

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



Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
28 October 2024

Overview

- A robust MJO continues to propagate eastward through the global tropics, with the enhanced convective envelope currently over the western and central Pacific Ocean.
- Dynamical models are in good agreement that the MJO continues to propagate eastward into the western Hemisphere during early November.
- This predicted MJO evolution would enhance the potential for tropical cyclone (TC) development over the Eastern Pacific and Caribbean Sea during the week 1-2 period.
- The continued shift towards La Nina conditions has been notably slow in recent months, though enhanced trade winds over the equatorial Pacific may increase upwelling via Ekman transport and push down upper-ocean heat content east of the Date Line.

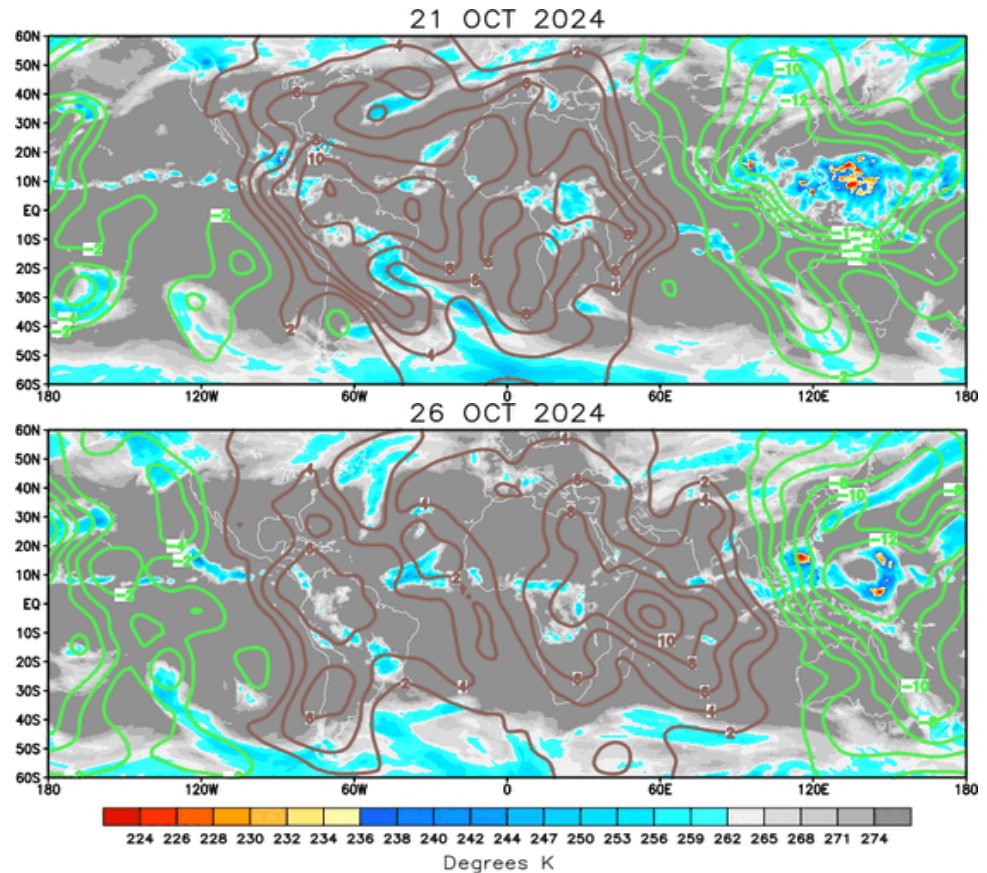
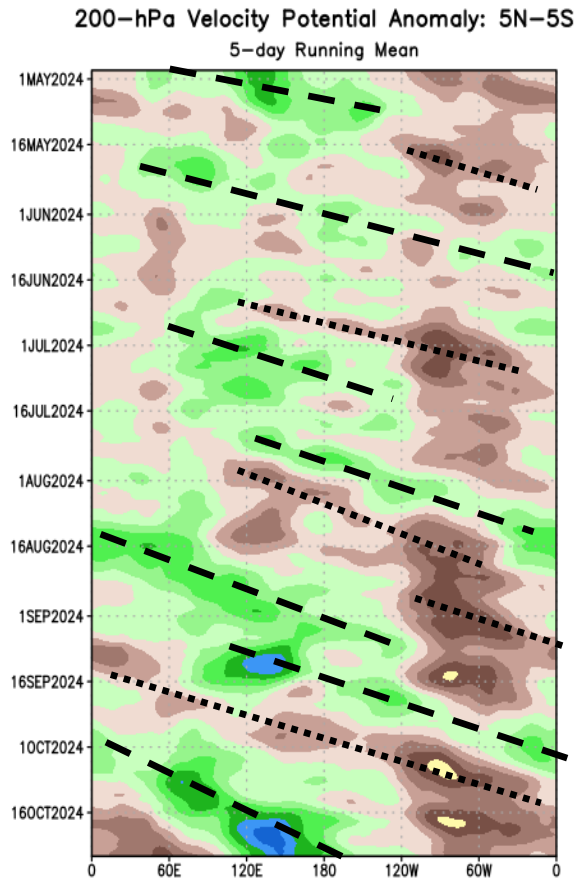
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:

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

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

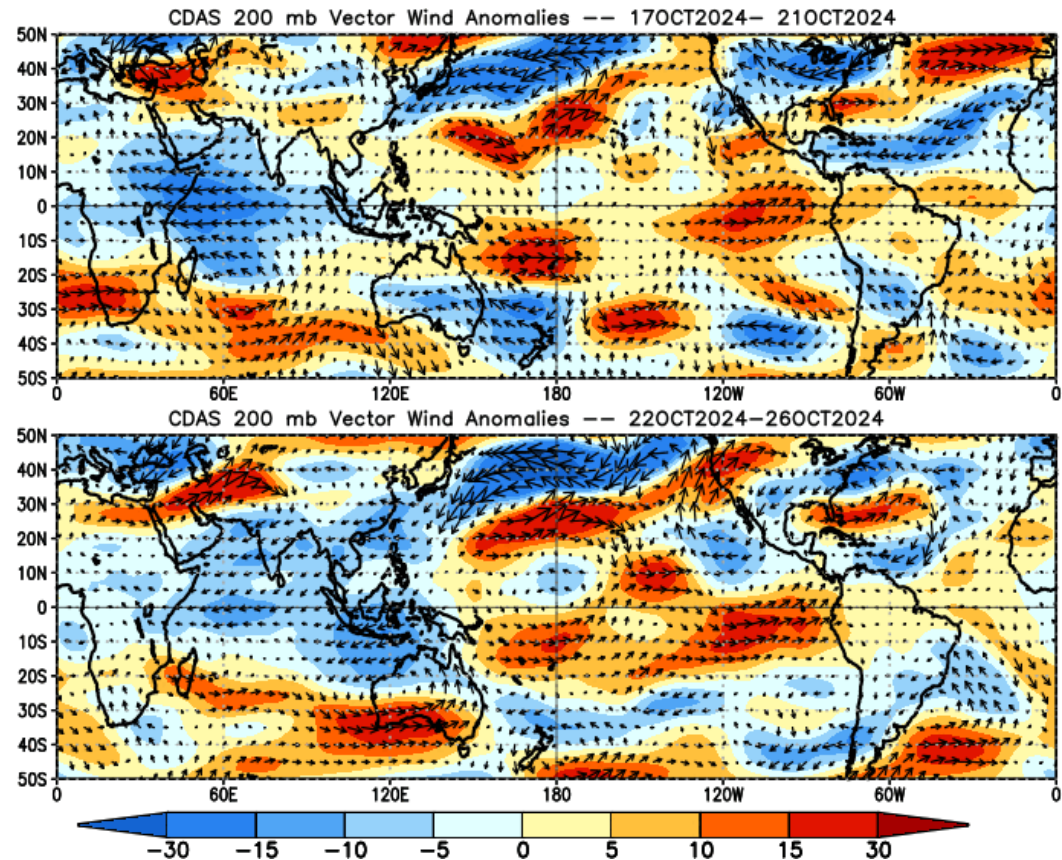
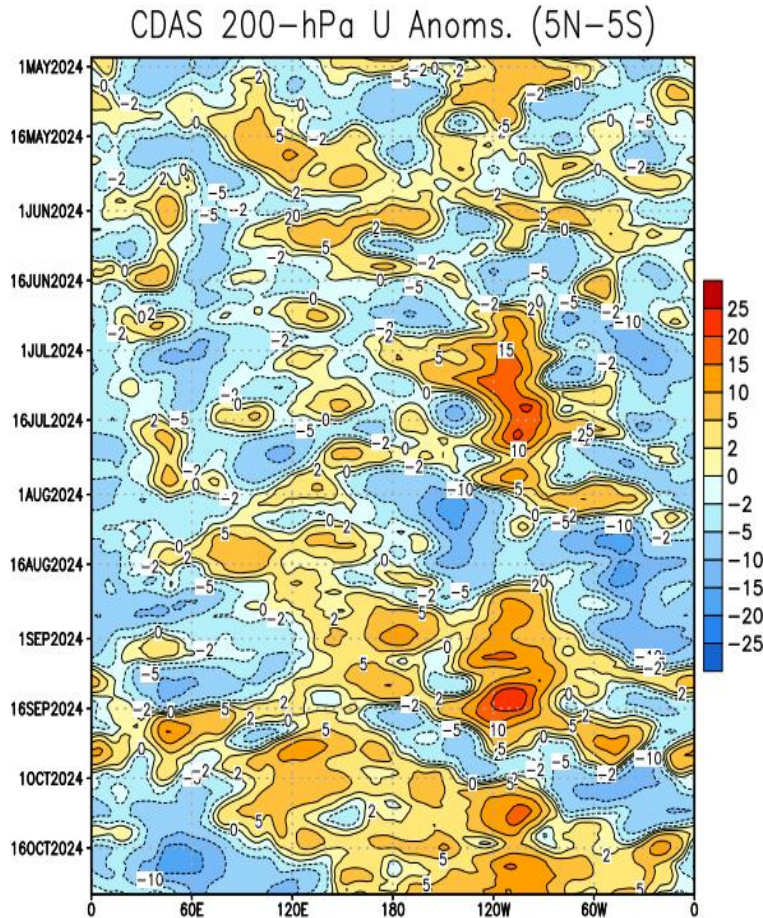
Brown shades: Anomalous convergence (unfavorable for precipitation)



- Upper-level velocity potential anomalies depict an amplified wave-1 pattern, where the enhanced (suppressed) divergence envelope is observed over the western and central Pacific (Americas to the western Indian Ocean).
- This wave-1 pattern is consistent with a robust MJO. The phase speed slowed during the first week of October potentially due to interference from persistent upper-level convergence over the East Pacific.

200-hPa Wind Anomalies

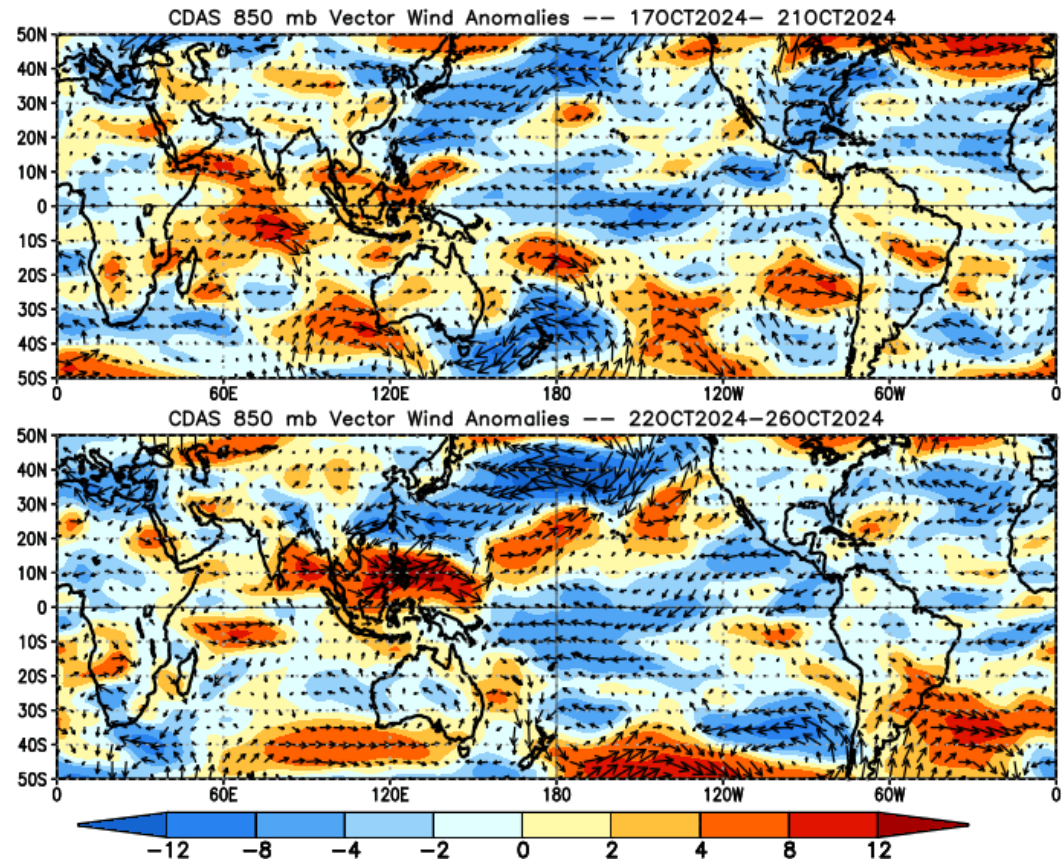
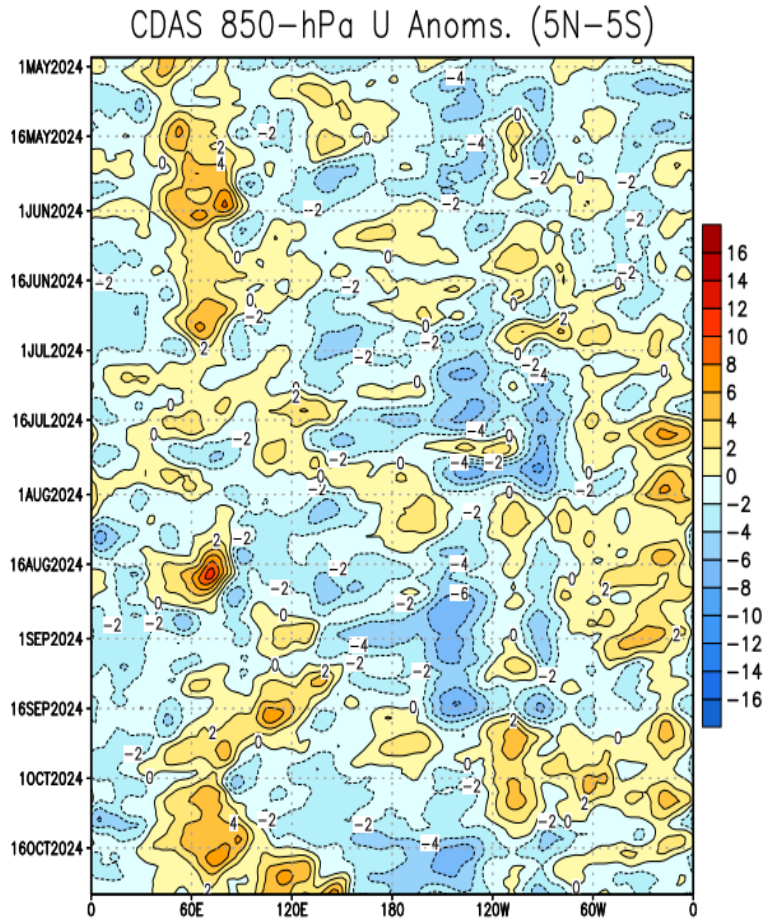
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- The westerly phase of the MJO is evident in the time longitude plot, and appears to have contributed to an enhanced subtropical jet over the North Pacific.
- The easterly phase of the MJO has migrated across the equatorial Indian Ocean, with enhanced easterlies recently emerging over the Maritime Continent.

850-hPa Wind Anomalies

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

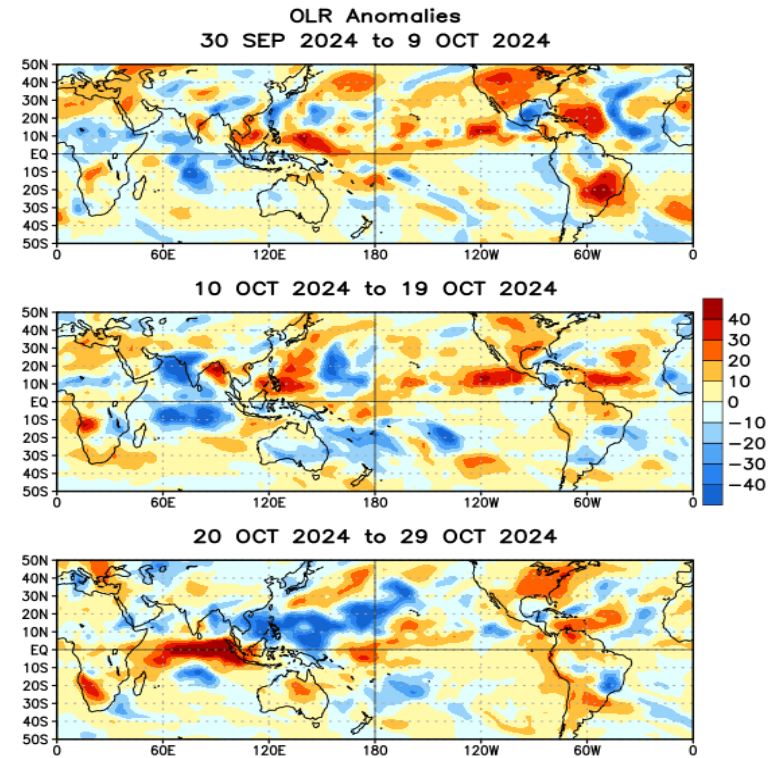
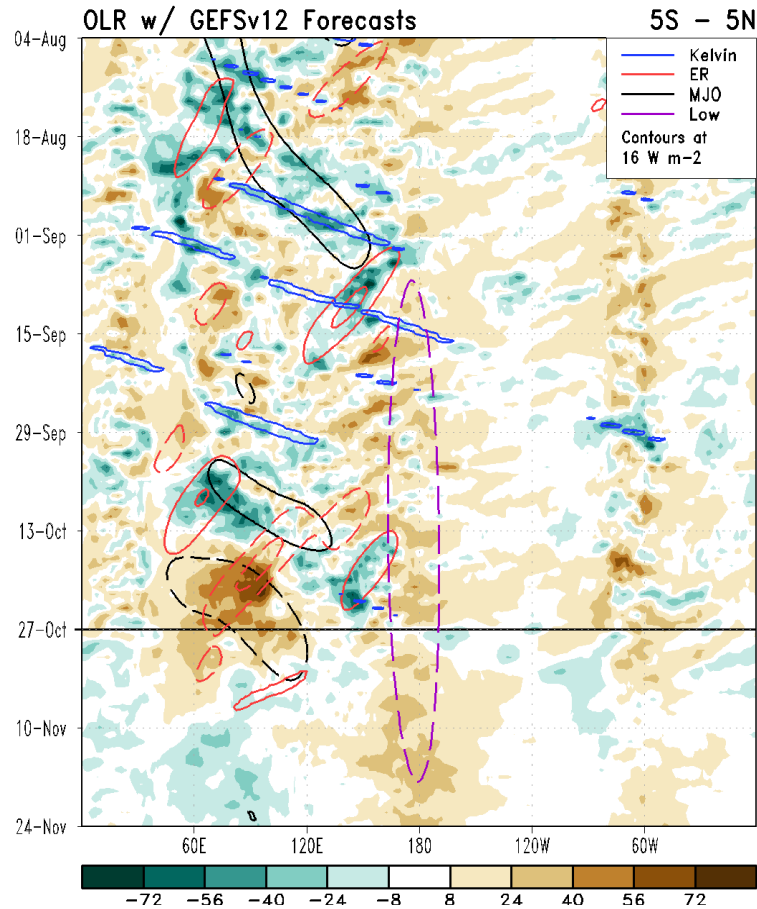


- Anomalous low-level westerlies have traversed the Indian Ocean in similar fashion to anomalous upper-level easterlies and are now centered over the Maritime Continent.
- Meanwhile, enhanced trade winds have continued over the equatorial Pacific, potentially aided by constructive interference between the developing La Niña and the MJO.

Outgoing Longwave Radiation (OLR) Anomalies

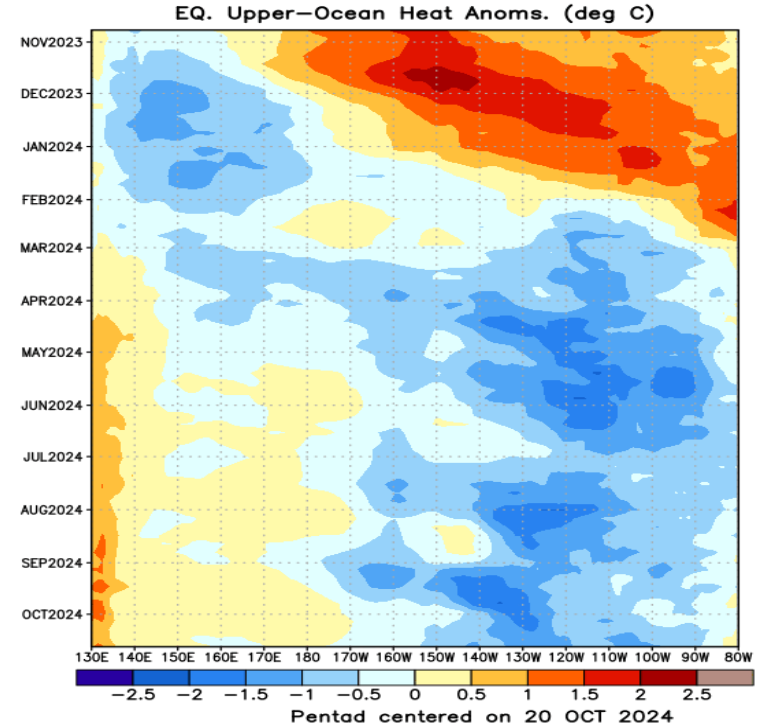
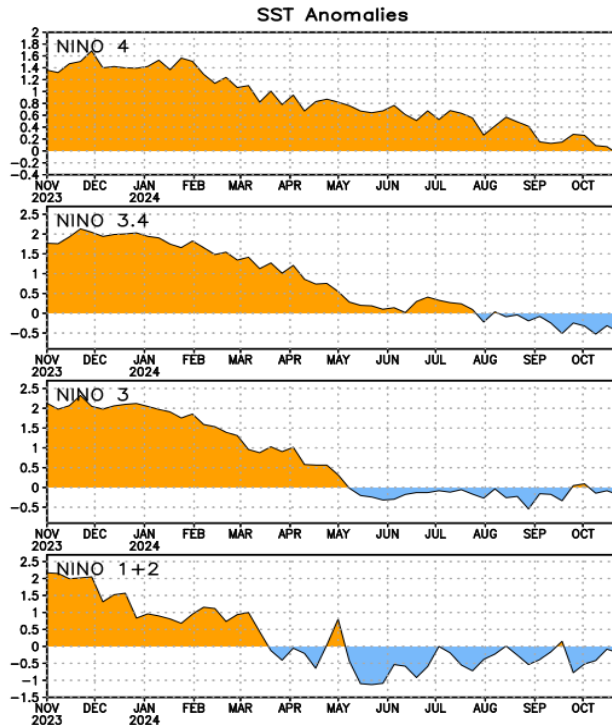
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- Enhanced convection moved from the Indian Ocean to the Maritime Continent and Western Pacific while suppressed convection continued to be widespread over the Western Hemisphere.
- OLR forecasts from the GEFS along the equator show the suppressed convection persisting across the equatorial central Pacific, associated with the developing La Niña, as well as a reemerging MJO signal over the Indian Ocean later in the forecast period.

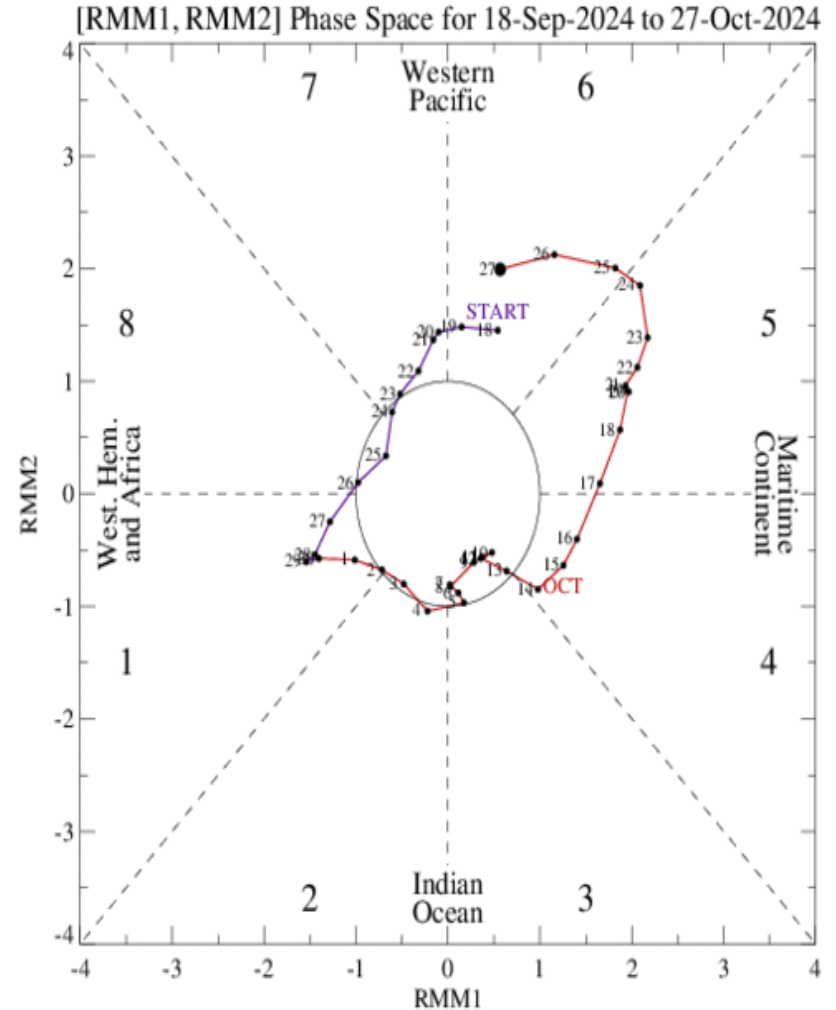
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- The eastern Niño regions remain neutral to slightly below normal, with Niño 4 now near zero.
- Ocean heat anomalies have not changed much over the last several months, with continued moderate cold anomalies east of 160°W and a much weaker warm signal east of the Date Line.

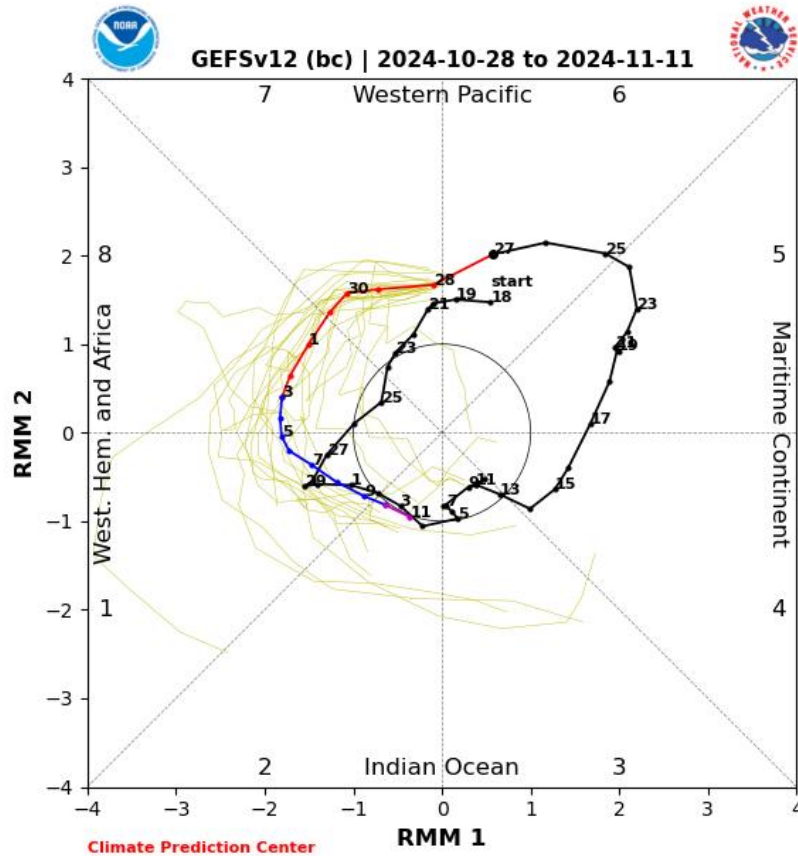
MJO Index: Recent Evolution

- RMM observations depict a circumnavigation during the past 35 days with a surge in signal strength as the RMM index moved through phases 5&6, consistent with a well-defined MJO.
- The MJO has lost amplitude somewhat as it propagated eastward to the Western Pacific but remains robust, with a higher amplitude than when the MJO was last moving through phase 6.

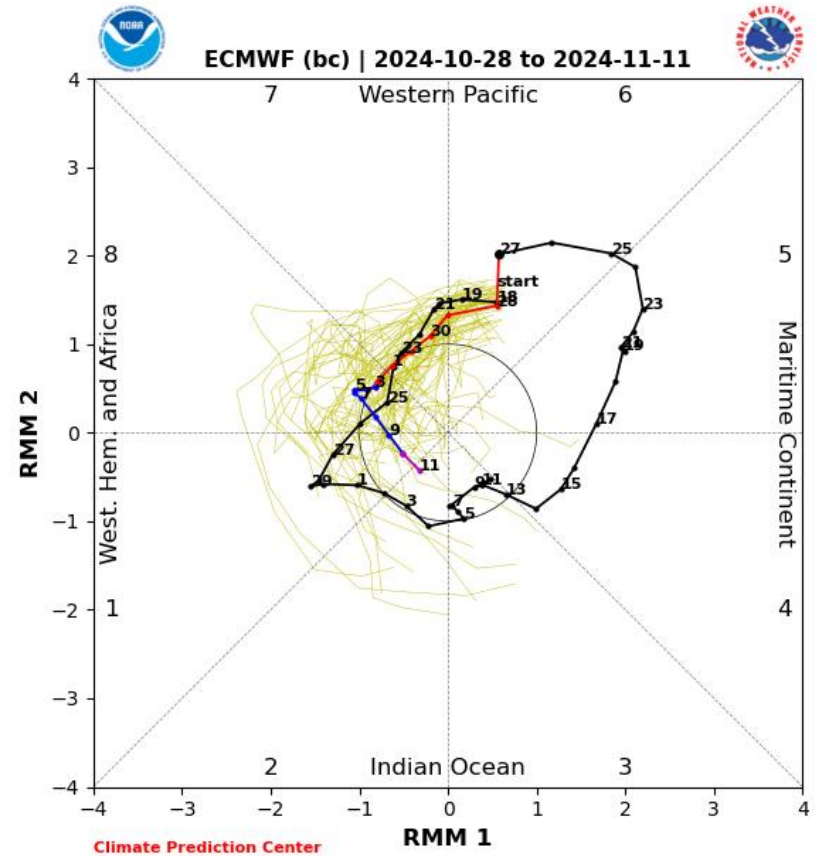


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



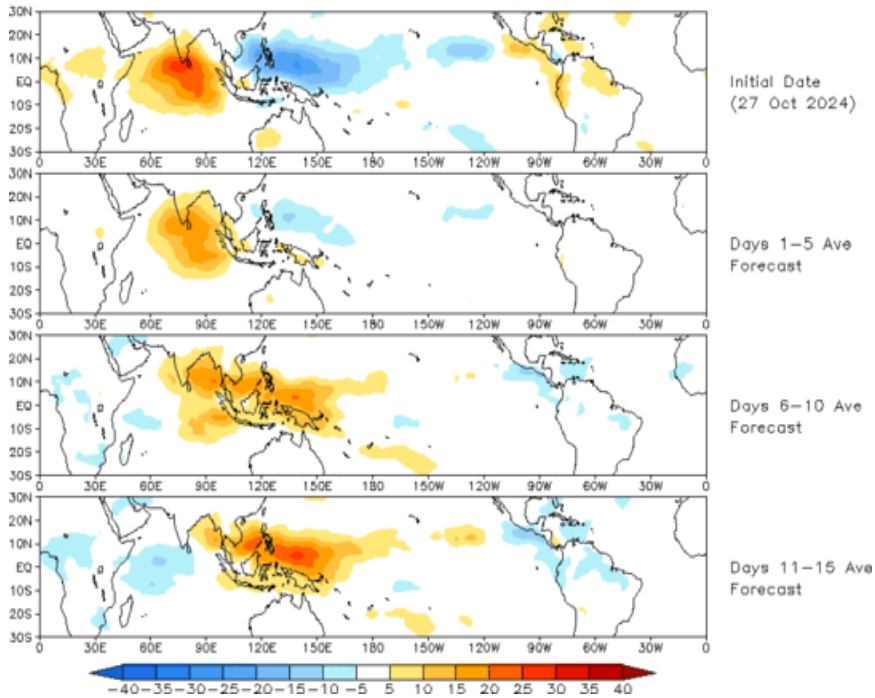
ECMWF Forecast

- Dynamical models are in good agreement and depict a continued eastward propagation of the MJO from the Maritime Continent to the western Hemisphere by the beginning of November.
- The GEFS favors the MJO to remain coherent and amplified well into week-2, while the ECMWF is less bullish regarding the strength of the MJO beyond week-1. Both models are in very good agreement regarding phase speed.

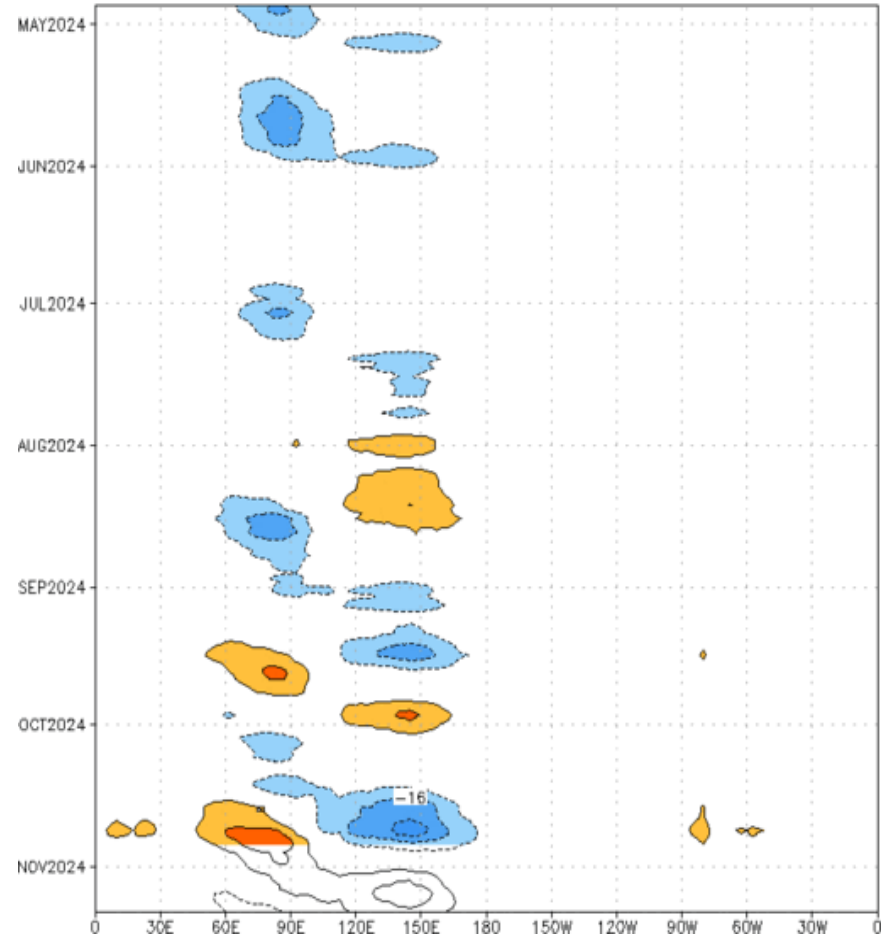
MJO: GEFS Forecast Evolution

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: 27 Oct 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: 27-Apr-2024 to 27-Oct-2024
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

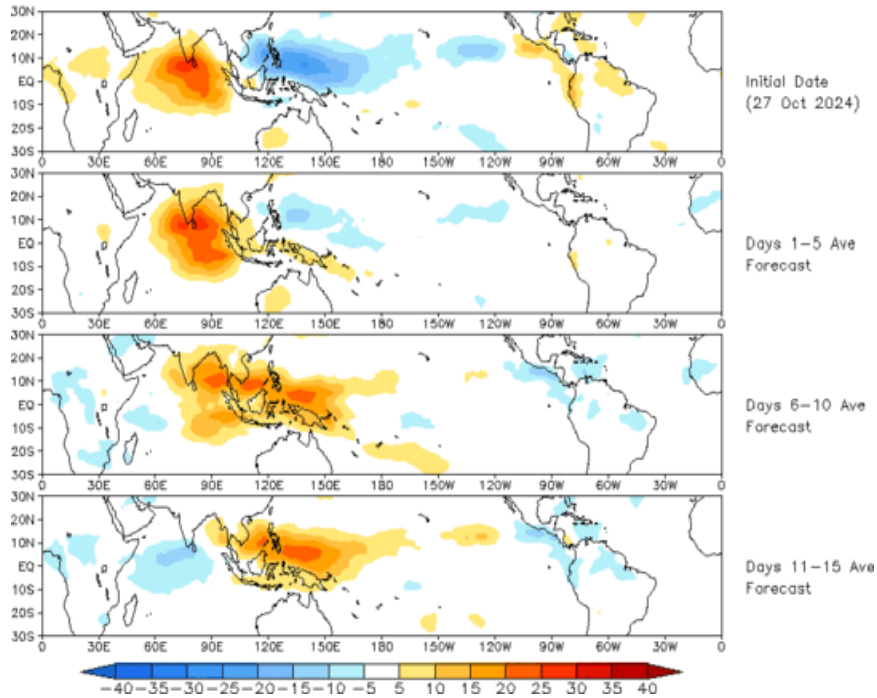


- The GEFS OLR anomaly forecast depicts enhanced convection moving into the Western Hemisphere while strong suppressed convection emerges over the Maritime Continent during week-2.

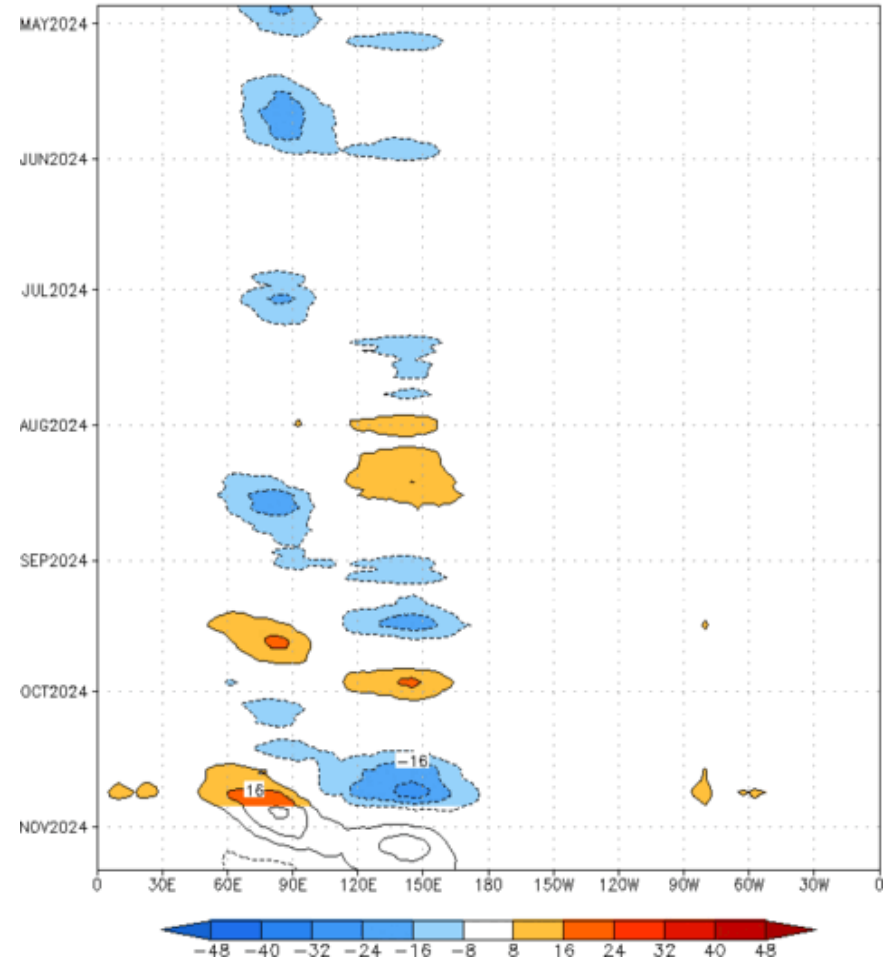
MJO: Constructed Analog Forecast Evolution

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 (27 Oct 2024)



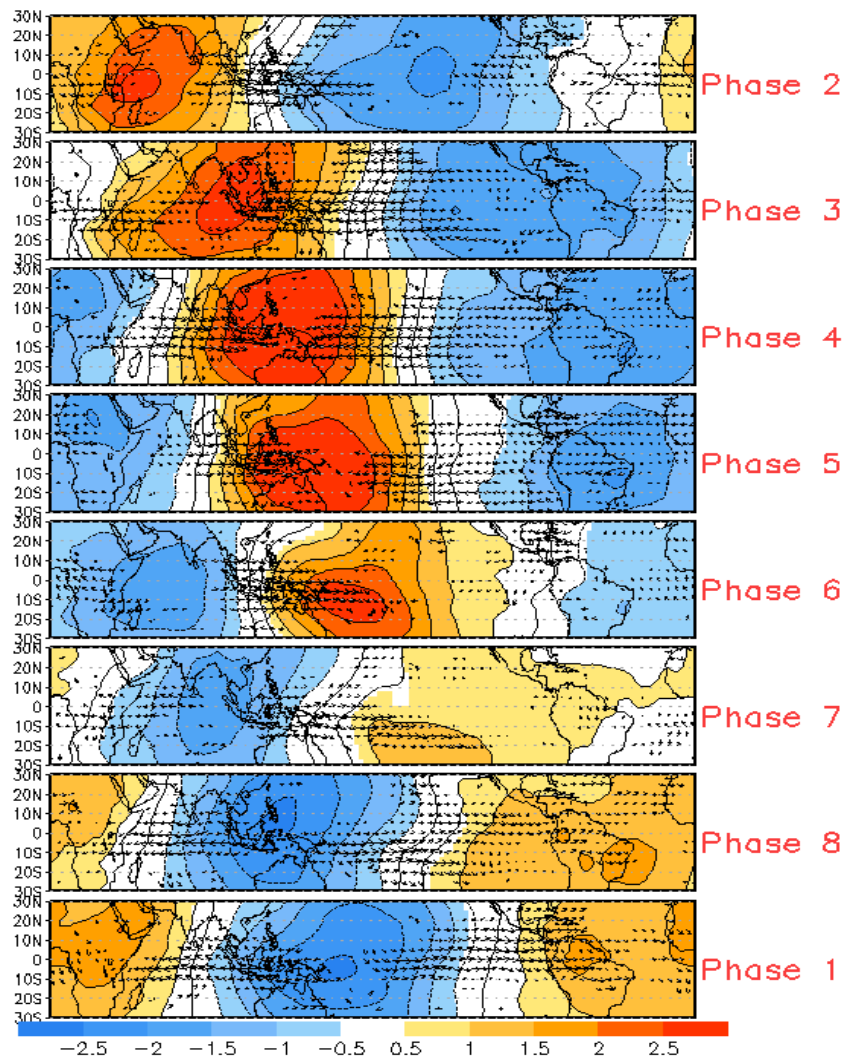
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:27-Apr-2024 to 27-Oct-2024
The unfilled contours are CA forecast reconstructed anomaly for 15 days



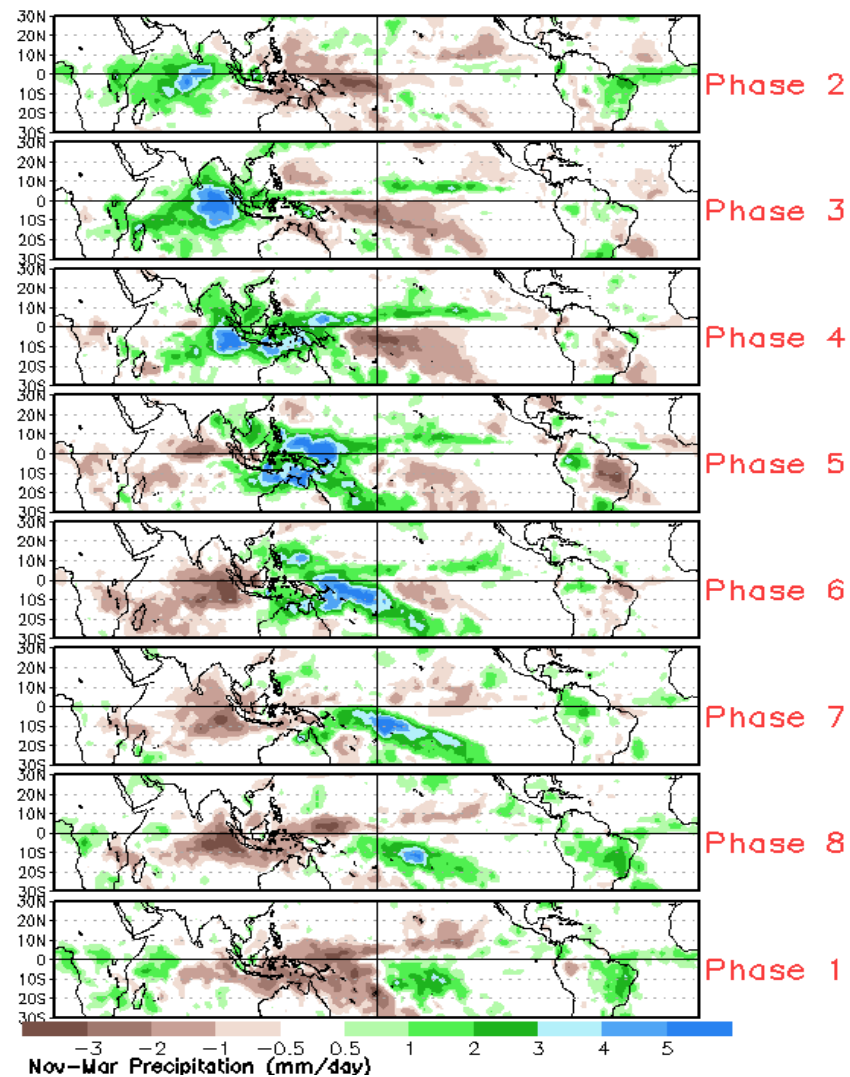
- The constructed analog forecast is very similar to the GEFS forecast.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



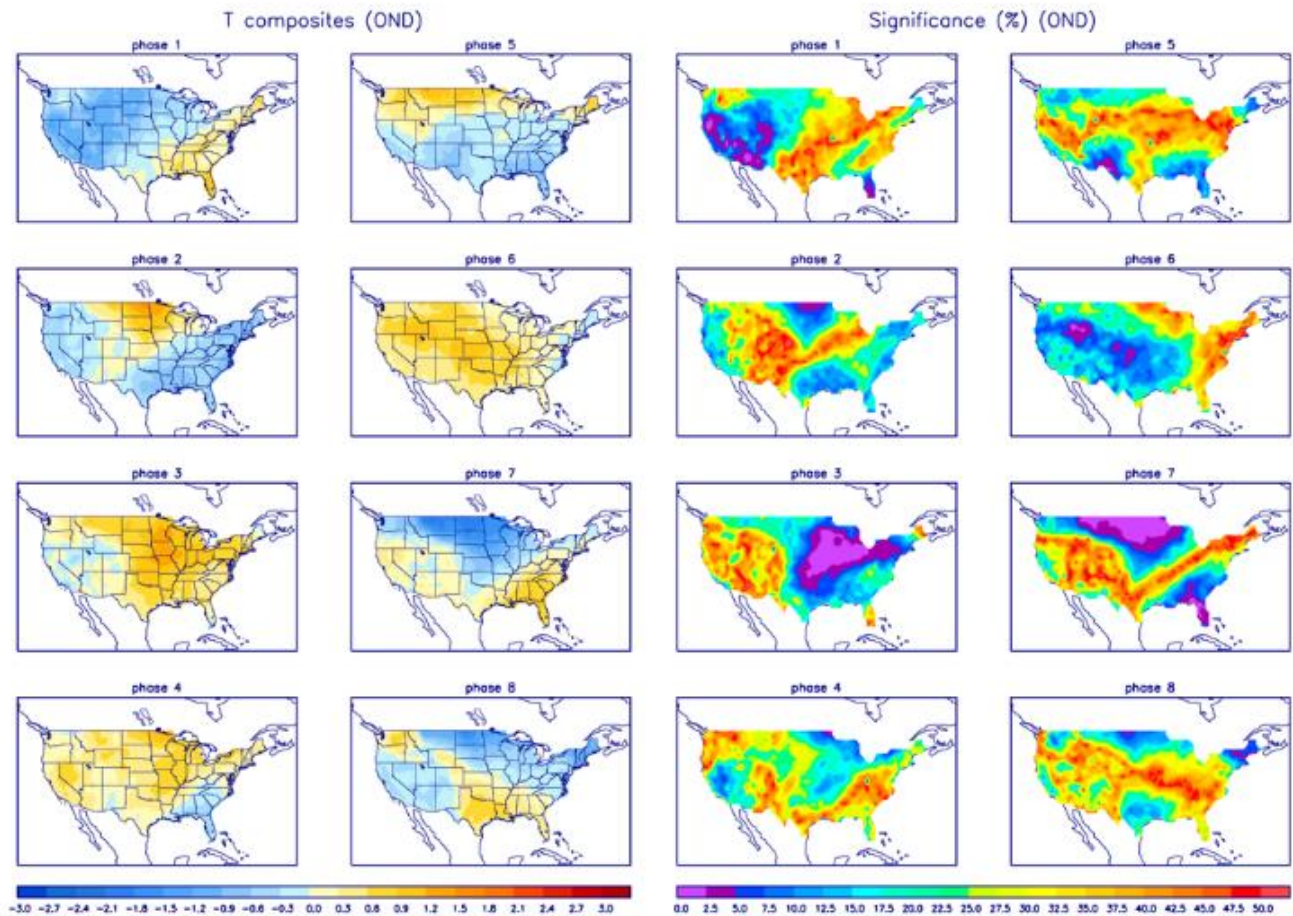
Precipitation Anomalies



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.

