

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



Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
1 April 2024

Overview

- The MJO remains active, but has slowed down as it crosses back into the Eastern Hemisphere.
- The MJO is forecast to continue its eastward propagation into the Indian Ocean and Western Pacific during the first half of April, with some constructive interference with equatorial Rossby Wave activity possible as the MJO nears the Date Line.
- Over the past couple of weeks, there has been a notable increase in the low-frequency signal across the Indian Ocean. This may be attributed to the MJO slowing down over the region along with some destructive interference with enhanced equatorial Rossby Wave activity.
- Tropical cyclone development chances remain most favored to the north of Australia during weeks 2 and 3, although decreasing seasonal climatology reduces confidence.

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

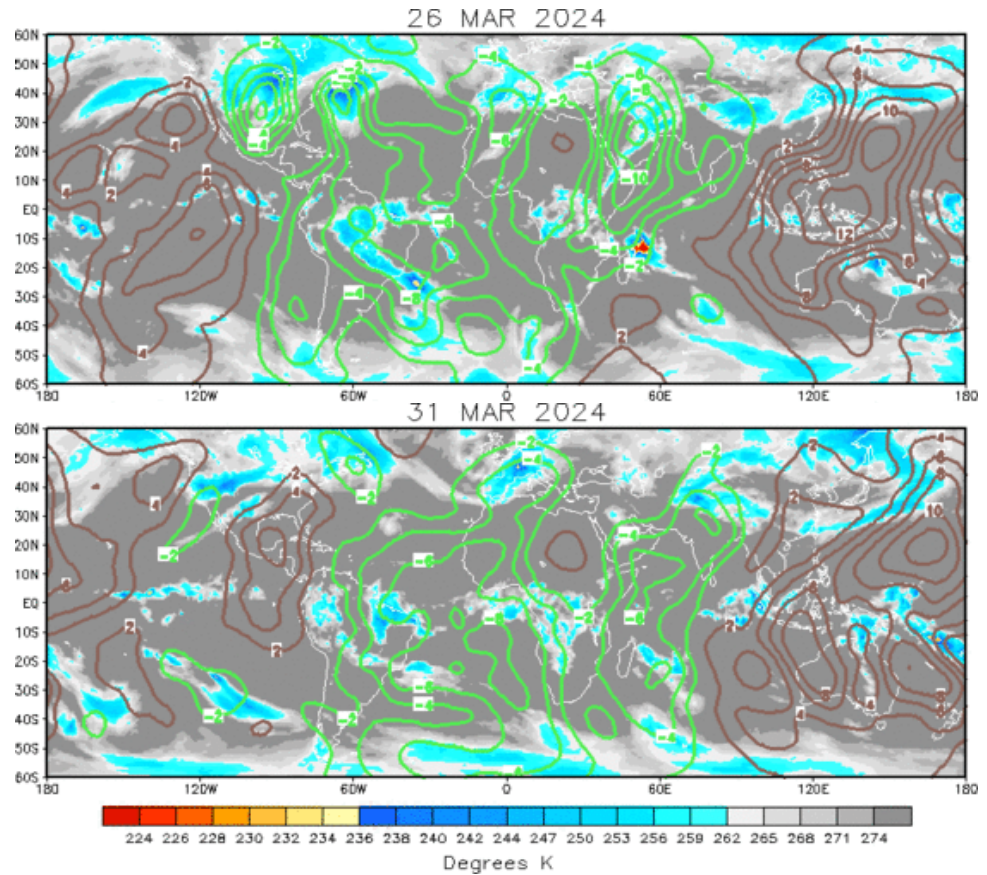
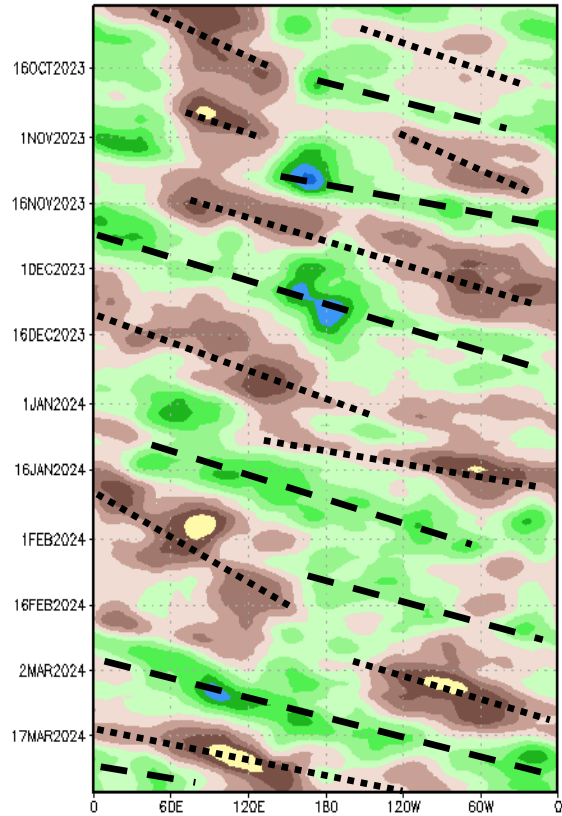
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

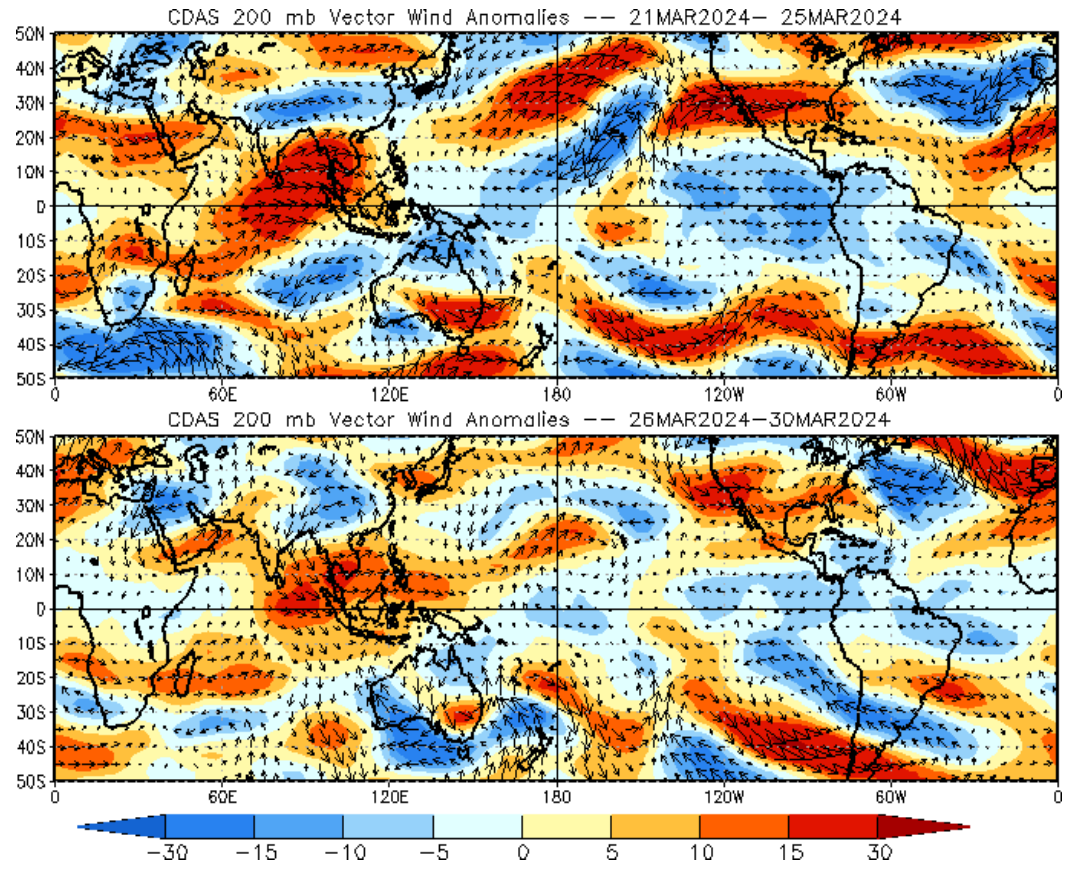
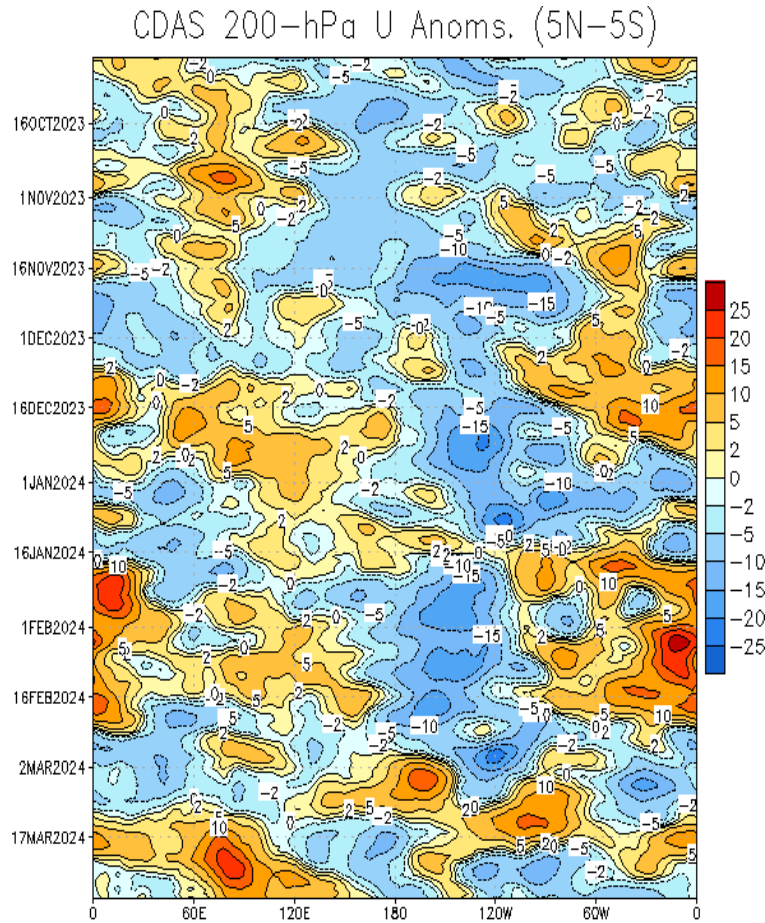
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- The upper-level velocity potential time-lon plots indicates a complete circumnavigation of negative upper-level velocity potential anomalies during the past month.
- There is little change in the global upper-level velocity potential field compared to last week, although there are hints of the wave-1 asymmetry pattern beginning to decay.

200-hPa Wind Anomalies

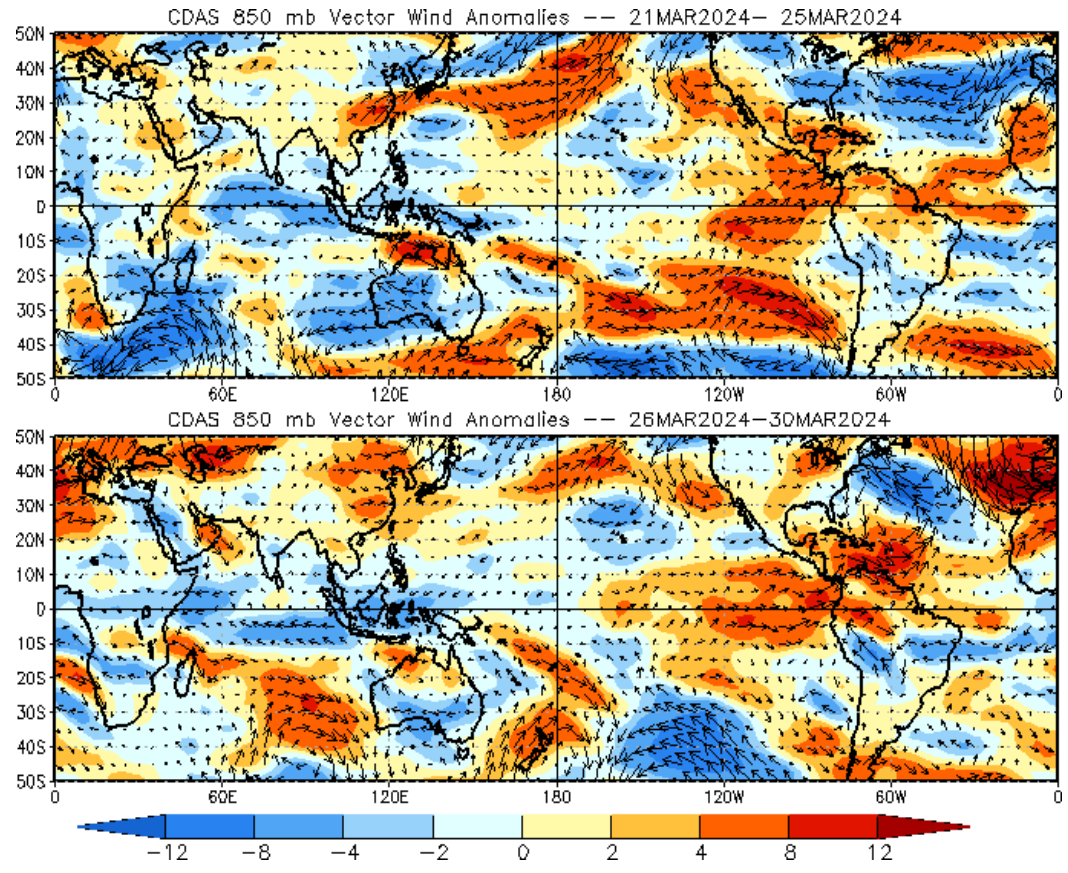
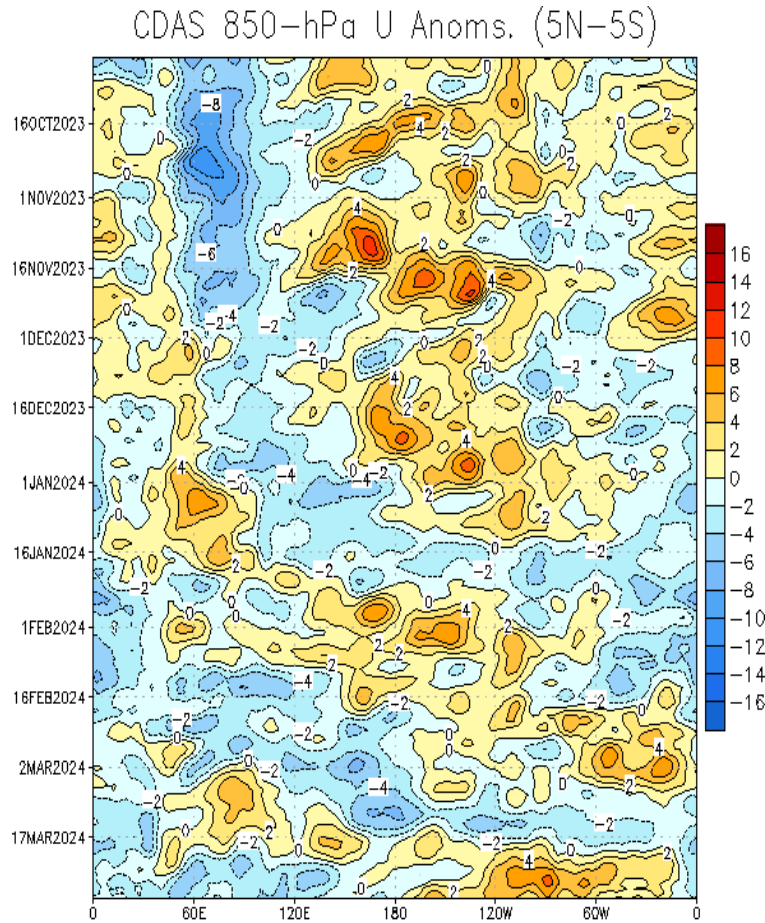
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- A robust area of anomalous upper-level westerlies remains established across the Indian Ocean.
- Anomalous upper-level easterlies are noted across the Pacific east of the Date Line in the wake of the departing MJO.
- The subtropical jet remains active across southern North America, with a progression of storm systems across the southern U.S. that are likely to continue into early April based on model guidance.

850-hPa Wind Anomalies

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

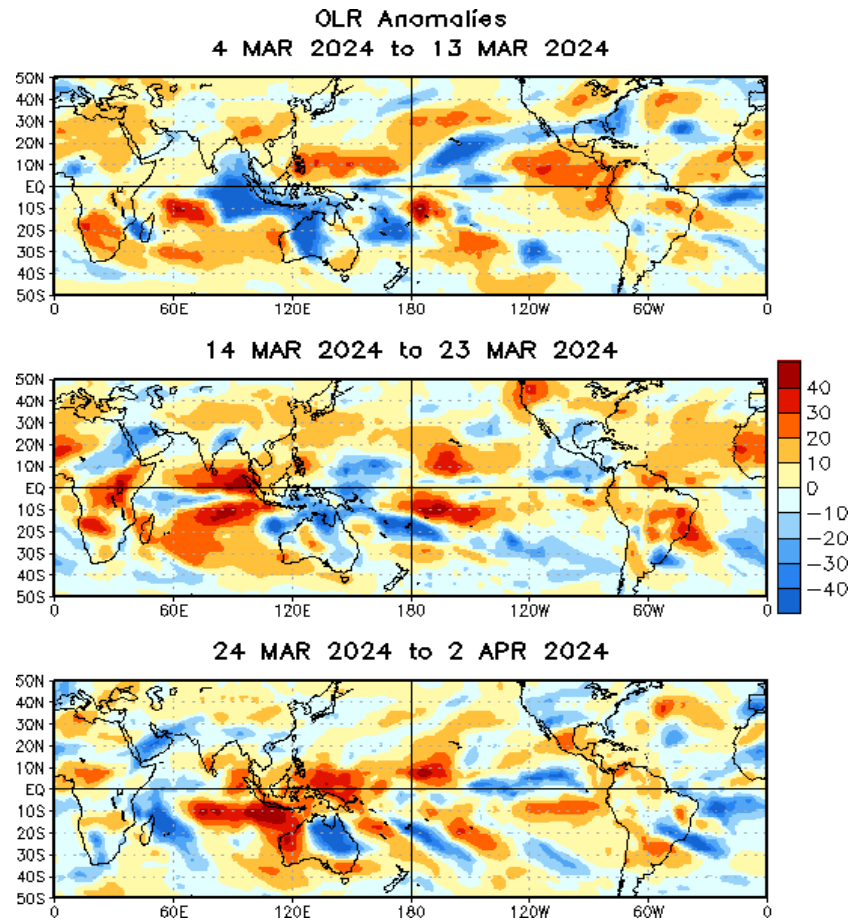
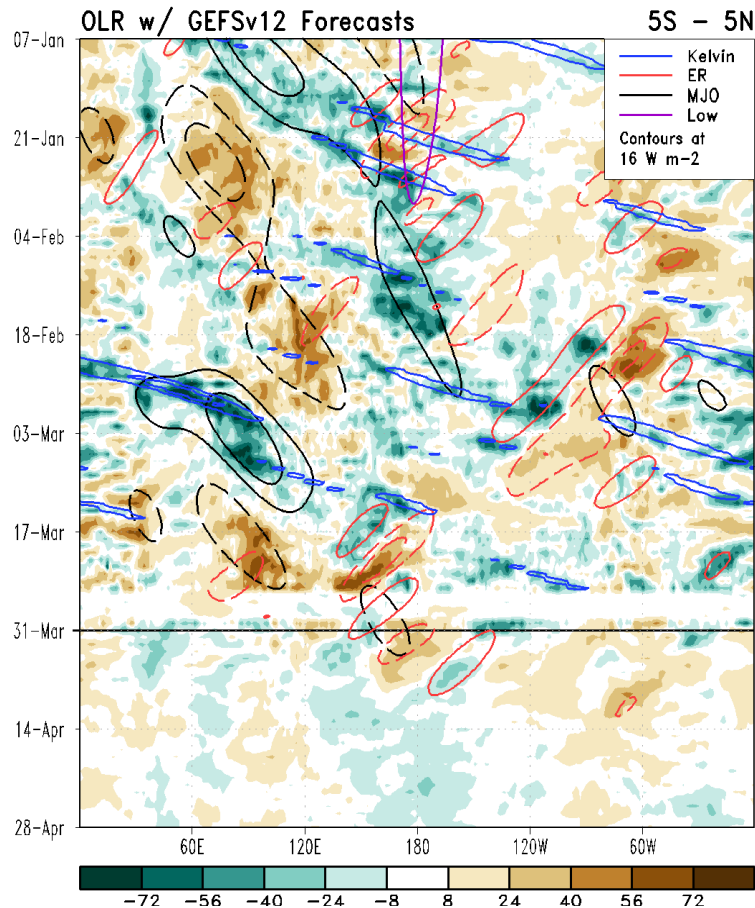


- Anomalous low-level easterlies have increased across the equatorial Indian Ocean.
- Following a notable eastward propagation across the globe, anomalous low-level westerlies have persisted across the eastern Pacific throughout late March.

Outgoing Longwave Radiation (OLR) Anomalies

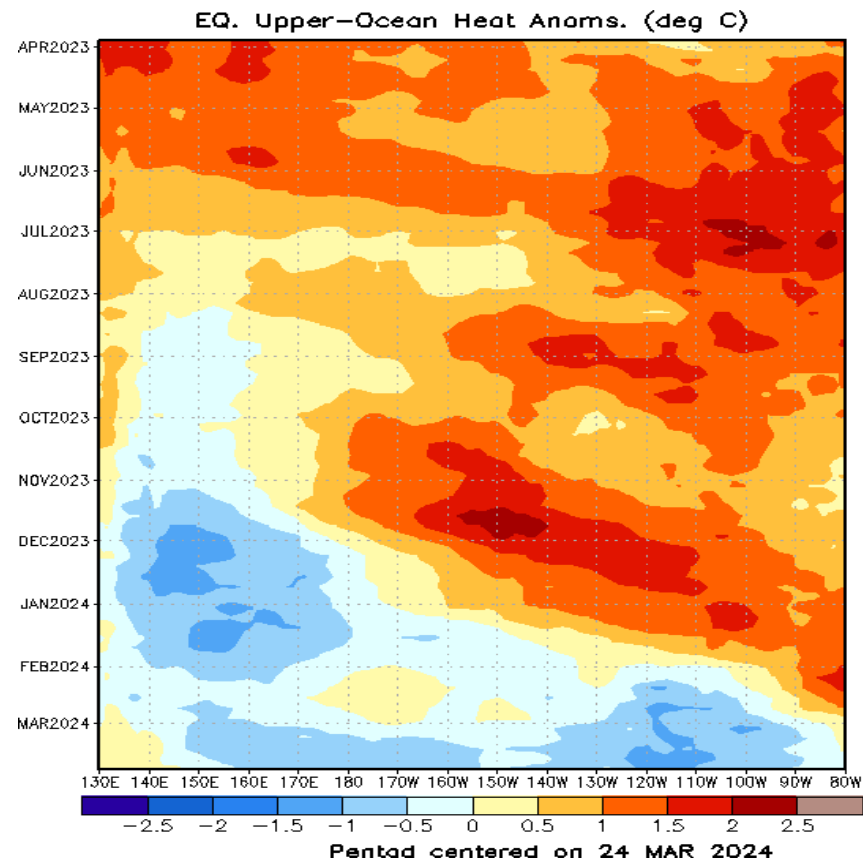
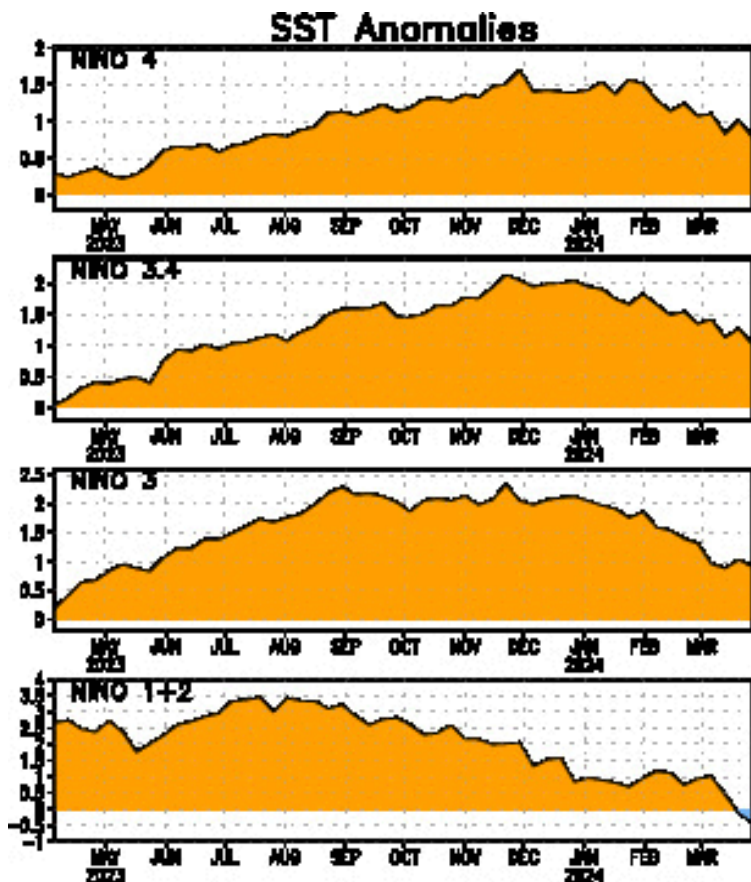
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- OLR-based forecasts remain weak but do show some areas of negative OLR anomalies increasing near the Date Line during the next 2 weeks, with enhanced equatorial Rossby Wave activity depicted in the objective filtering which may constructively interfere with the MJO.
- Negative OLR anomalies have increased across eastern Africa and the western Indian Ocean during the past week, with positive OLR anomalies across the eastern Indian Ocean and the Maritime Continent.

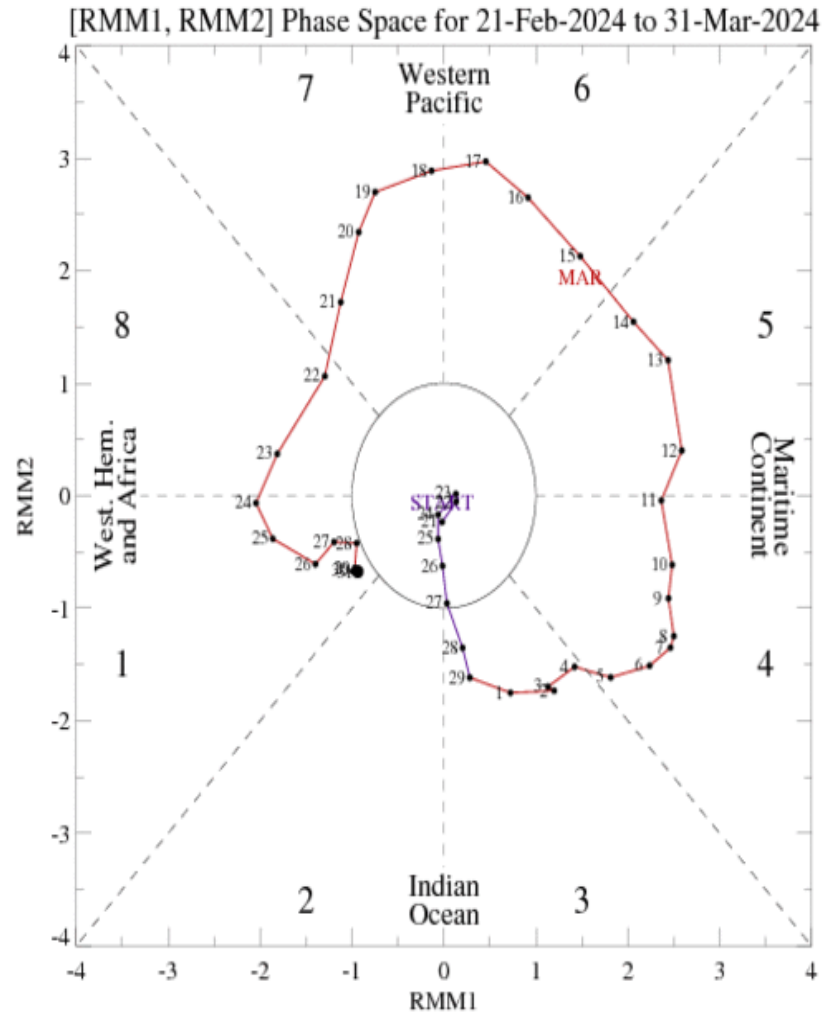
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- SSTs in all NINO regions have trended downward over the past 2 months, suggestive of a decaying El Niño, with a sharp decrease across NINO 1+2 during March where the SST anomalies have flipped to negative tied to strong upwelling over the region.
- Negative subsurface temperature anomalies continue to be observed across nearly the entire Pacific, with increasing negative anomalies across the eastern Pacific.

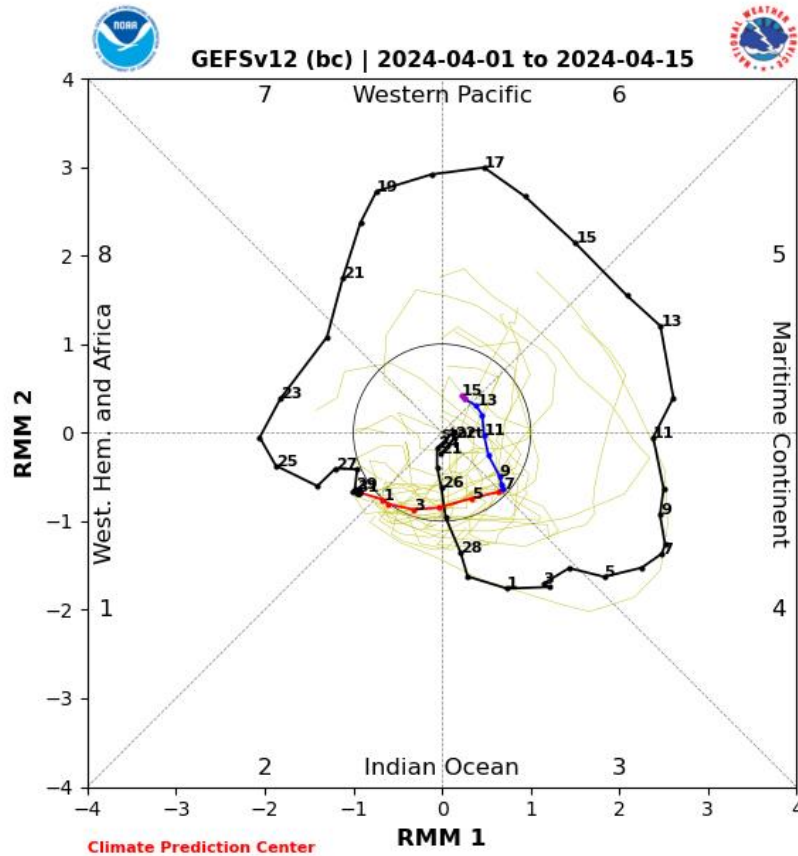
MJO Index: Recent Evolution

- Following a robust global propagation, the RMM-based MJO index has slowed down and weakened as it crosses back into the Eastern Hemisphere.

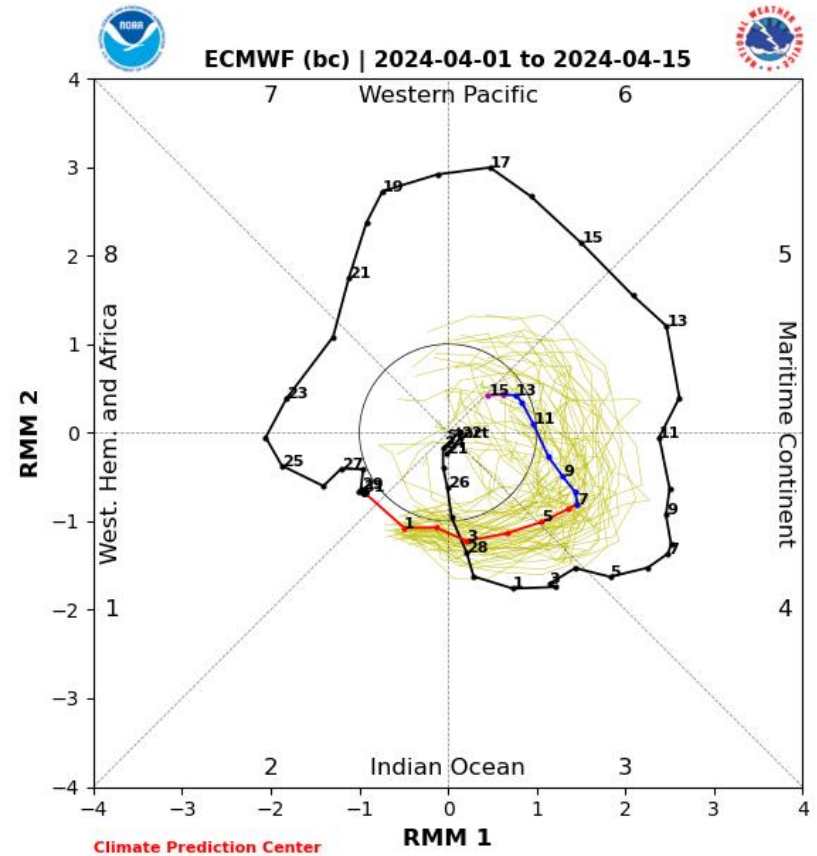


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



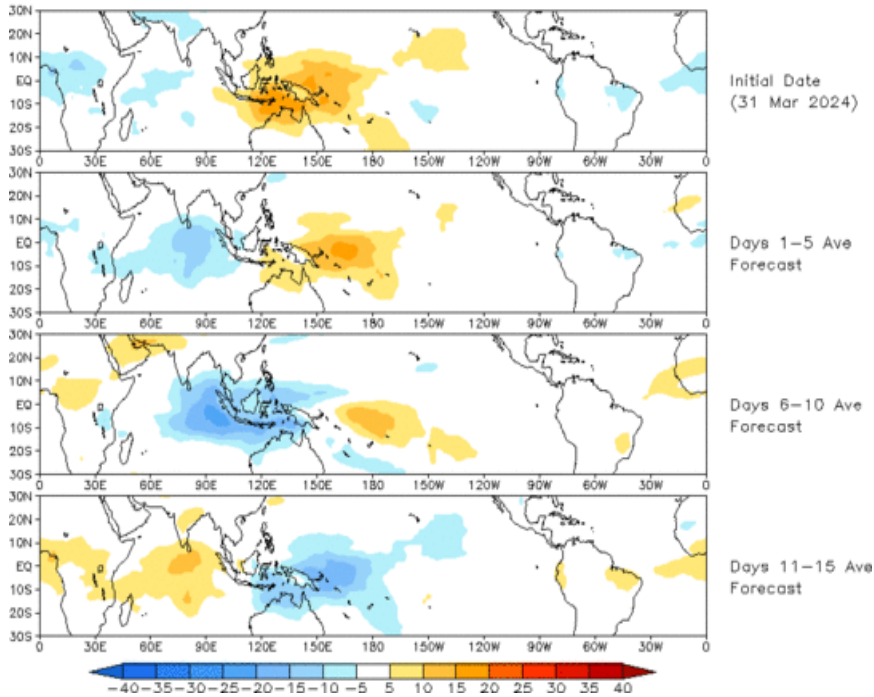
ECMWF Forecast

- Good agreement exists between the GEFS and the ECMWF ensembles regarding the MJO propagating across from the Indian Ocean to the western Pacific during the first half of April.
- There are some indications that the MJO may weaken back into the RMM-based unit circle, especially in many of the individual GEFS ensemble members.

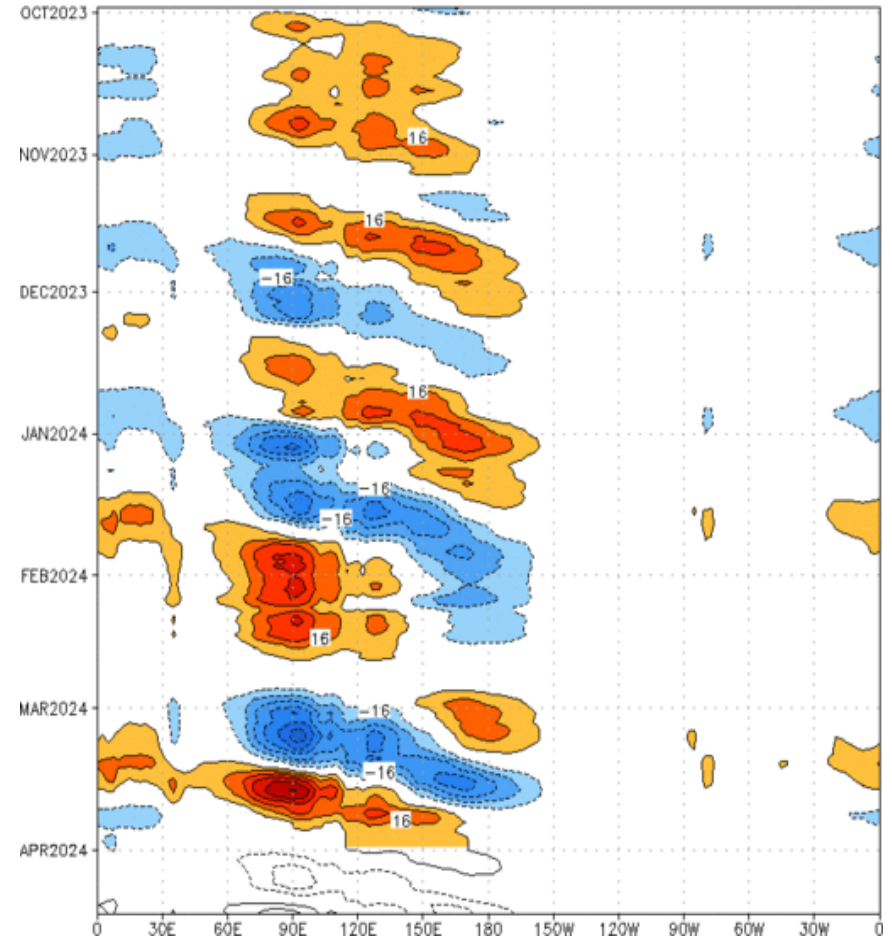
MJO: GEFS Forecast Evolution

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: 31 Mar 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: 30-Sep-2023 to 31-Mar-2024
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

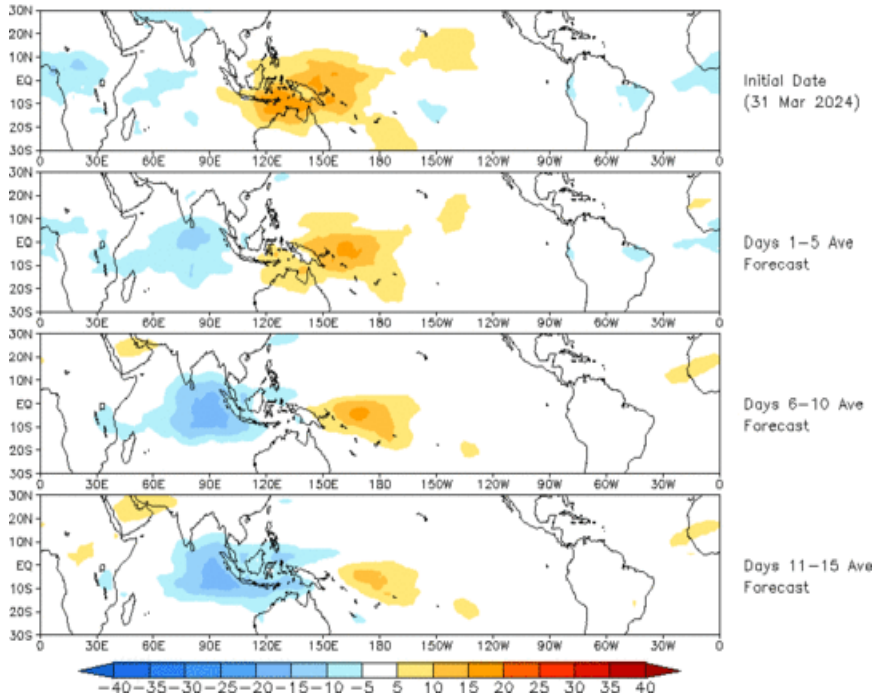


- The GEFS RMM-based tool depicts negative OLR anomalies (enhanced convection) initially across the Indian Ocean, and shifting into the Maritime Continent and western Pacific by week-2.
- By week-2, positive OLR anomalies (suppressed convection) are forecast to develop over the Indian Ocean.

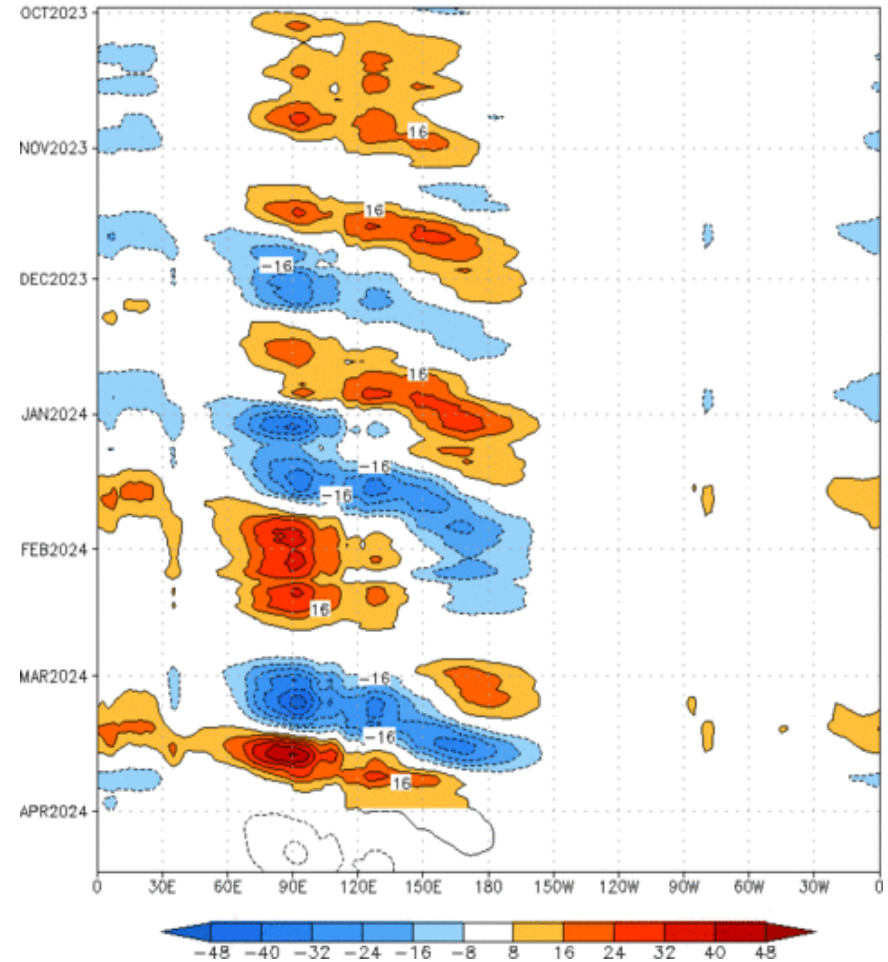
MJO: Constructed Analog Forecast Evolution

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 (31 Mar 2024)



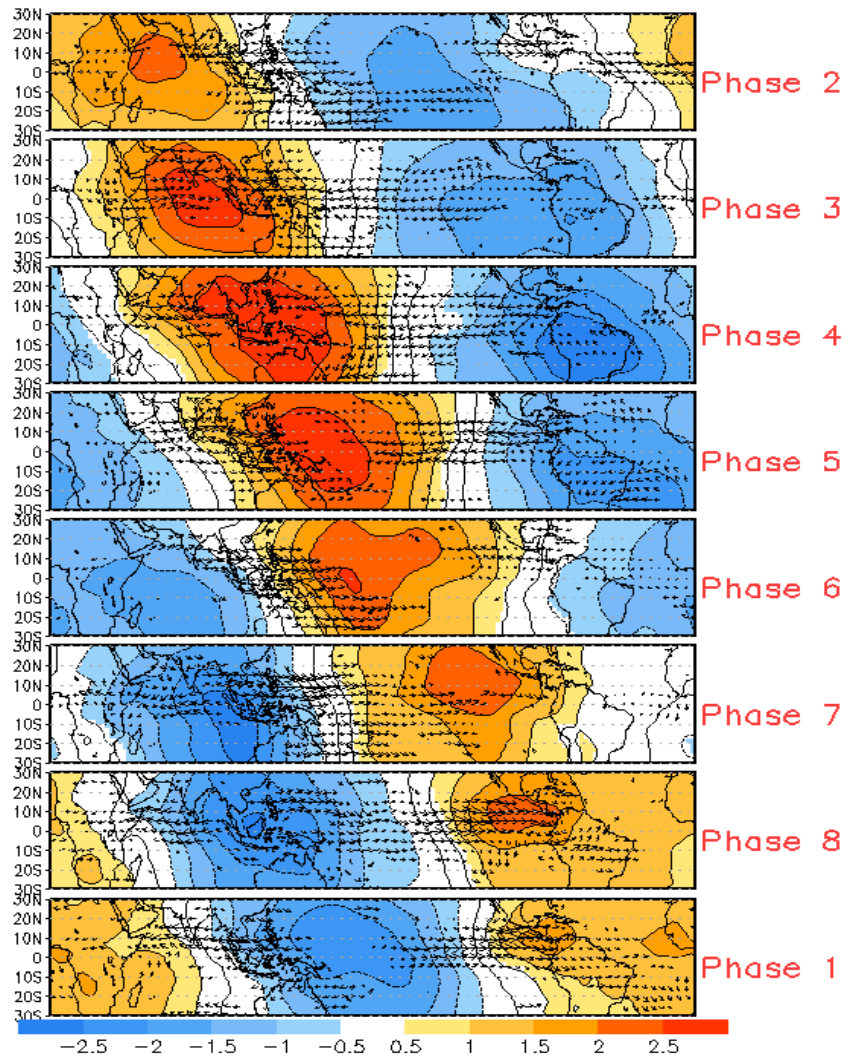
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:30-Sep-2023 to 31-Mar-2024
The unfilled contours are CA forecast reconstructed anomaly for 15 days



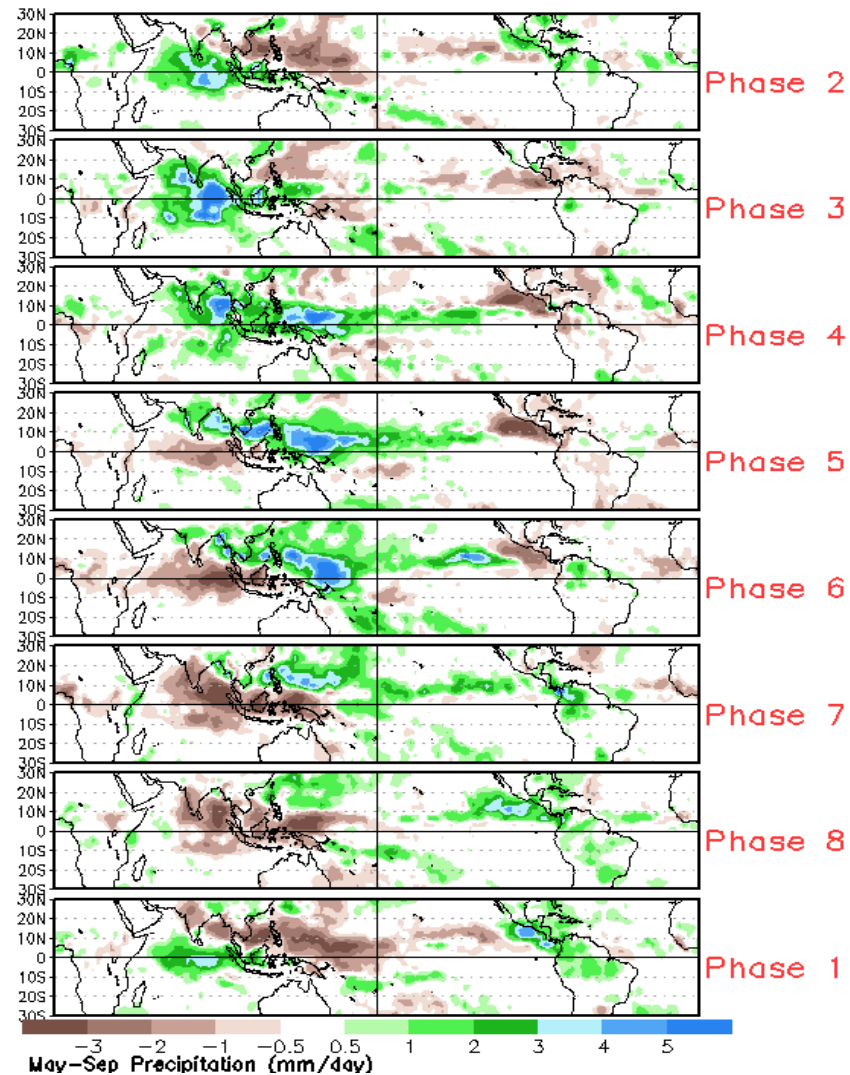
- The constructed analog tool depicts a slower MJO progression, with negative OLR anomalies persisting across the Indian Ocean and Maritime Continent through week-2, and positive OLR anomalies over the western and central Pacific.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



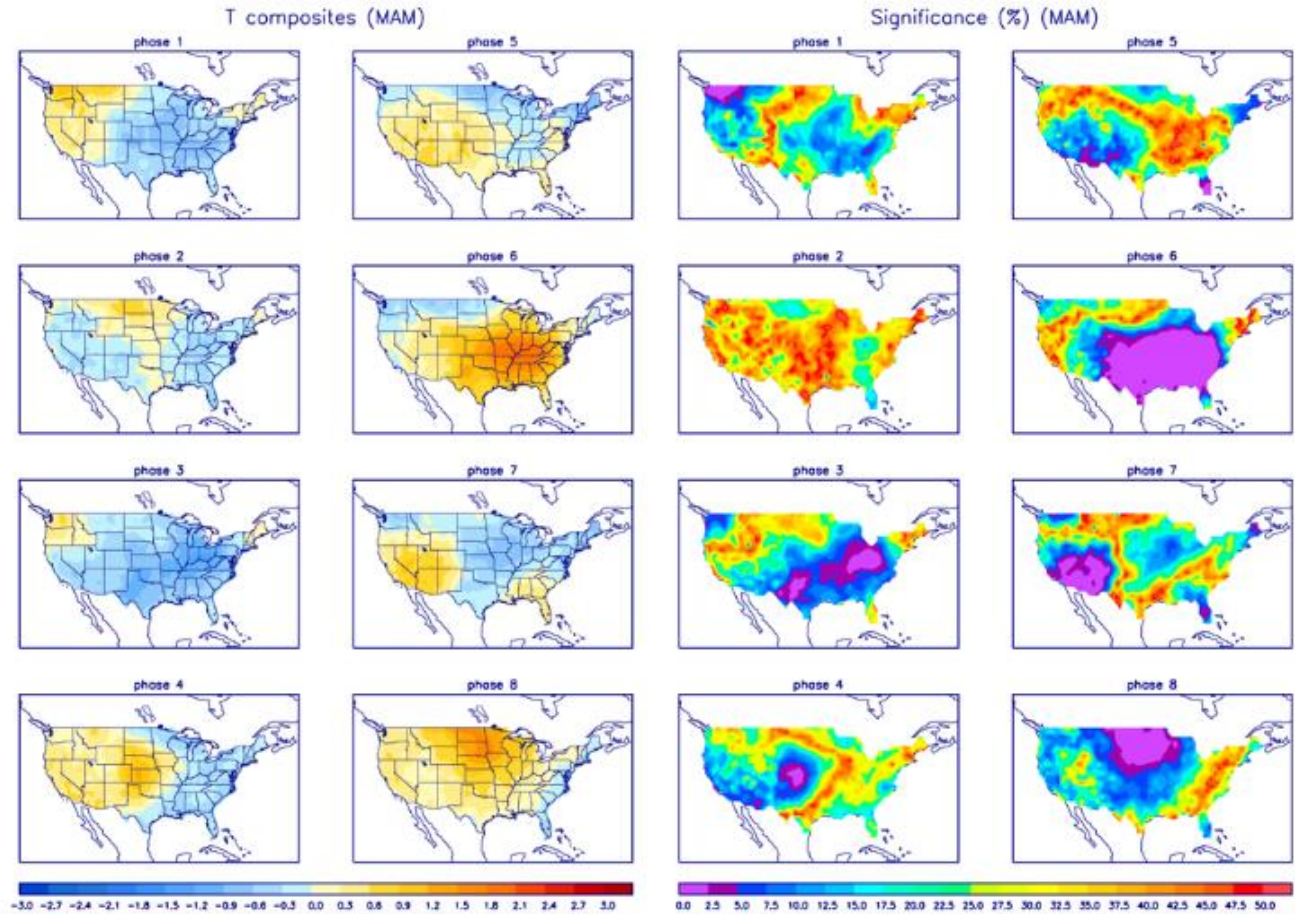
Precipitation Anomalies



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.

