

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



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

Overview

- The MJO has continued to be a significant player in the tropics. However, the emerging La Niña base state has been a growing source of interference with both the propagation and amplitude of the MJO.
- Dynamical model forecasts depict continued eastward propagation of the MJO signal with a slow phase. Extended range RMM-index solutions indicate the potential for a surge in the strength of the MJO during weeks 3&4 as it moves out into the Central Pacific and La Niña interference lessens.
- A continued eastward MJO propagation over the Pacific would favor a period of below-normal temperatures across the northeastern U.S. to start off the New Year, as well as a wet start for the West Coast.

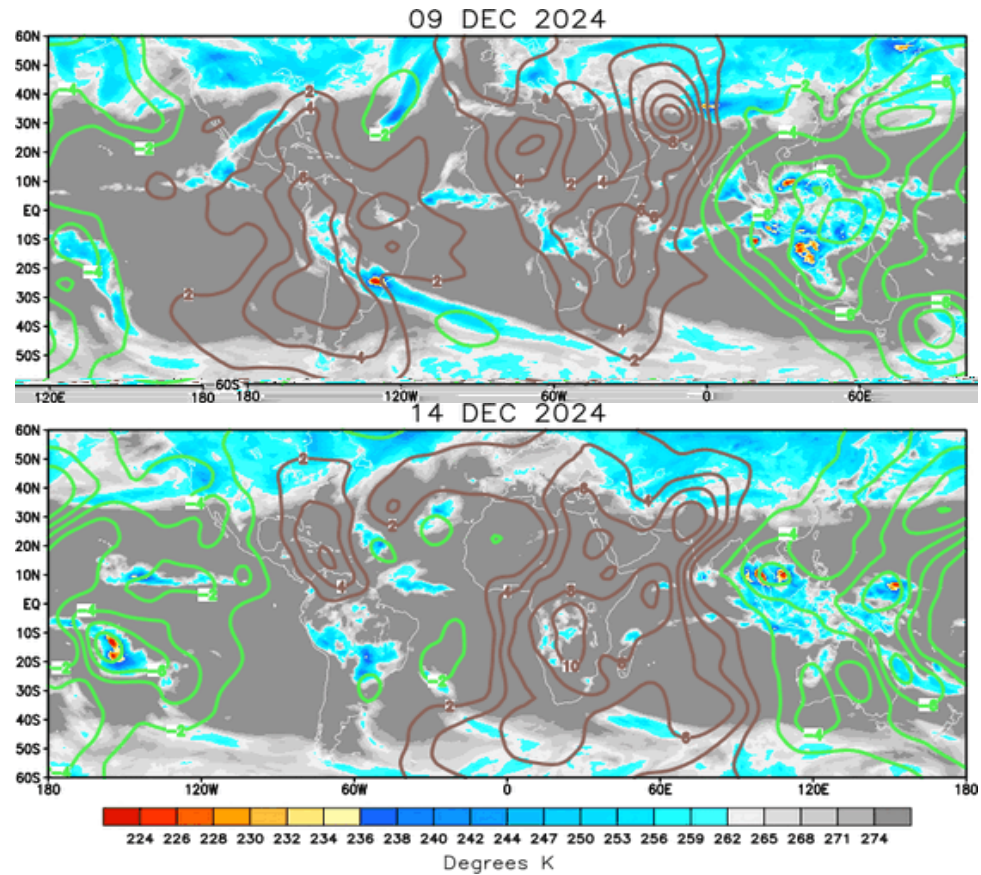
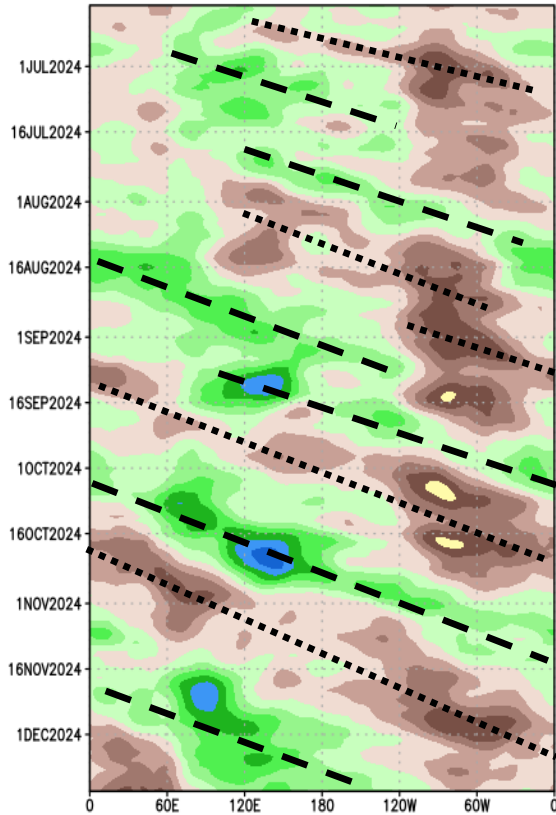
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

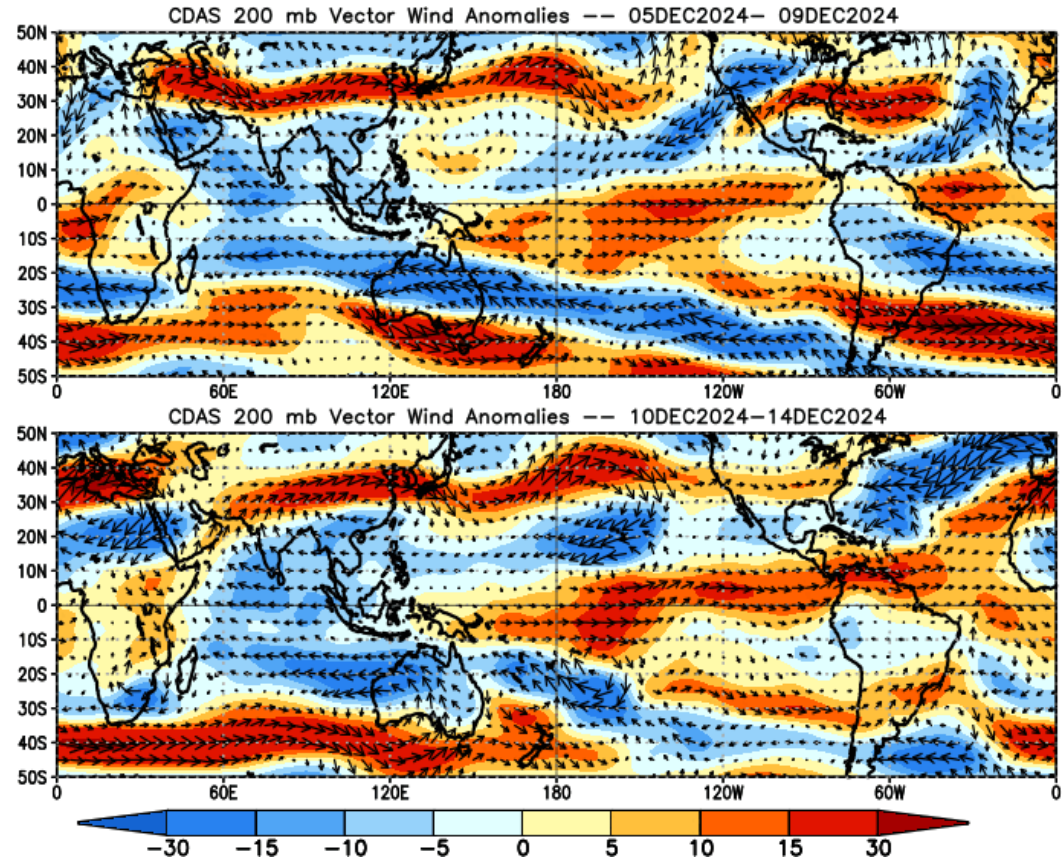
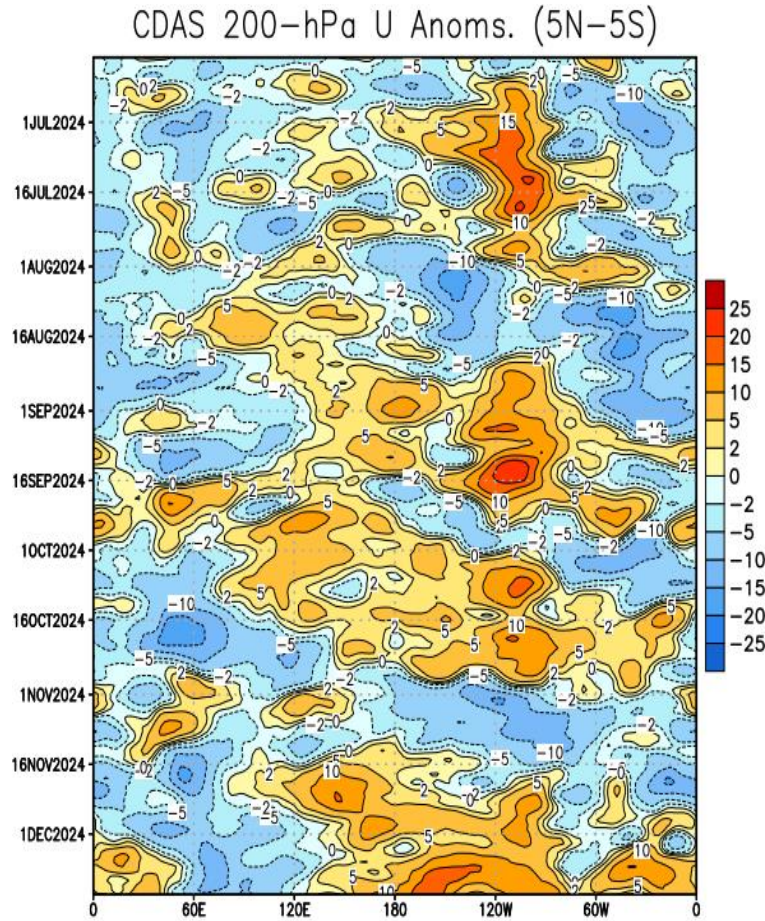
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- The VP anomalies have shown a robust wave-1 pattern since early November, an indication of an active MJO.
- Eastward propagation of this signal remains apparent, with the enhanced divergence aloft moving away from the Maritime Continent and out into the Central Pacific.
- Constructive interference with the emerging low frequency base state is likely slowing the overall eastward propagation of the broad-scale enhanced envelope.

200-hPa Wind Anomalies

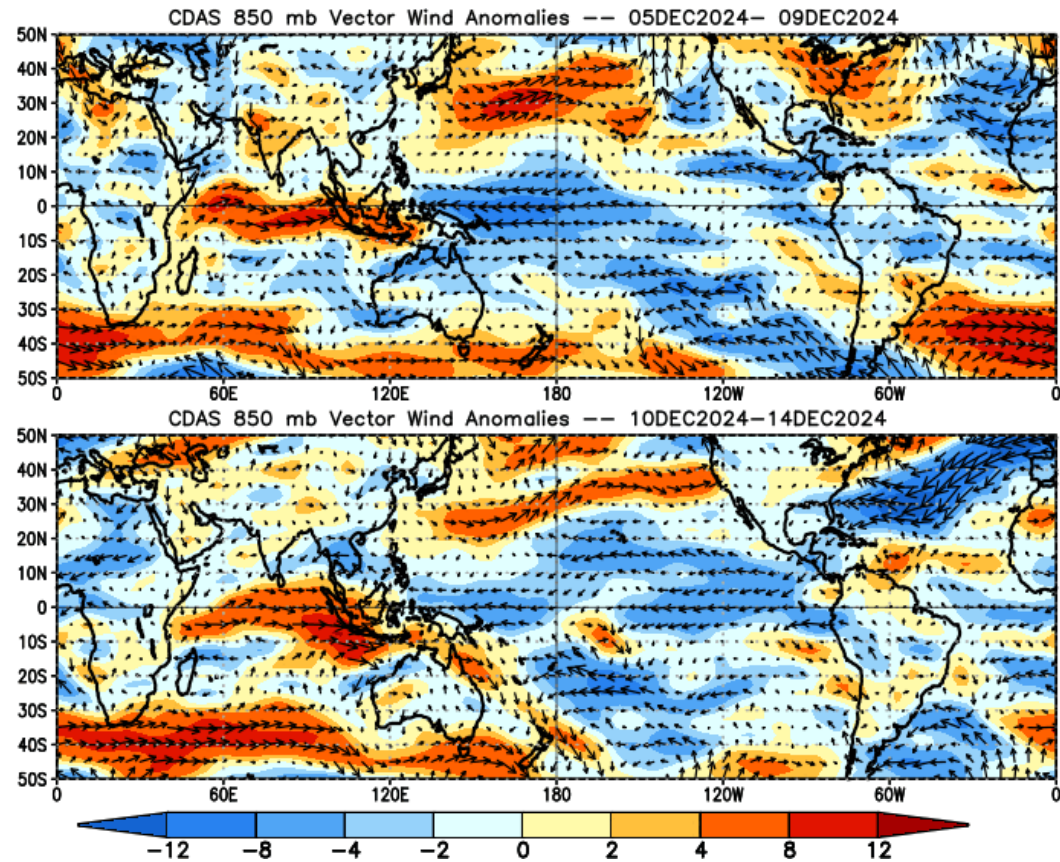
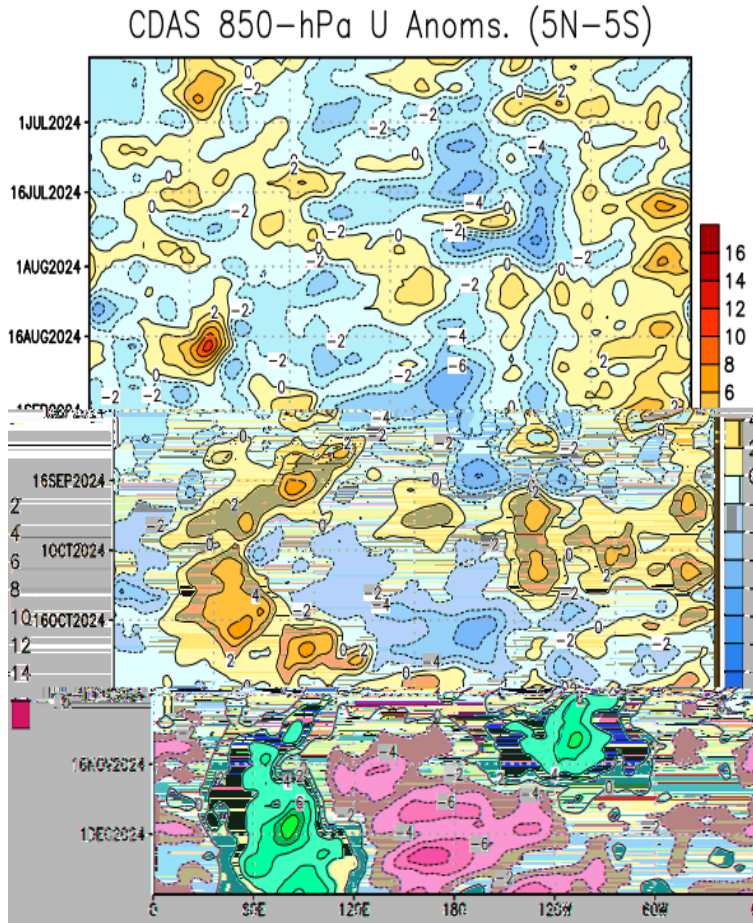
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Enhanced westerlies aloft over the Pacific have been observed from late November through early December, while easterly anomalies continued over the Indian Ocean basin.
- The growing westerly anomalies east of the Date Line are suggestive of the increased emergence of La Niña impacts on tropical circulation.

850-hPa Wind Anomalies

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

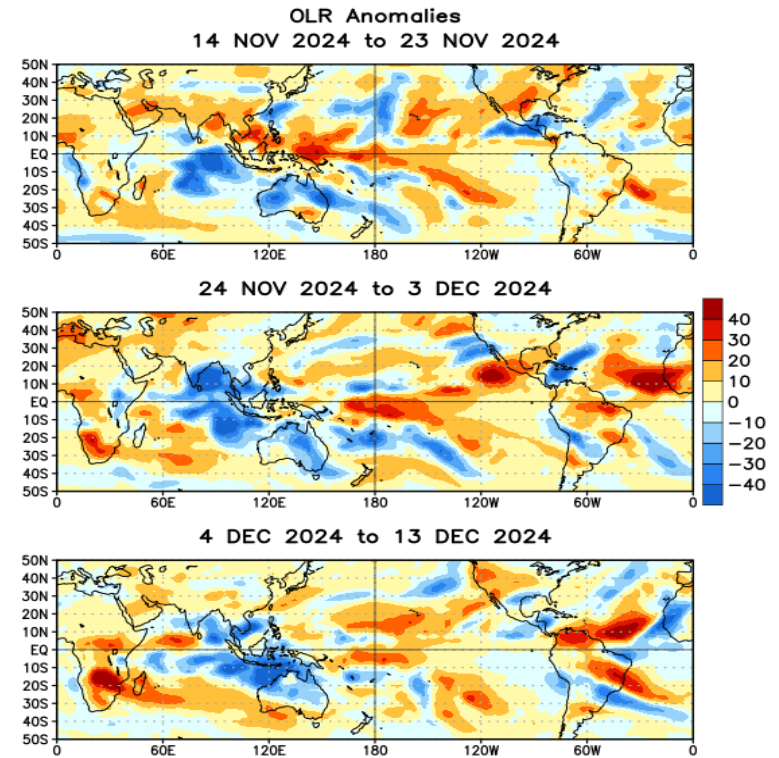
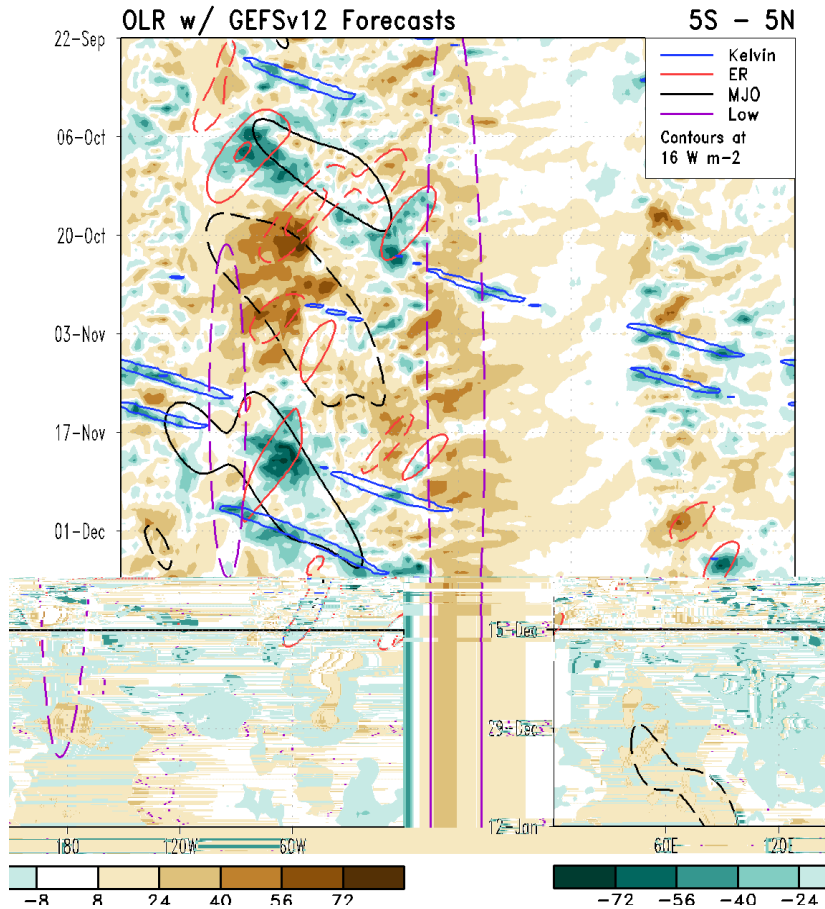


- Following a westerly wind burst (WWB) event observed over the eastern Indian Ocean at the beginning of December, lower level westerlies remain quite strong across the equatorial Indian Ocean.
- In contrast, a trade wind surge is underway across the central Pacific, with enhanced easterlies initially west of the Date Line, which have since spread to cover most of the tropical Pacific.

Outgoing Longwave Radiation (OLR) Anomalies

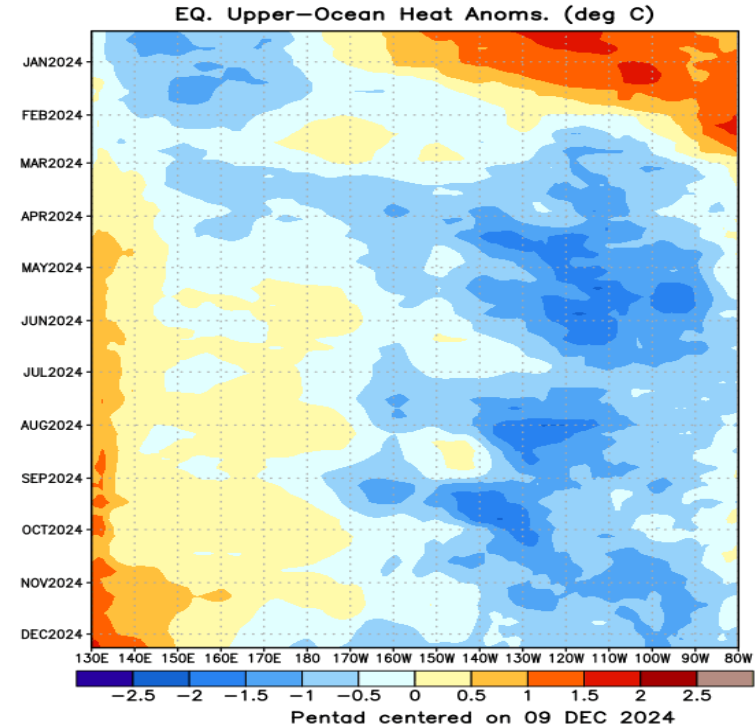
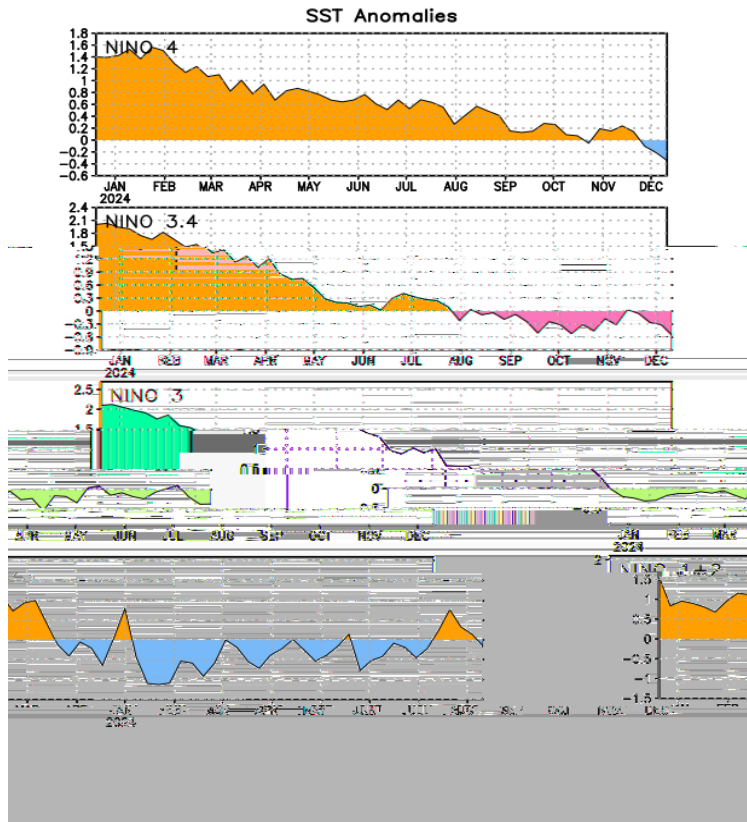
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- While MJO activity has been evident in OLR anomalies, a La Niña-like low-frequency footprint has emerged and appears to be becoming more established.
- GEFS-based OLR anomaly forecasts depict enhanced convection persisting over the Maritime Continent and far West Pacific through late December, and suppressed convection near the Date Line. This pattern is consistent with a La Niña response.

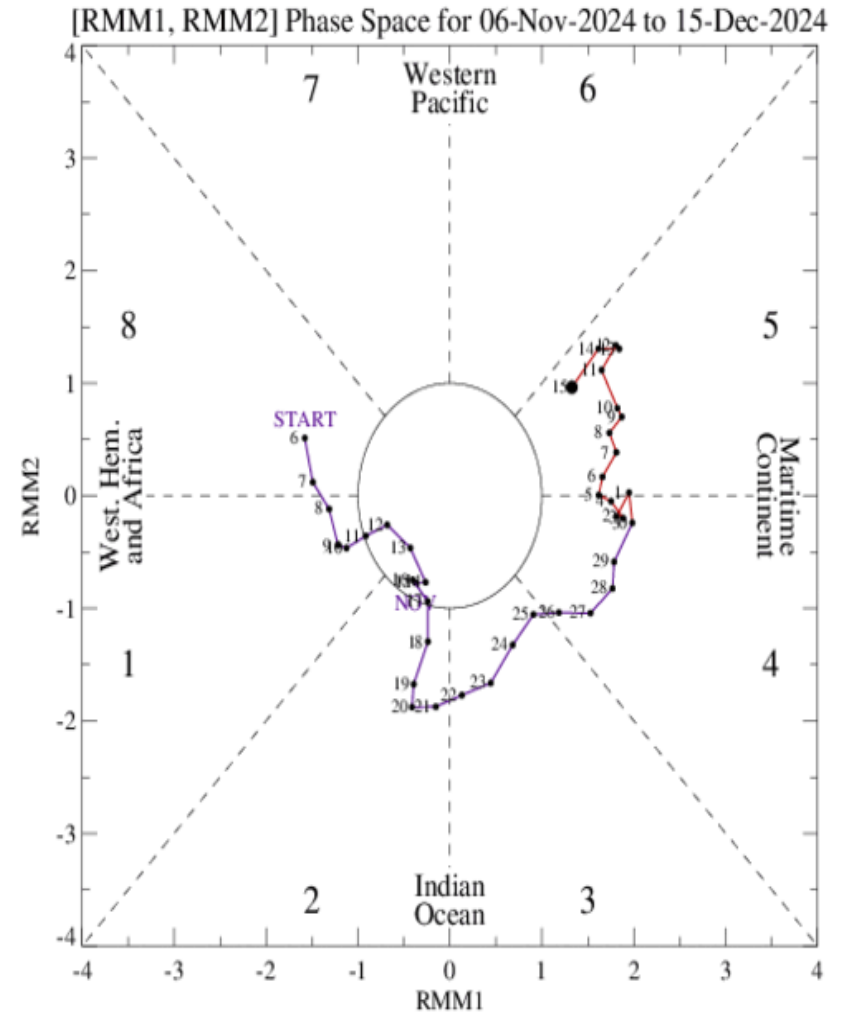
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- SST anomalies remain slightly below average across most of the Pacific basin, though recent enhanced trade winds over the Pacific likely resulted in the notable drop in the Niño 4 region.
- Upper-ocean heat anomalies recently trended upward at and just west of the Date Line, likely as a result of the MJO and enhanced trade winds.

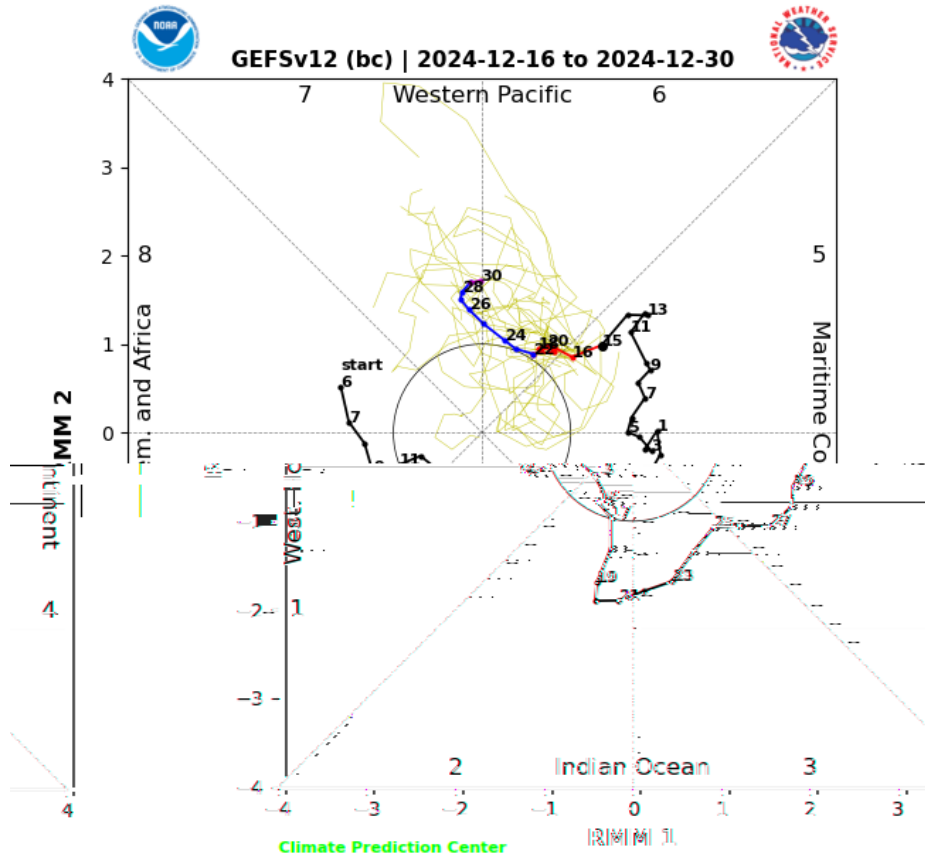
MJO Index: Recent Evolution

- Steady eastward propagation of the MJO was observed during the most of the past two weeks. The RMM signal has stalled and weakened somewhat in recent days as the MJO works to move out of the Maritime Continent and into the Western Pacific.

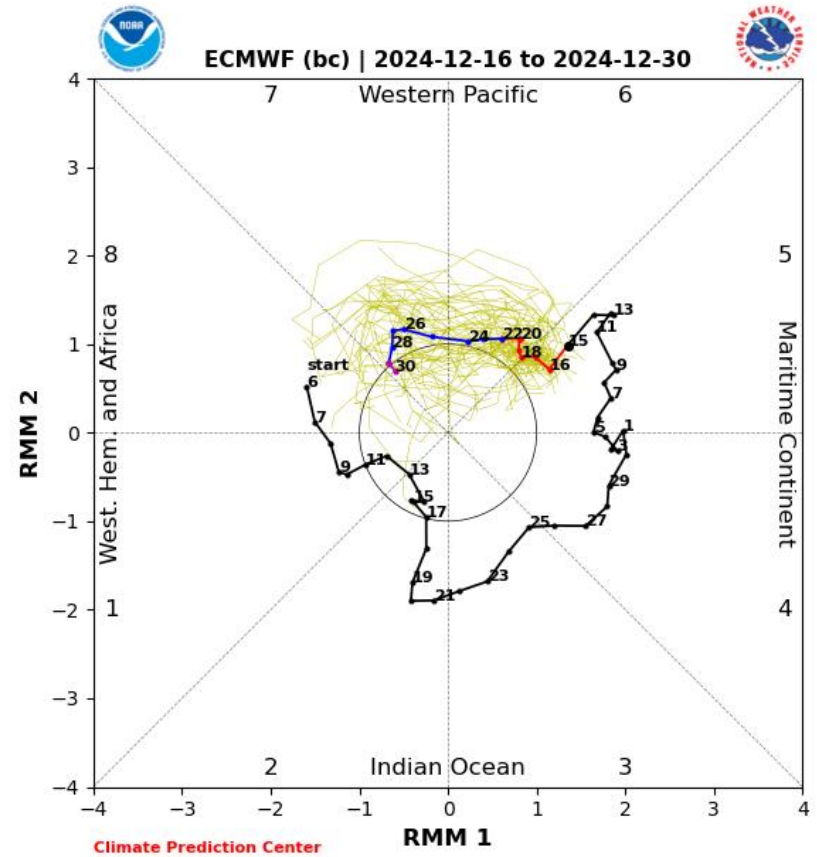


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



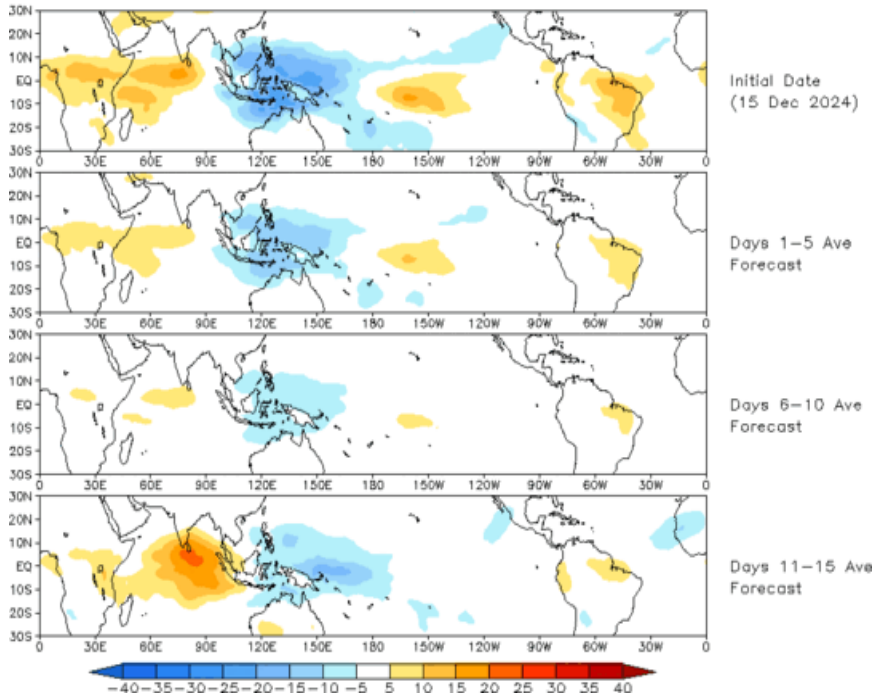
ECMWF Forecast

- Both the GEFS and ECMWF depict continued eastward propagation of the MJO signal, but with a slower phase speed and initially a lower amplitude due to interference from the emerging low frequency base state.
- The extended GEFS and ECMWF ensemble mean forecasts (not pictured) indicate the potential for a reamplification of the MJO during weeks 3&4 as the MJO moves closer to the Western Hemisphere.

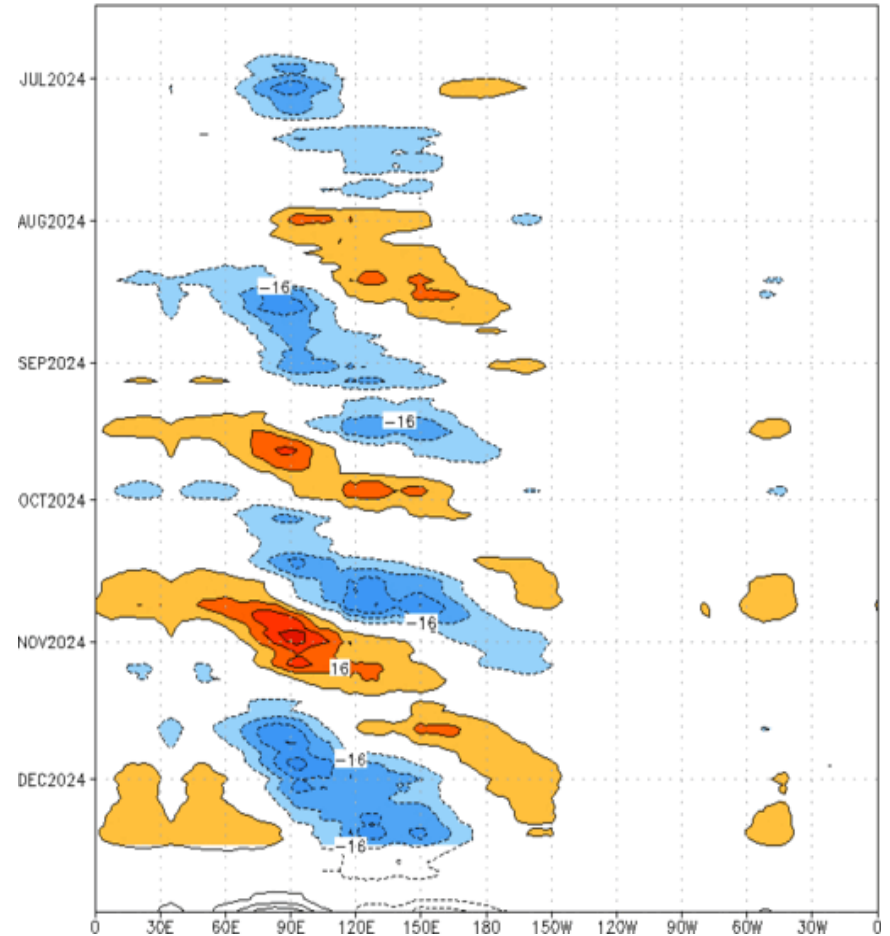
MJO: GEFS Forecast Evolution

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 Dec 2024
OLR



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

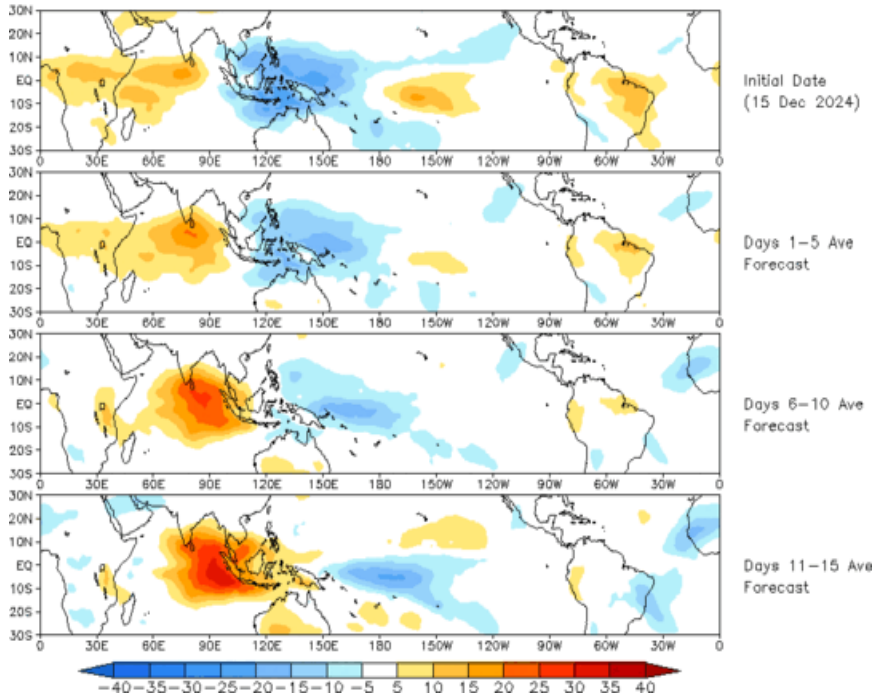


- The GEFS OLR anomaly forecast based on the RMM index shows a nearly stationary signal for most of weeks 1&2. Convective anomalies increase late in the forecast.

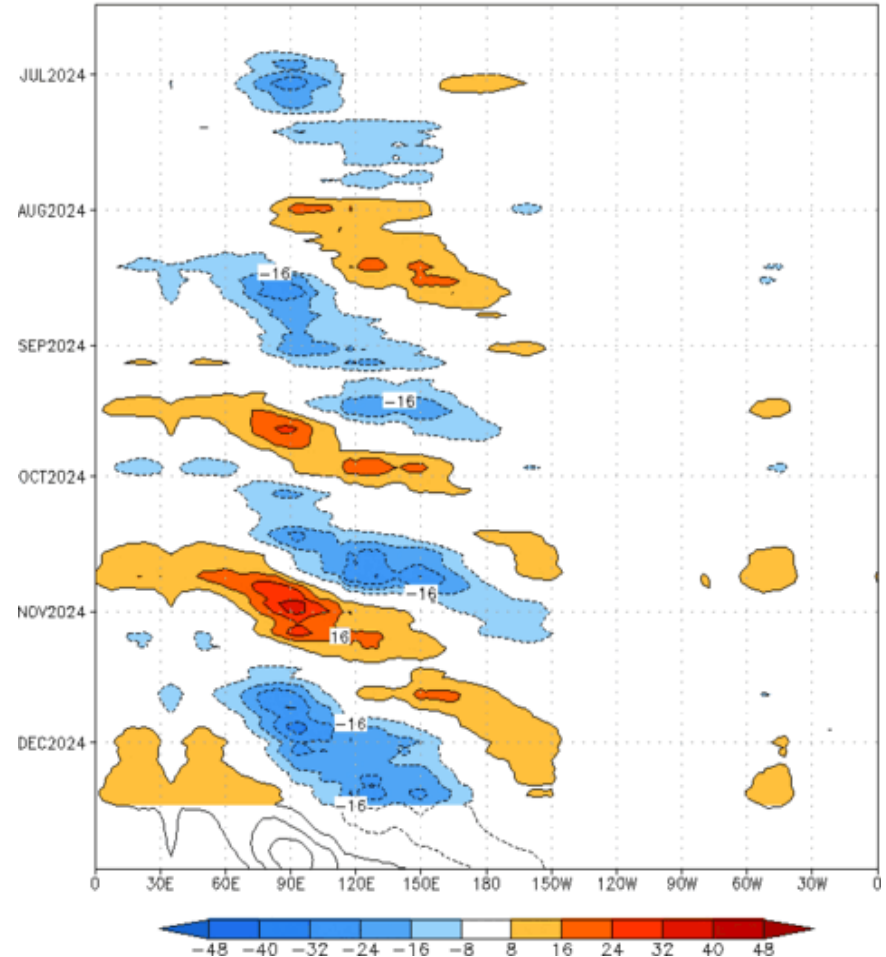
MJO: Constructed Analog Forecast Evolution

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 Dec 2024)



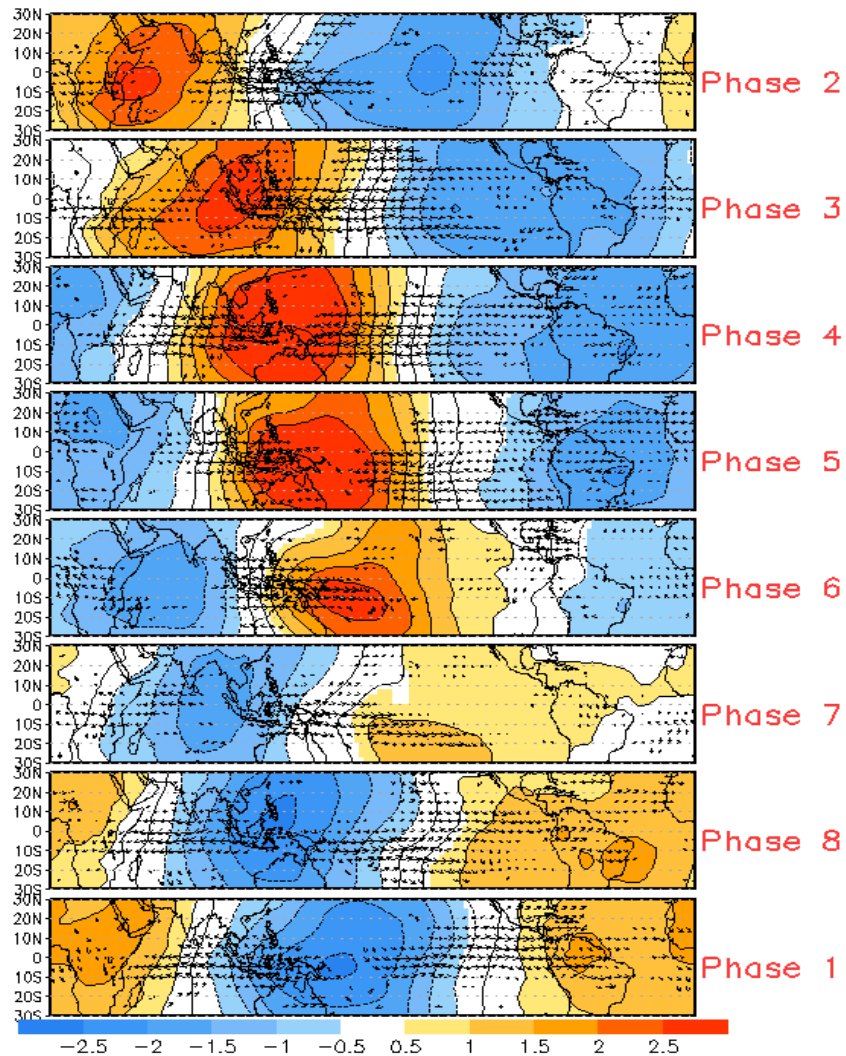
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:15-Jun-2024 to 15-Dec-2024
The unfilled contours are CA forecast reconstructed anomaly for 15 days



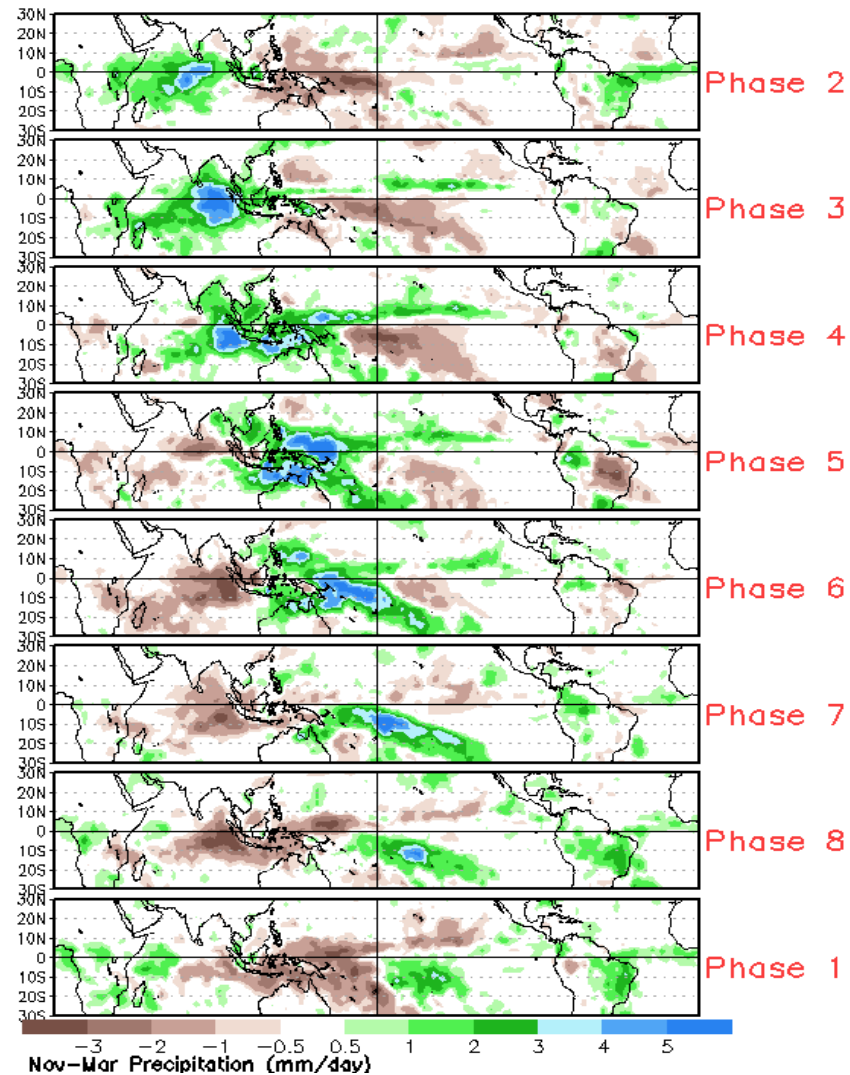
- The constructed analog forecast depicts more eastward propagation, especially with the suppressed phase shifting east from Africa to the Indian Ocean and western Maritime Continent.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



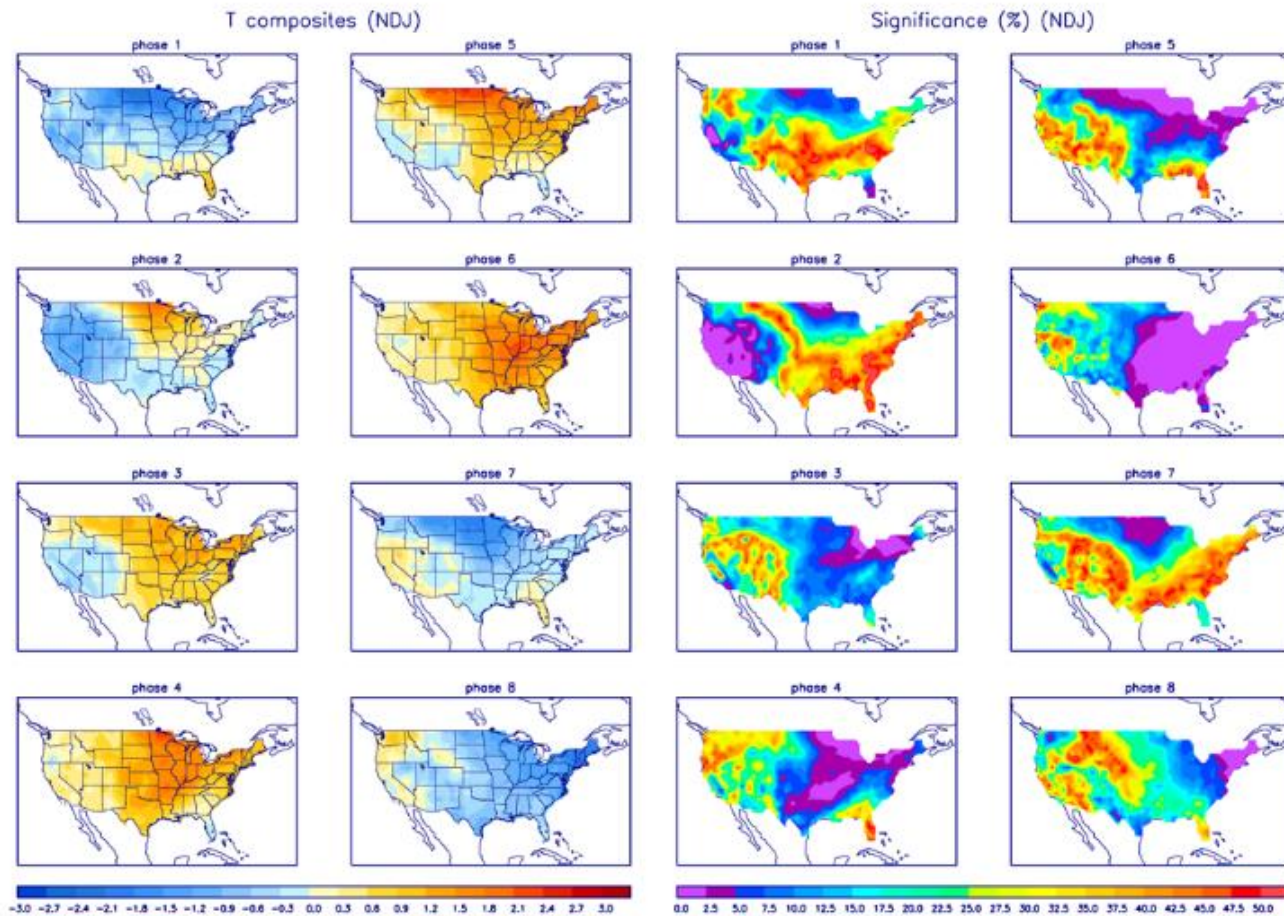
Precipitation Anomalies



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.

