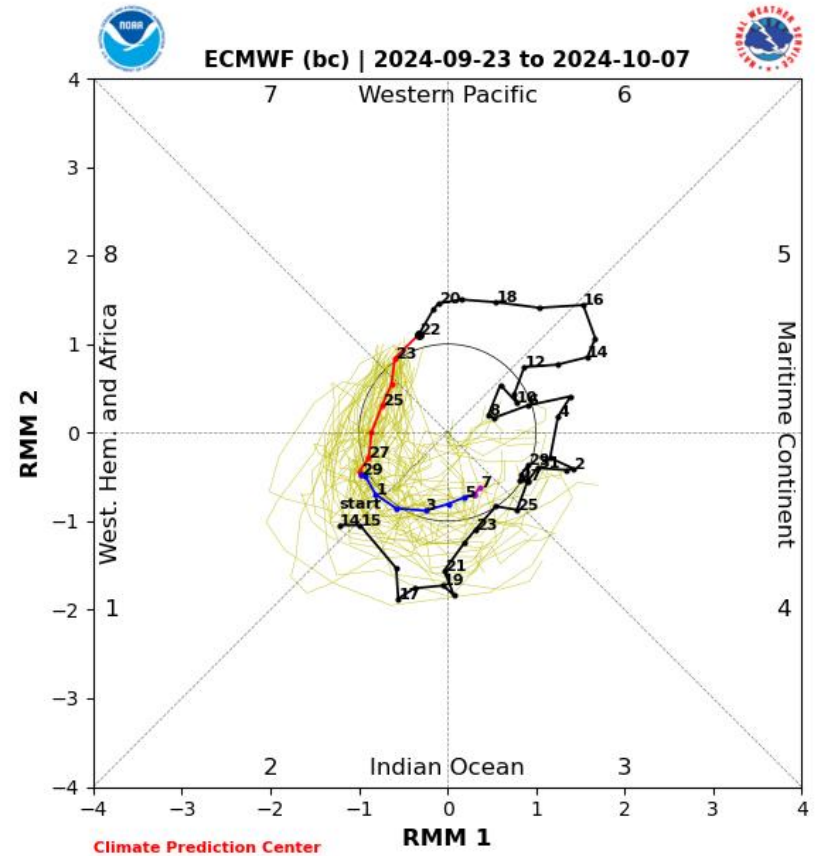


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



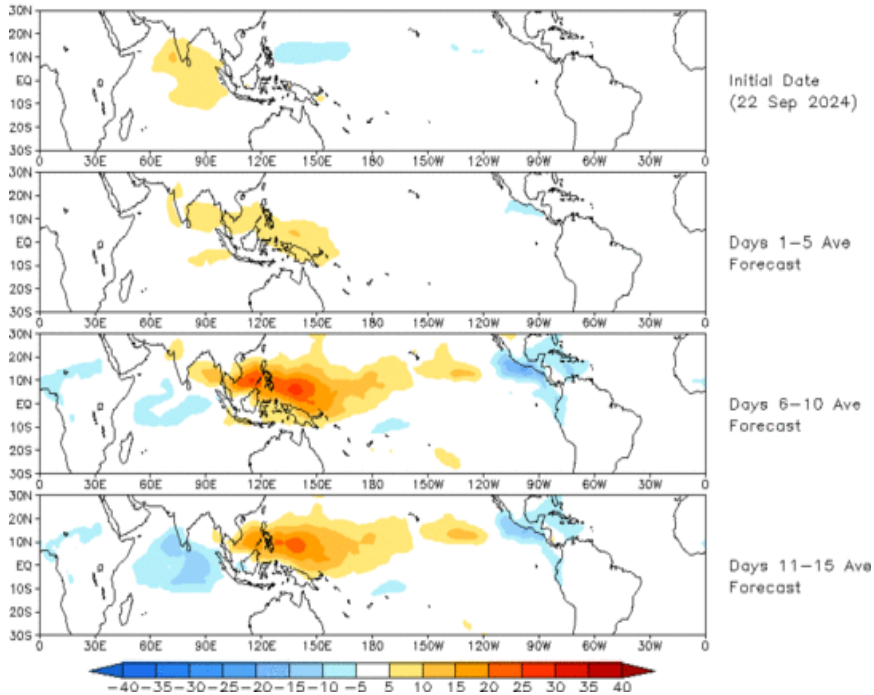
ECMWF Forecast

- Dynamical models favor continued MJO-like eastward propagation over the next several weeks, with the enhanced convective phase reaching the Indian Ocean basin during Week-2.
- The GEFS depicts a more amplified signal in general compared to the ECMWF, but robust eastward propagation is evident in both model systems.

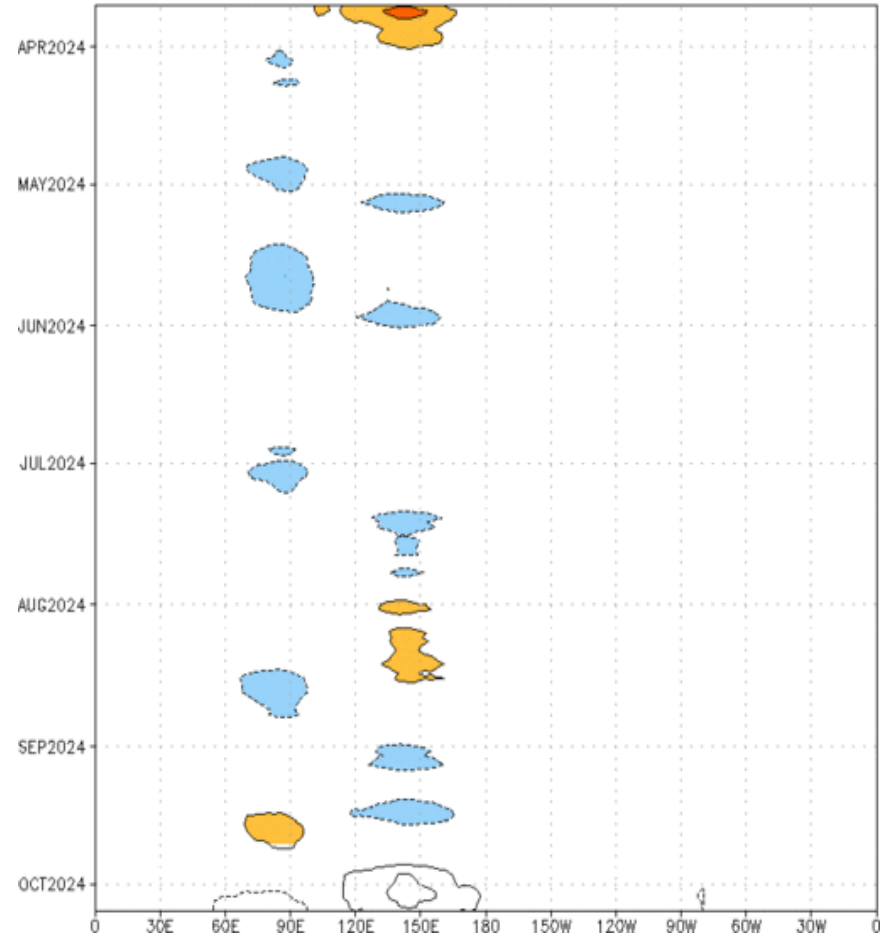
MJO: GEFS Forecast Evolution

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: 22 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: 23-Mar-2024 to 22-Sep-2024
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

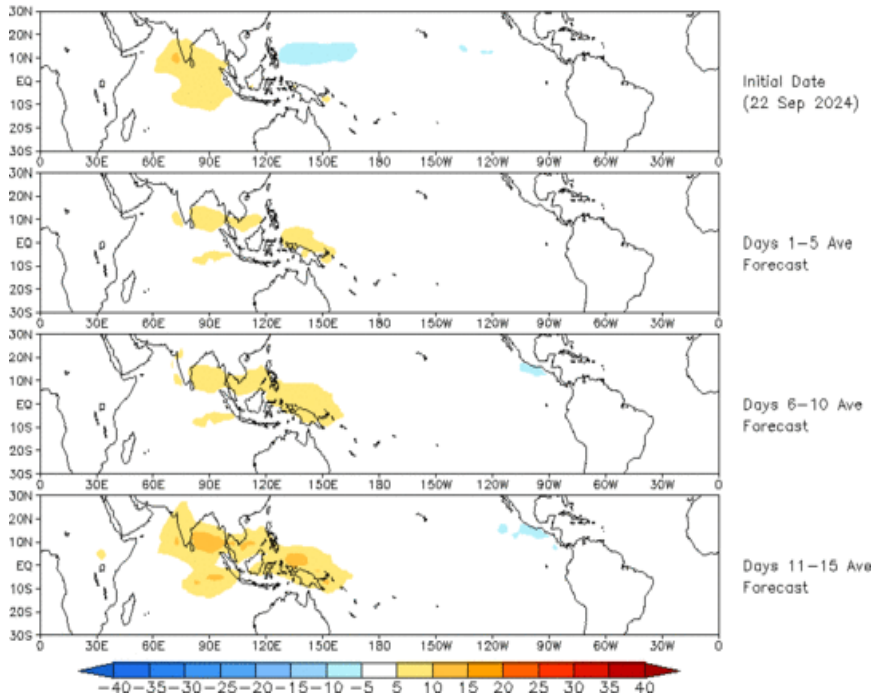


- The GEFS OLR anomaly forecast depicts a robust, canonical MJO-like evolution with the enhanced convective phase crossing the Western Hemisphere and entering the Indian Ocean basin by the end of Week-2.

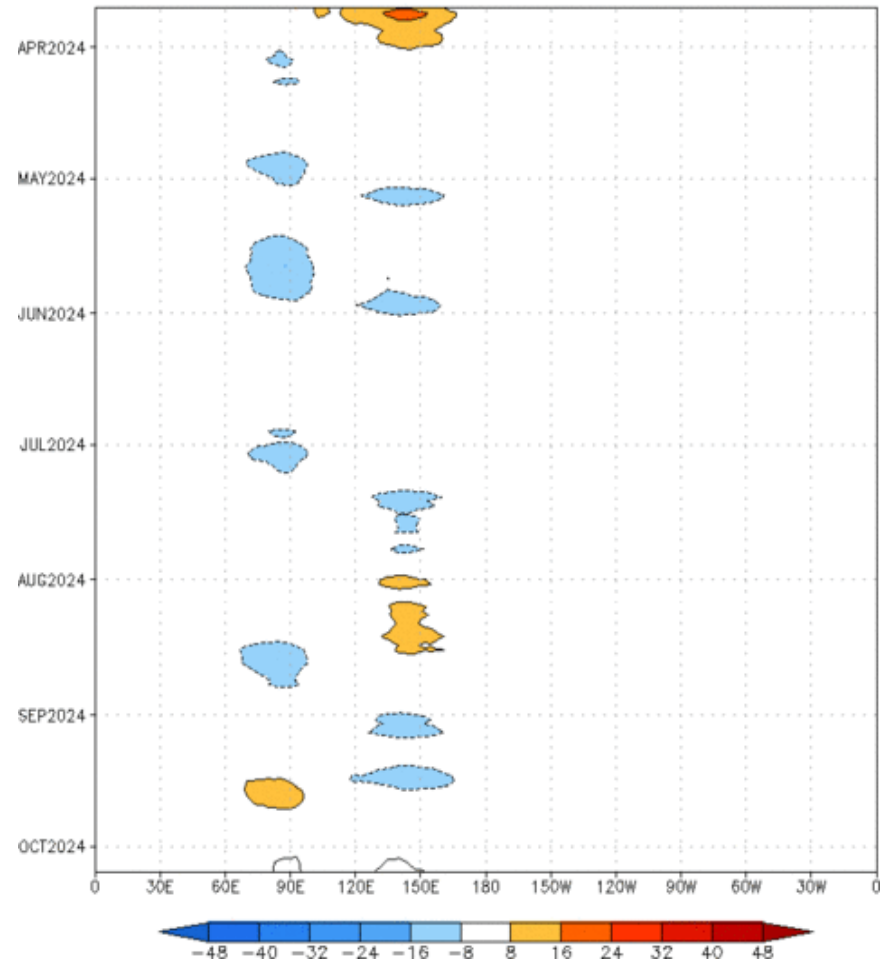
MJO: Constructed Analog Forecast Evolution

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 (22 Sep 2024)



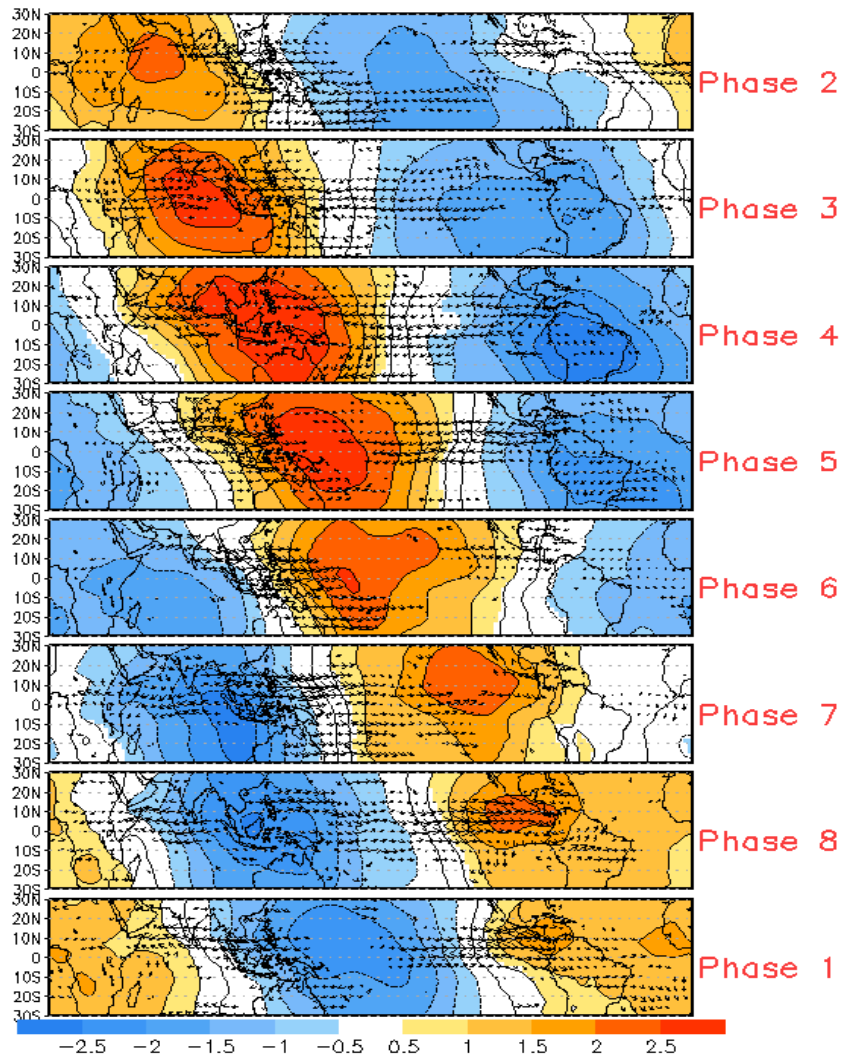
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:23-Mar-2024 to 22-Sep-2024
The unfilled contours are CA forecast reconstructed anomaly for 15 days



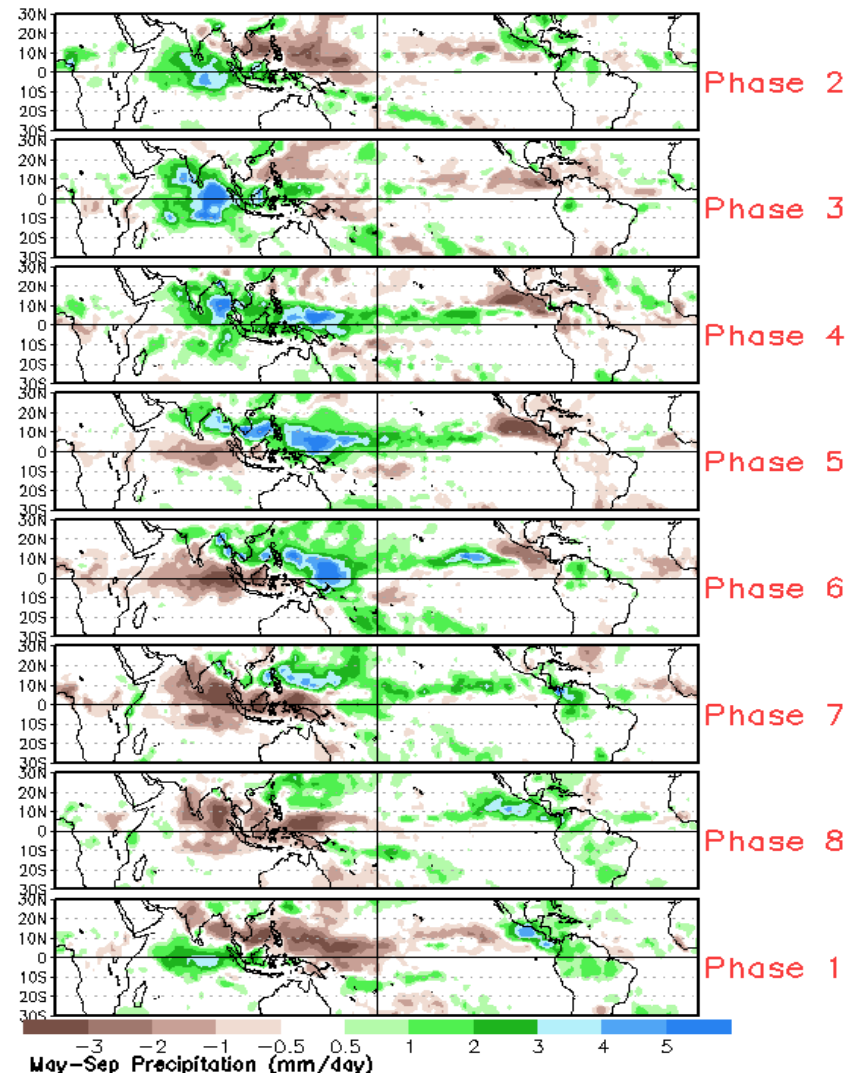
- The constructed analog forecast shows weaker convective anomalies compared to the GEFS, along with a much slower evolution that leaves it out of phase with the GEFS by the end of Week-2.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



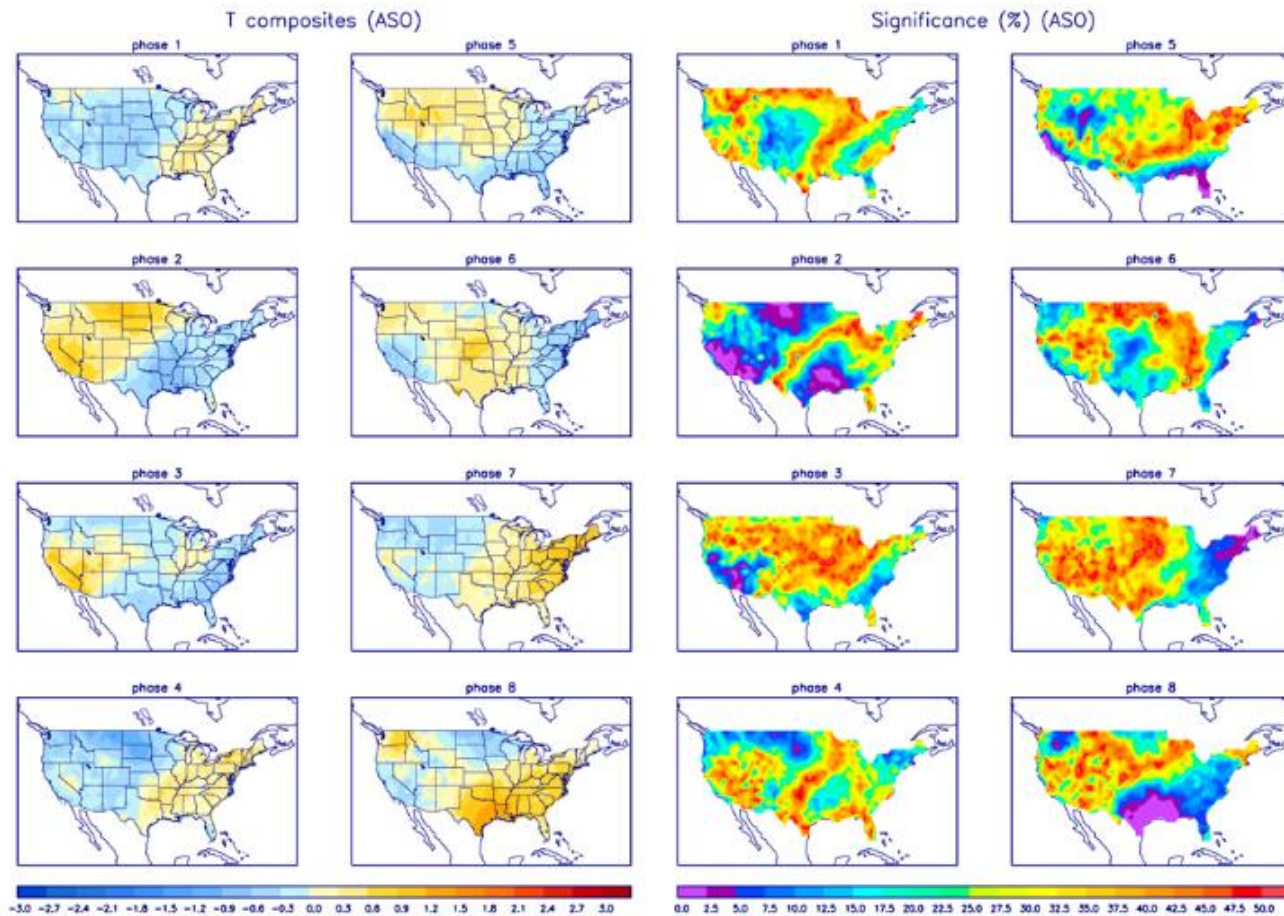
Precipitation Anomalies



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.



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.

