

Madden-Julian Oscillation:

Recent Evolution, Current Status and Predictions



Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
24 March 2025

Overview

- The MJO propagated eastward from the Indian Ocean to the Maritime Continent and West Pacific during mid to late March. However other modes of variability are playing a role influencing global tropical rainfall.
- Dynamical model RMM forecasts depict a weak MJO by the end of March which is due to destructive interference between the MJO and the residual La Niña along with a Kelvin wave crossing the Western Hemisphere. The GEFS ensemble members are most bullish with a continued eastward propagation of the MJO.
- Due to the expectation for a weak MJO and other competing modes of variability, forecast uncertainty is higher for weeks 2 and 3 (April 2-8 and 9-15).
- April is typically a less active time of year for tropical cyclones globally. Based on climatology and dynamical model forecasts, tropical cyclone development is most likely to occur surrounding northern Australia during early to mid-April although probabilities are limited.

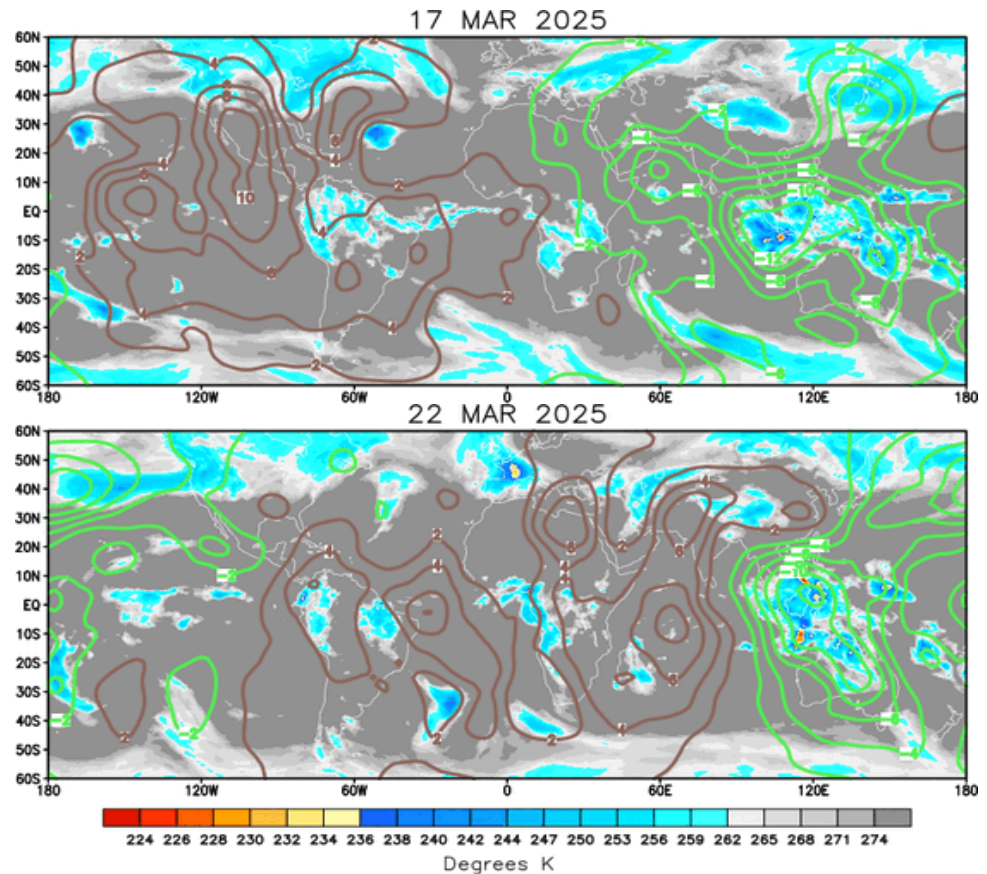
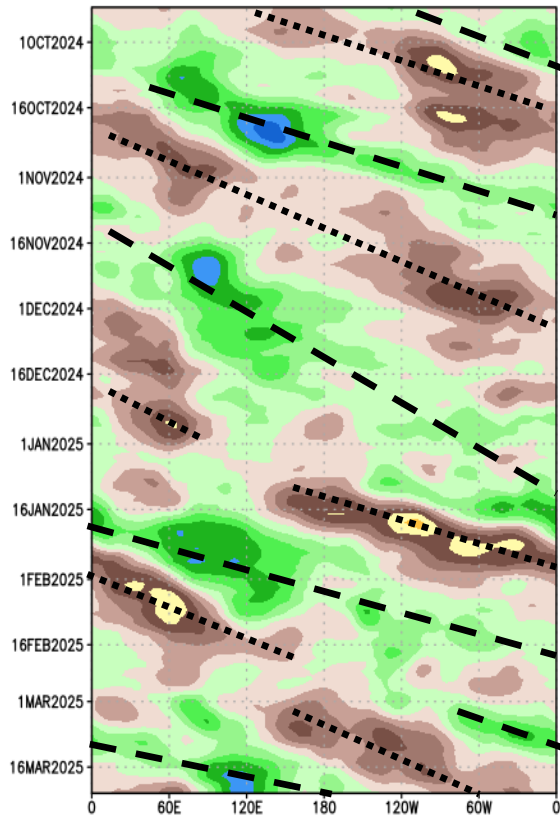
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

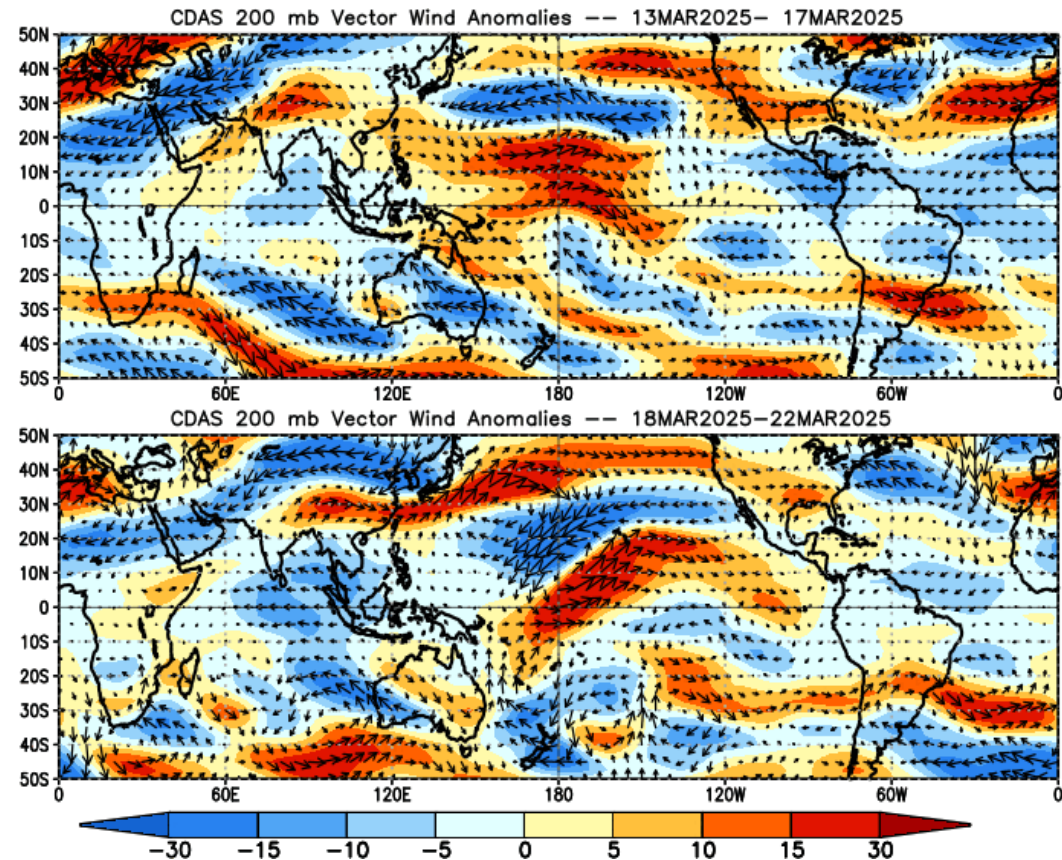
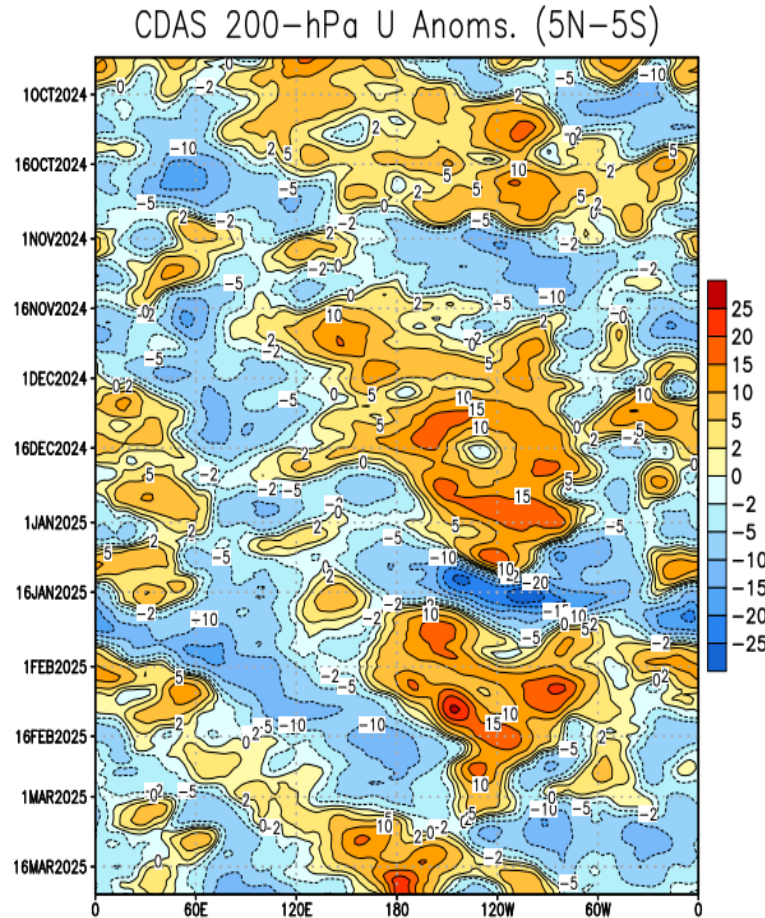
200-hPa Velocity Potential Anomaly: 5N–5S
5-day Running Mean



- Upper-level velocity potential anomaly field depicts a coherent wave-1 pattern from mid to late March.
- As the MJO constructively interfered with La Niña, anomalous upper-level divergence strengthened over the Maritime Continent. Recently, anomalous upper-level convergence shifted east to Africa and the western Indian Ocean.

200-hPa Wind Anomalies

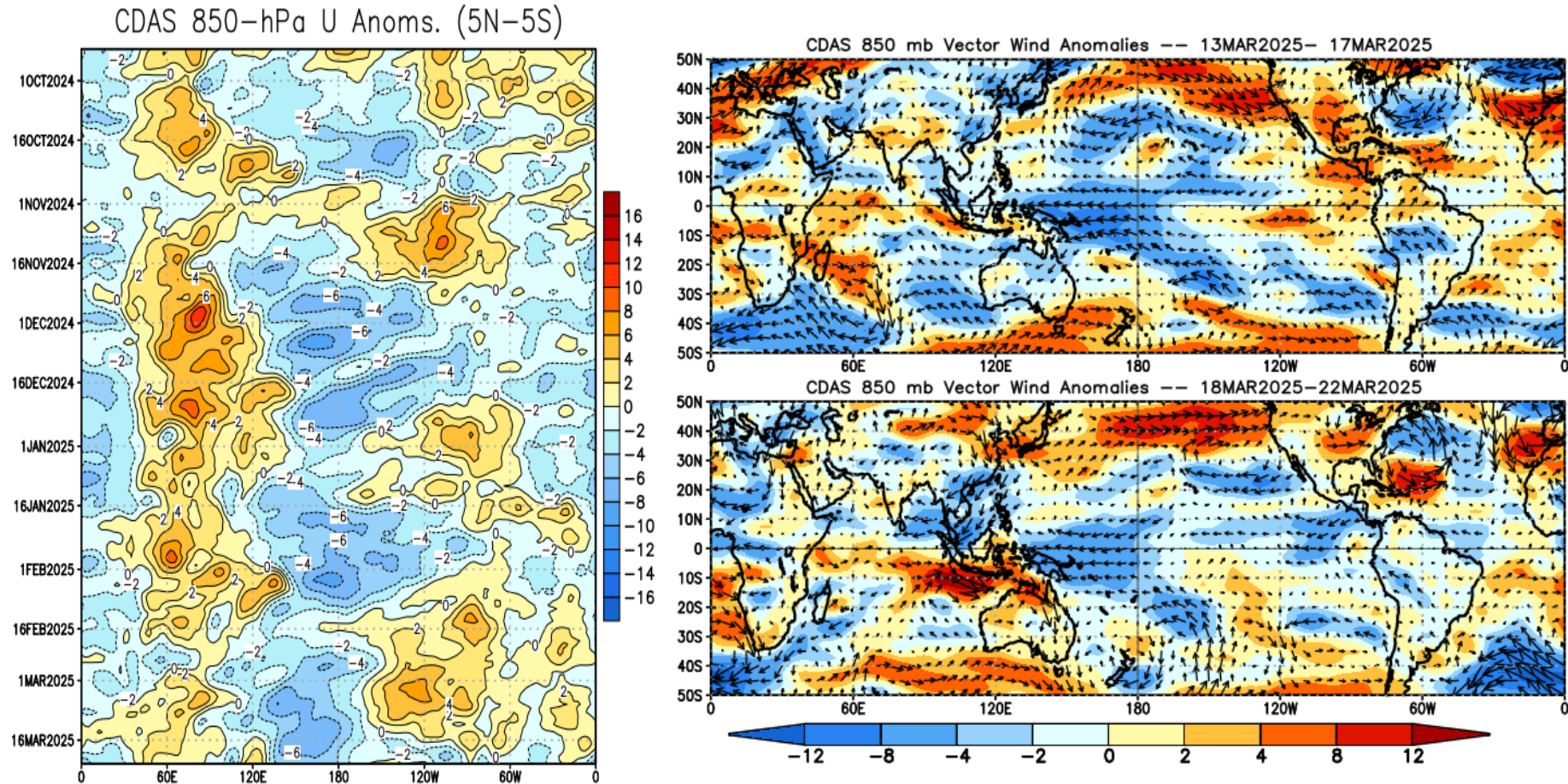
Shading denotes the zonal wind anomaly. Blue shades: Anomalous easterlies. Red shades: Anomalous westerlies.



- During mid-March, the easterly phase of the MJO managed to break through an area of persistent westerlies centered near 120W, with anomalous westerlies strengthening and expanding eastward beyond the Date Line.
- MJO activity appears less coherent over the Indian Ocean.
- From March 17-21, a jet extension developed from eastern Asia to the northern Pacific.

850-hPa Wind Anomalies

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

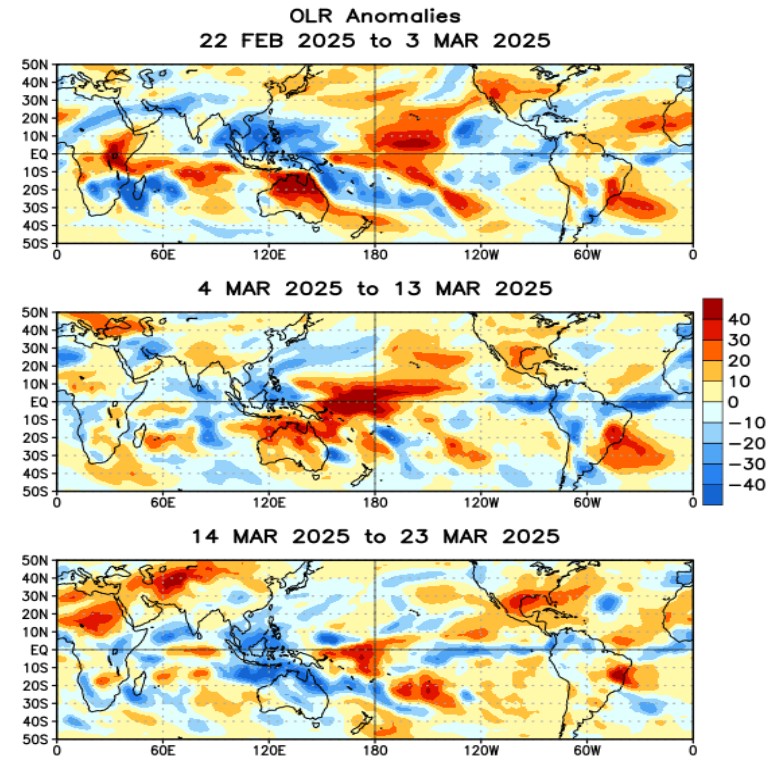
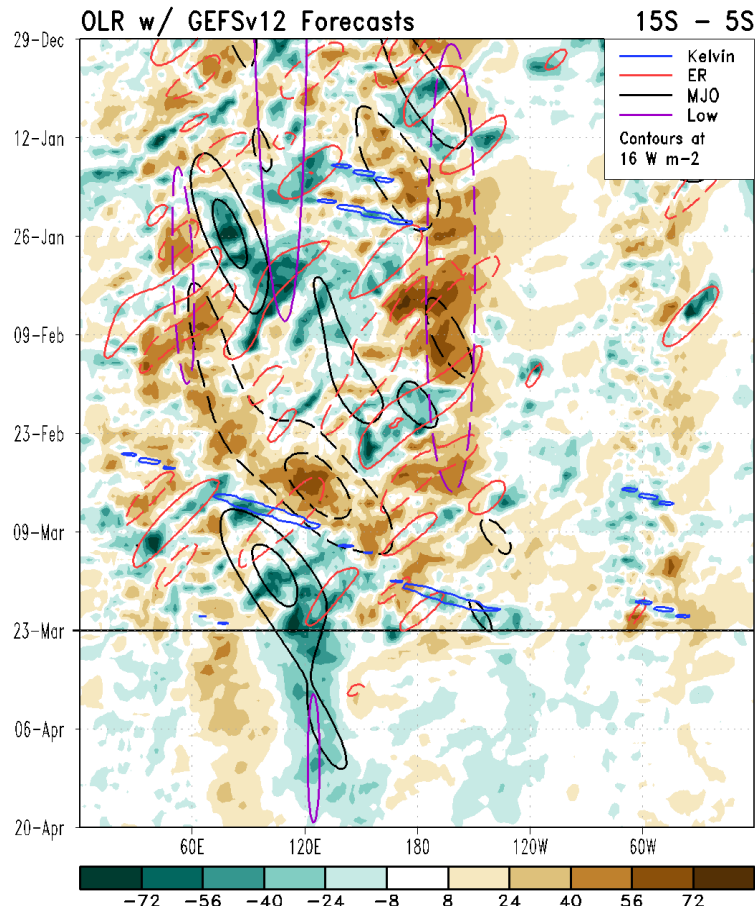


- Compared to the zonal winds aloft, there is less evidence of eastward propagating features in the low-level time/longitude plot.
- The persistent low-level westerlies recently eased over the equatorial East Pacific.
- Enhanced trades continue near and west of the Date Line, consistent with La Niña.

Outgoing Longwave Radiation (OLR) Anomalies

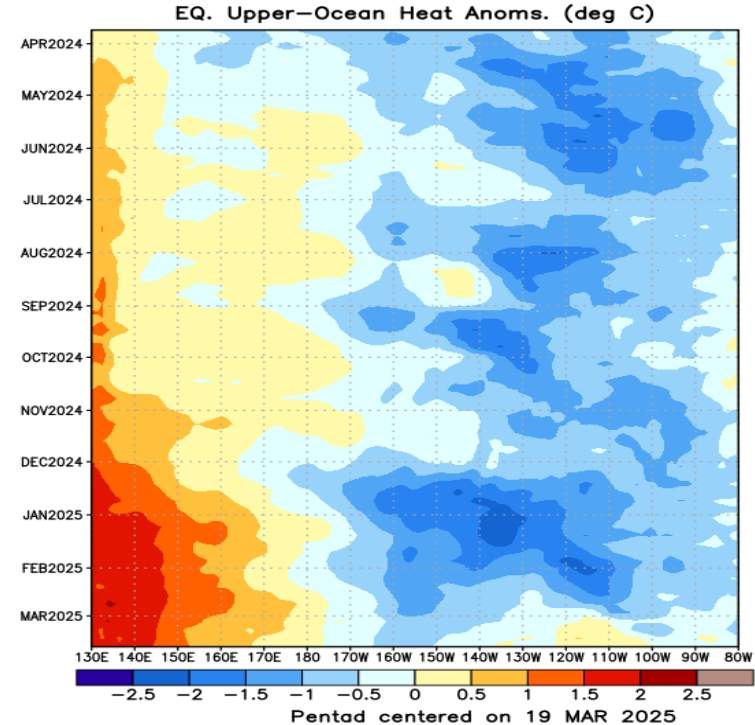
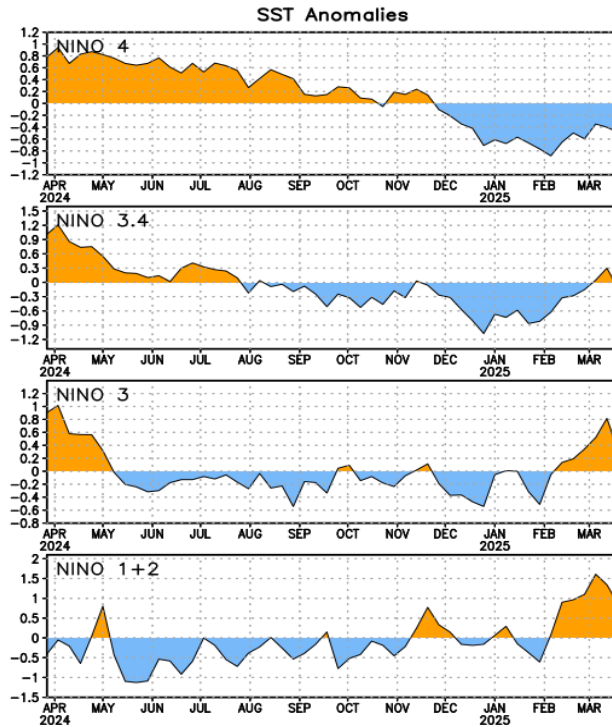
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- La Niña driven suppressed convection persisted across the equatorial Central Pacific and southern tier of the United States during the late winter and early spring. However, the suppressed convection at the Date Line recently weakened as the MJO propagated eastward.
- The MJO also led to more enhanced convection over the Maritime Continent during mid-March, while Kelvin wave activity has caused enhanced convection across portions of the Western Hemisphere.

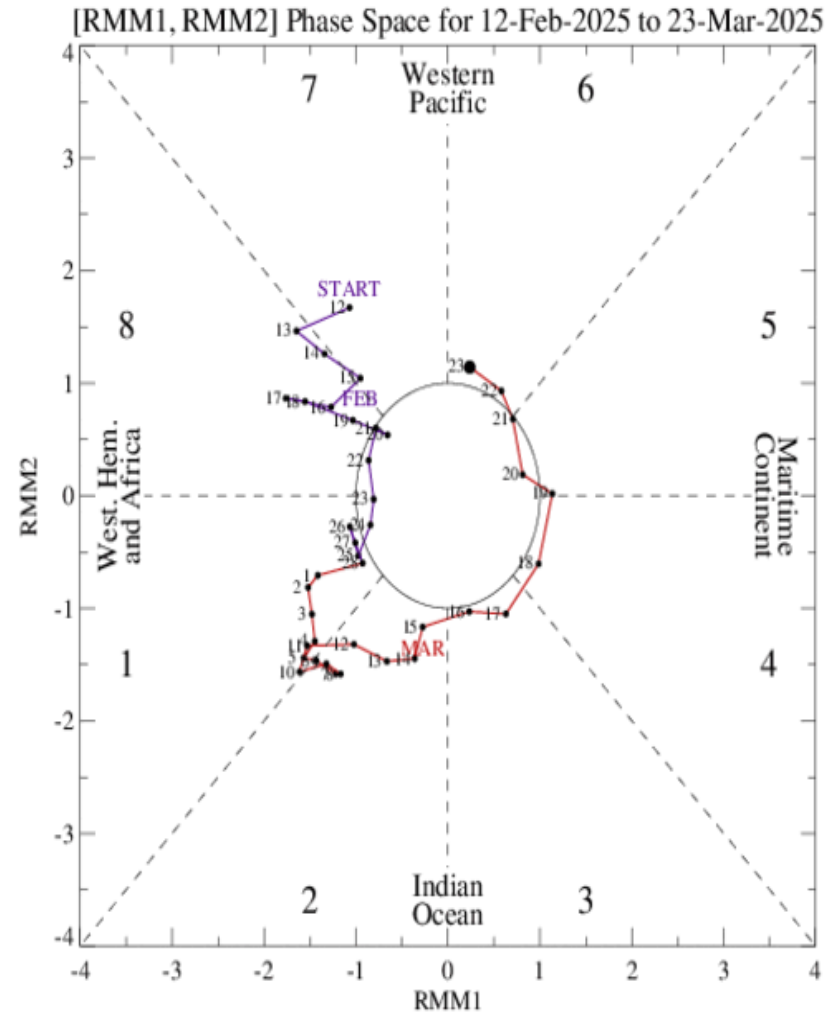
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- SST anomalies briefly became positive in the Nino 3.4 region.
- The Niño 1+2 and Niño 3 regions have remained positive since early February.
- Given the extent of warm ocean water availability over the West Pacific, the current La Niña conditions are vulnerable to any downwelling oceanic Kelvin wave events that could initiate due to MJO activity.

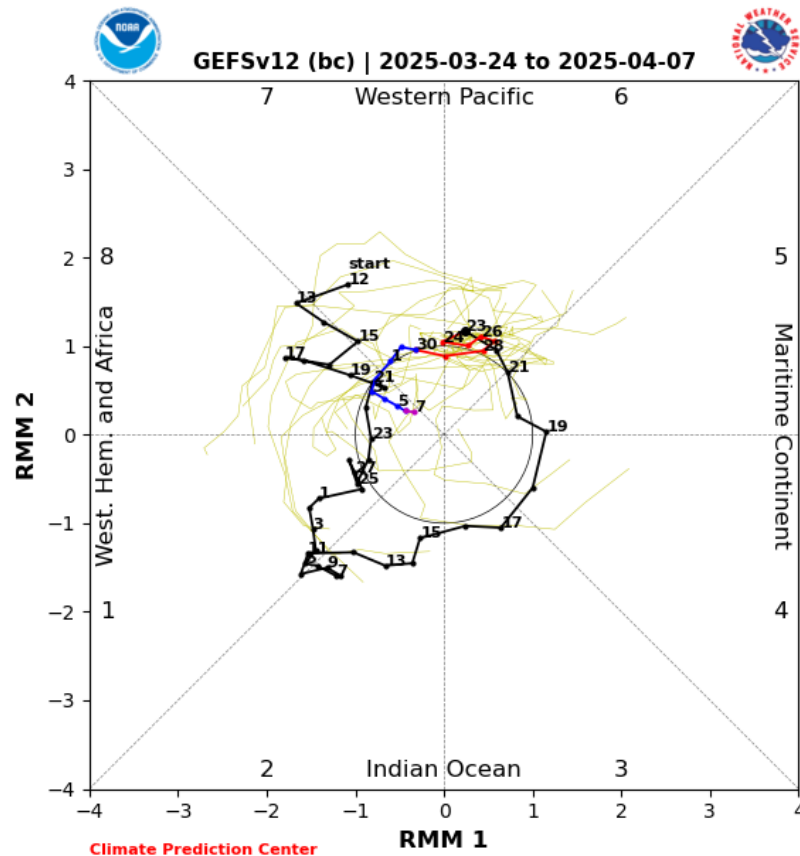
MJO Index: Recent Evolution

- During early March, RMM observations show a slow eastward propagating MJO after it entered the Indian Ocean.
- The RMM index accelerated eastward to the West Pacific during the past week.

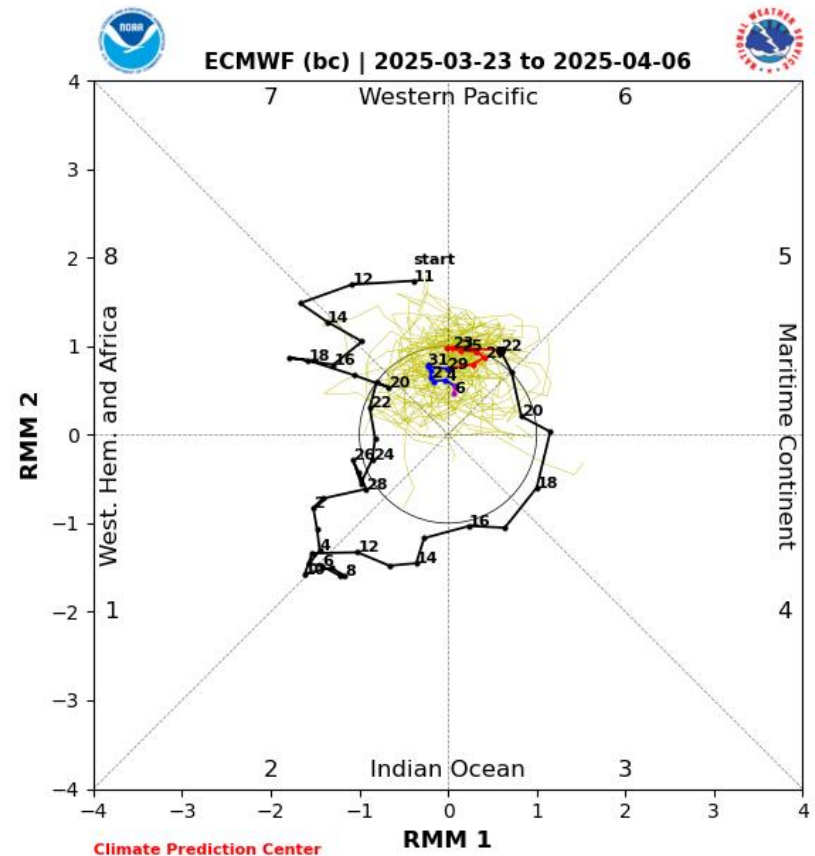


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



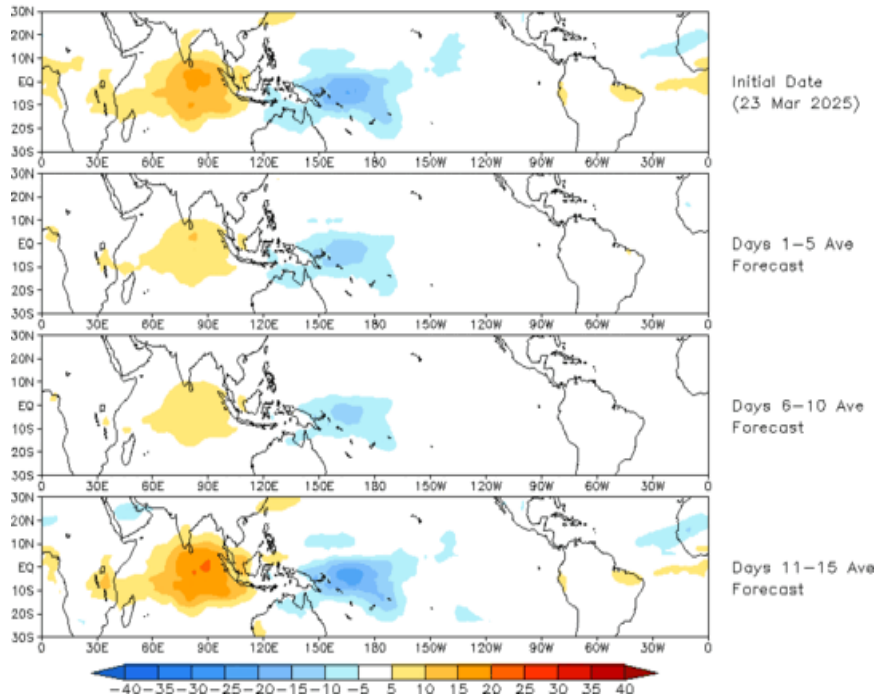
ECMWF Forecast

- A number of GEFS ensemble members have a MJO continuing to propagate eastward through early April but ensemble spread is large.
- The ECMWF model depicts a weak MJO during the next two weeks.

MJO: GEFS Forecast Evolution

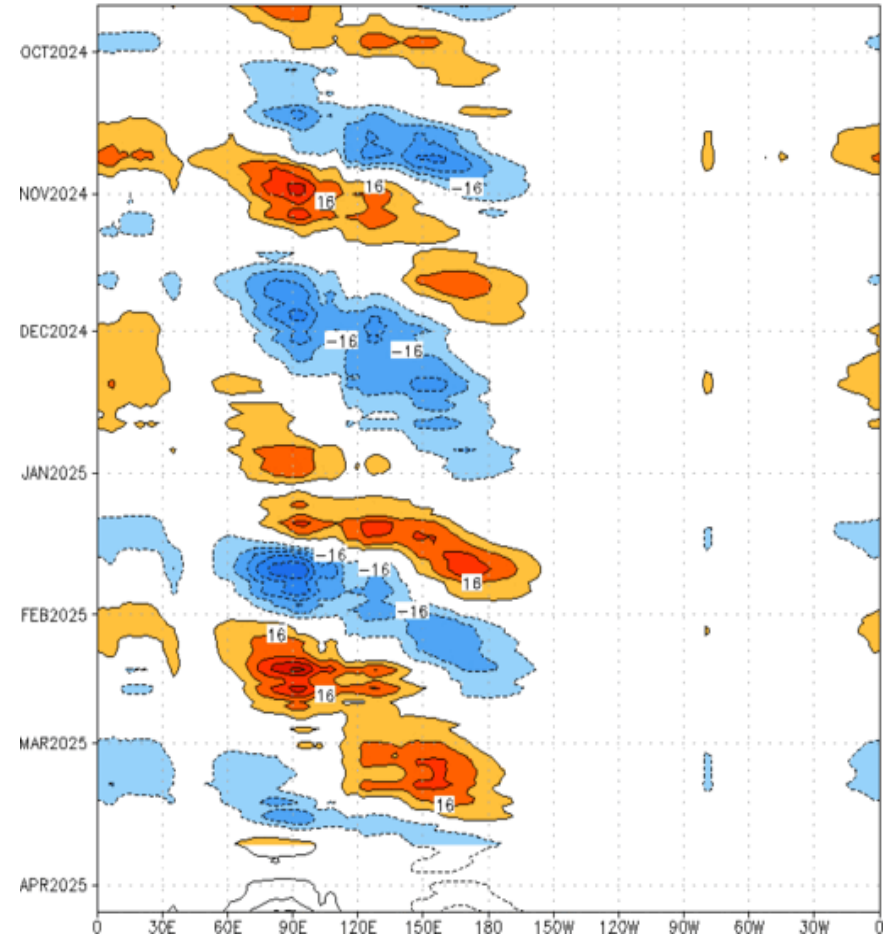
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

Prediction of MJO-related anomalies using GEFS operational forecast
Initial date: 23 Mar 2025
OLR



- The GEFS OLR forecast based on the RMM index forecast depicts a stationary pattern of anomalous convection with enhanced (suppressed) convection over the West Pacific (Indian Ocean).

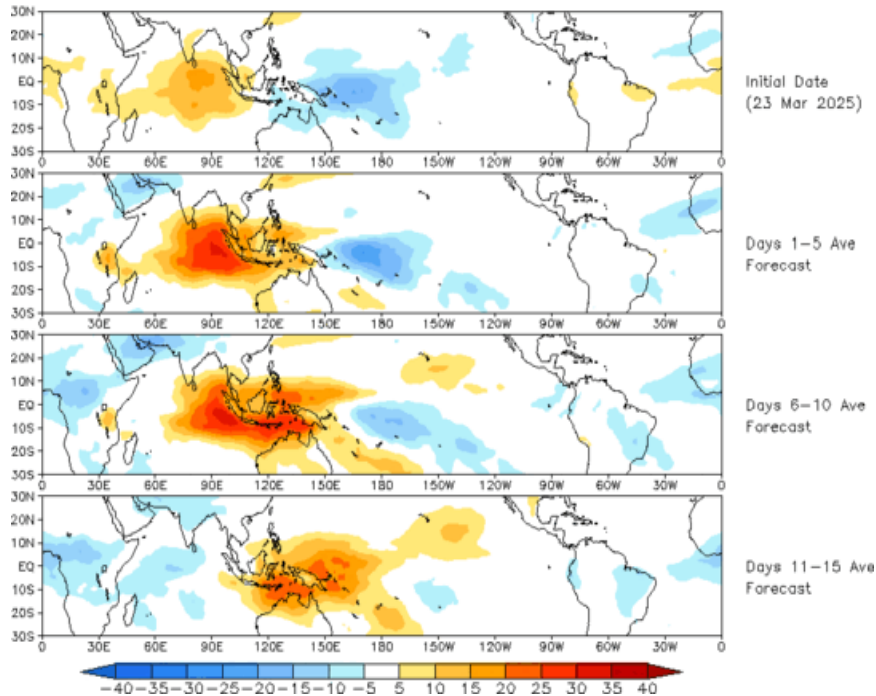
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [$7.5^{\circ}S, 7.5^{\circ}N$] ($cint: 4Wm^{-2}$) Period: 21-Sep-2024 to 23-Mar-2025
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days



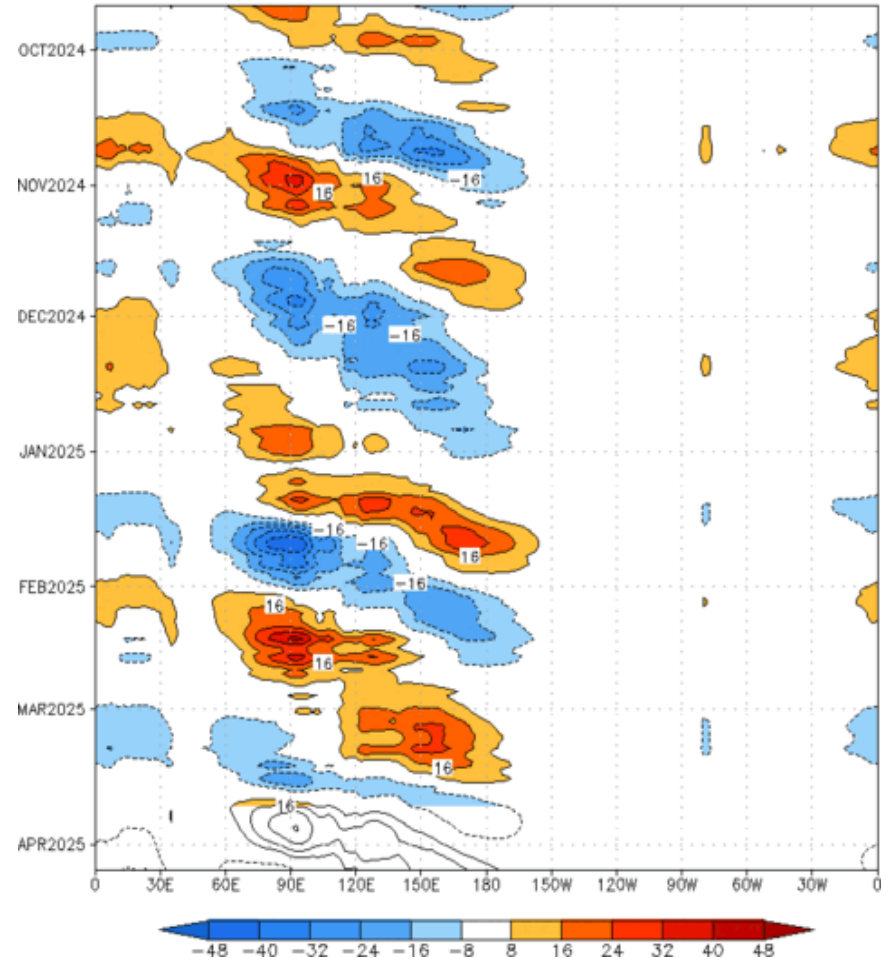
MJO: Constructed Analog Forecast Evolution

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 (23 Mar 2025)



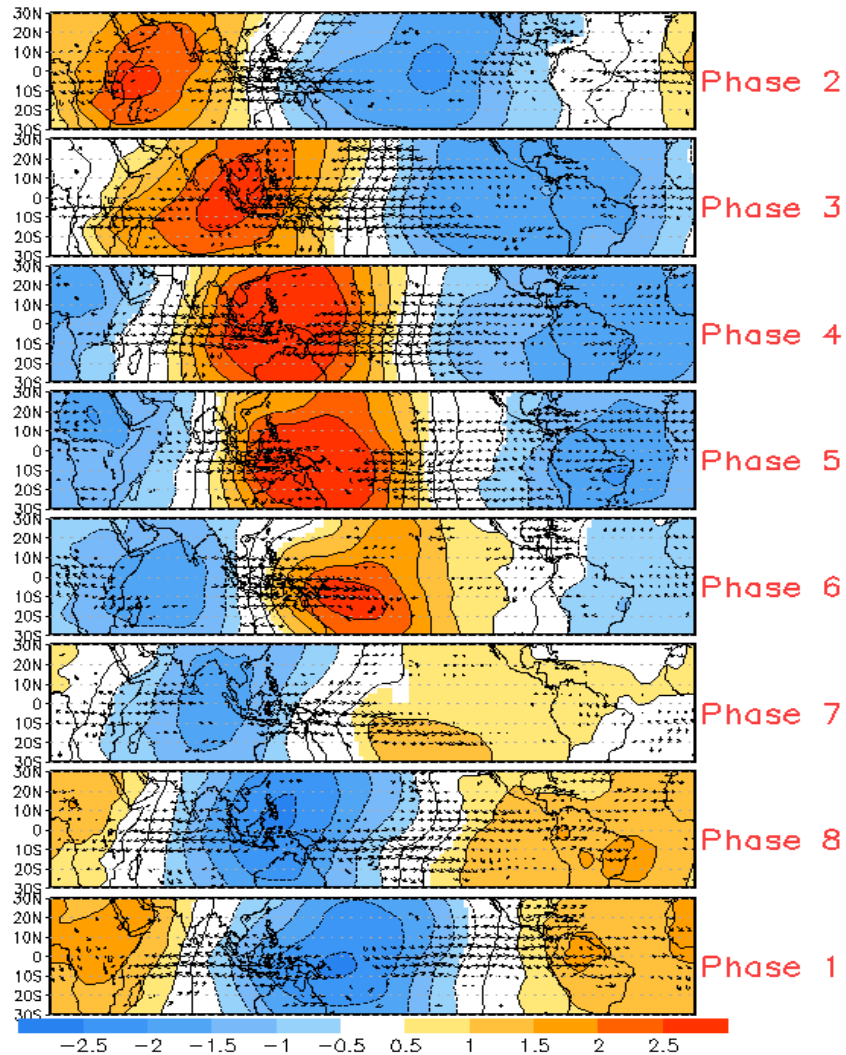
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:21-Sep-2024 to 23-Mar-2025
The unfilled contours are CA forecast reconstructed anomaly for 15 days



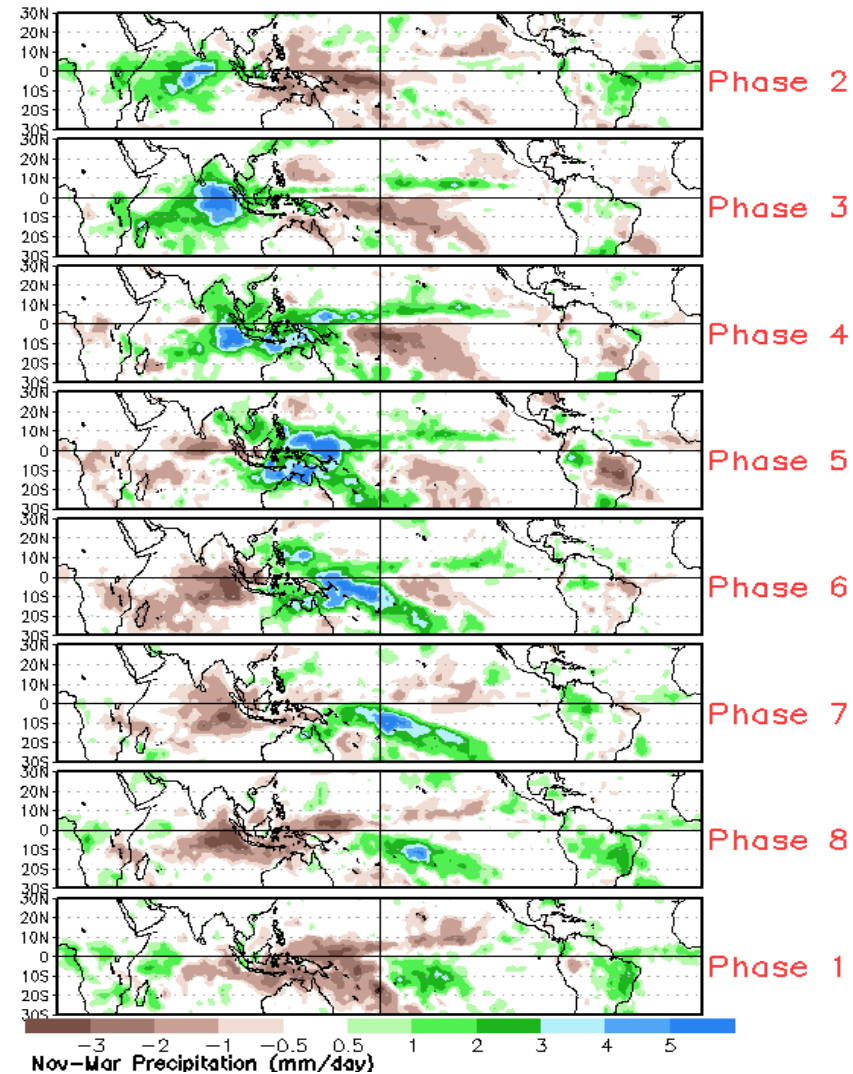
- The constructed analog forecast features enhanced convection becoming more prevalent over the Western Hemisphere while suppressed convection shifts eastward from the Indian Ocean to the Maritime Continent and West Pacific.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and
Wind Anomalies



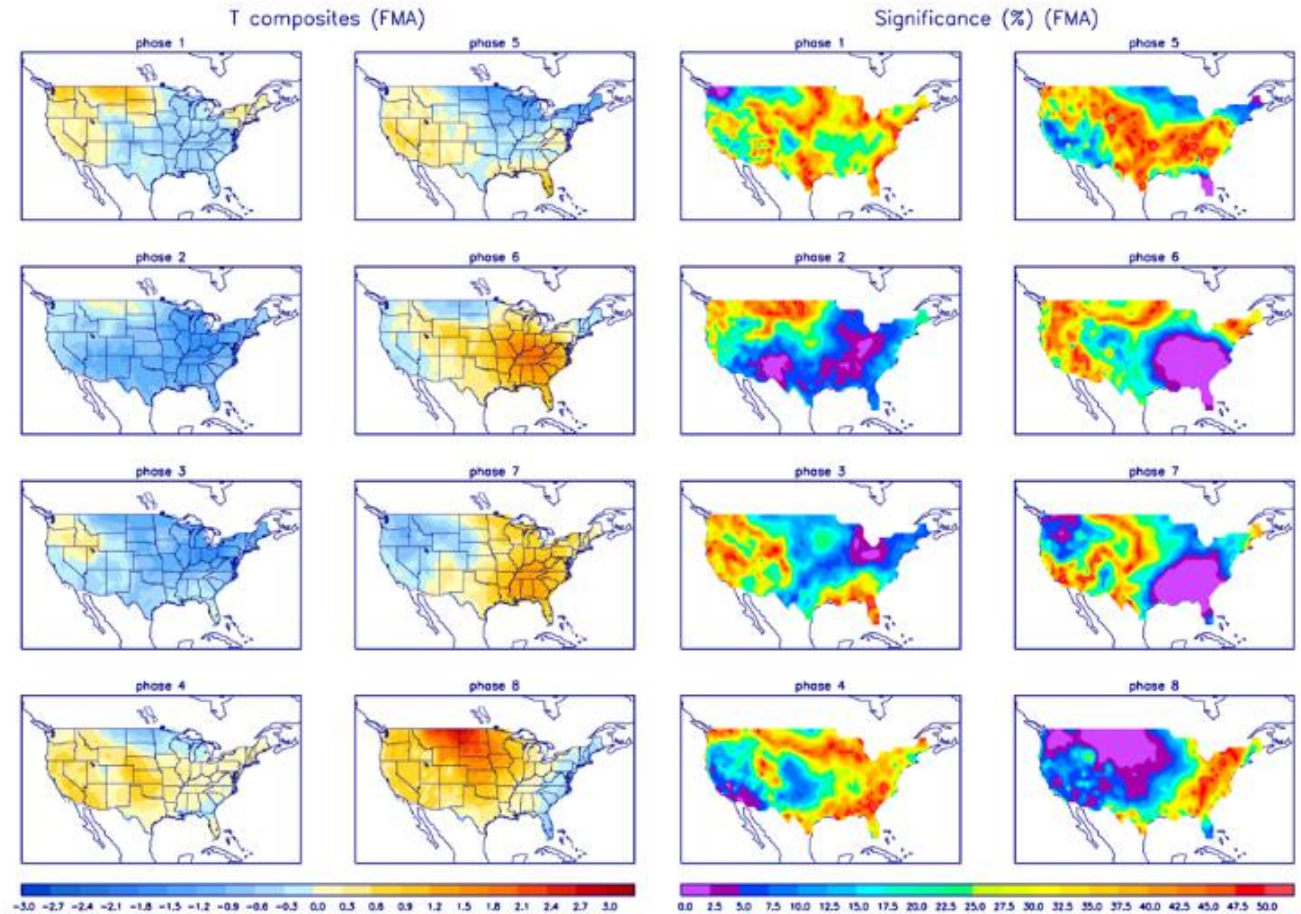
Precipitation Anomalies



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.

