

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



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

Overview

- The MJO remains active, but has maintained a low amplitude while propagating eastward across the Indian Ocean and into the Maritime Continent during the past week.
- While some ensemble solutions show continued eastward propagation of the MJO into the western Pacific, RMM forecasts generally favor much weaker and less coherent intraseasonal activity during the next few weeks.
 - The predicted weakening appears to be tied to destructive interference with an emerging low frequency convective response favored over the Africa and the western Indian Ocean.
 - Upper-level velocity potential anomaly forecasts offer a more coherent MJO outlook than RMM, which depicts the enhanced phase reaching the western Hemisphere towards the end of April.
- Constructive interference between the MJO and an equatorial Rossby wave is expected to provide an environment conducive for tropical cyclogenesis to the north of Australia and the western Pacific during the next week or so.
- Beyond this time, there is much uncertainty in Tropical Cyclone (TC) formation potential given a lack of coherent signals in the model guidance, a potentially weak MJO, and a quiet TC climatology across all basins during late April.

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

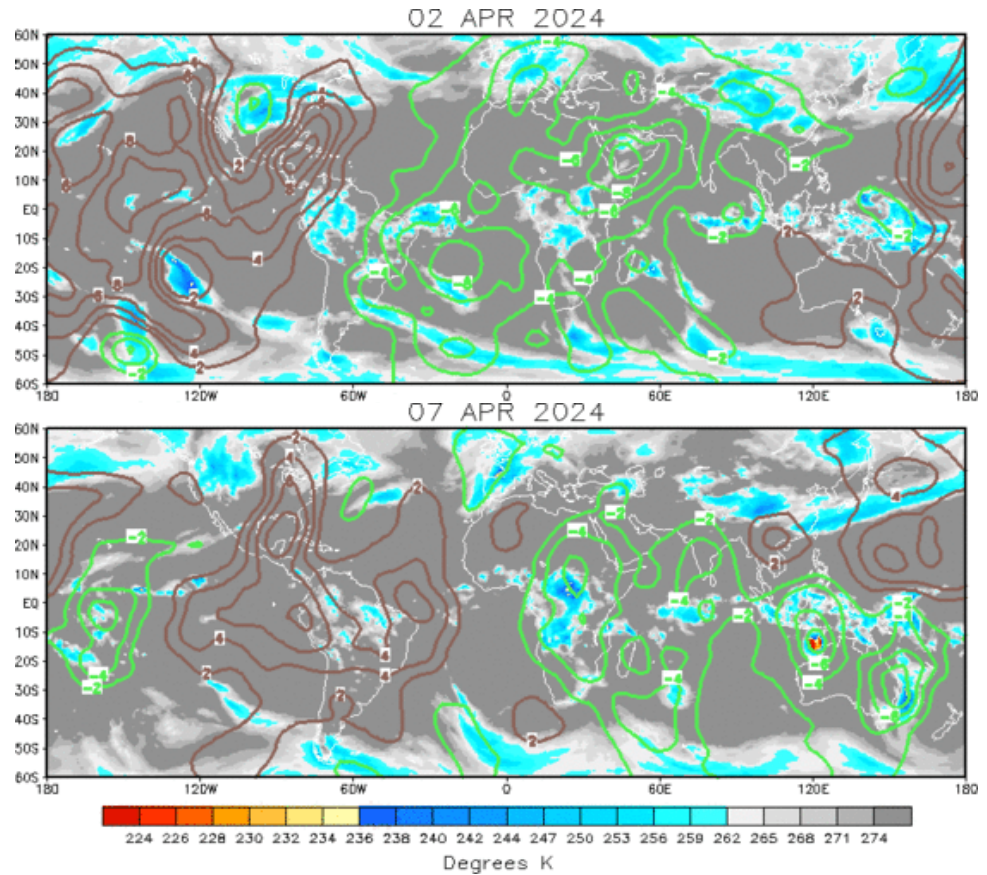
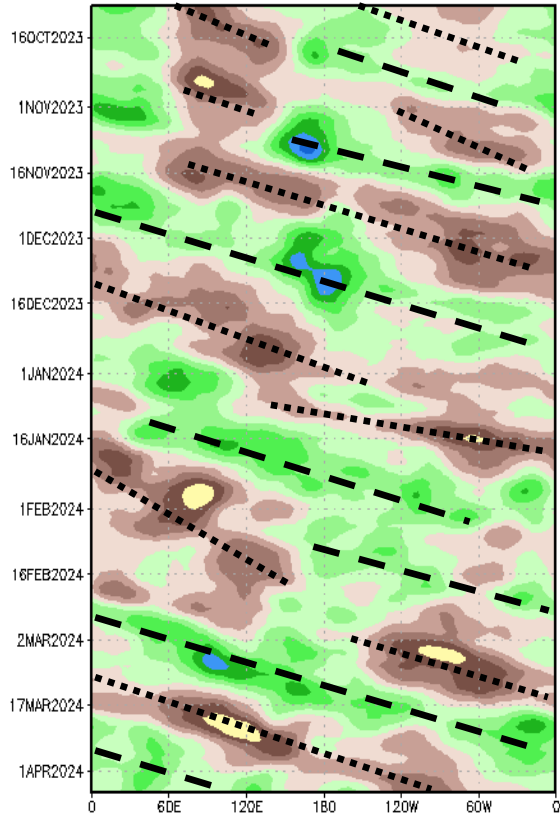
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

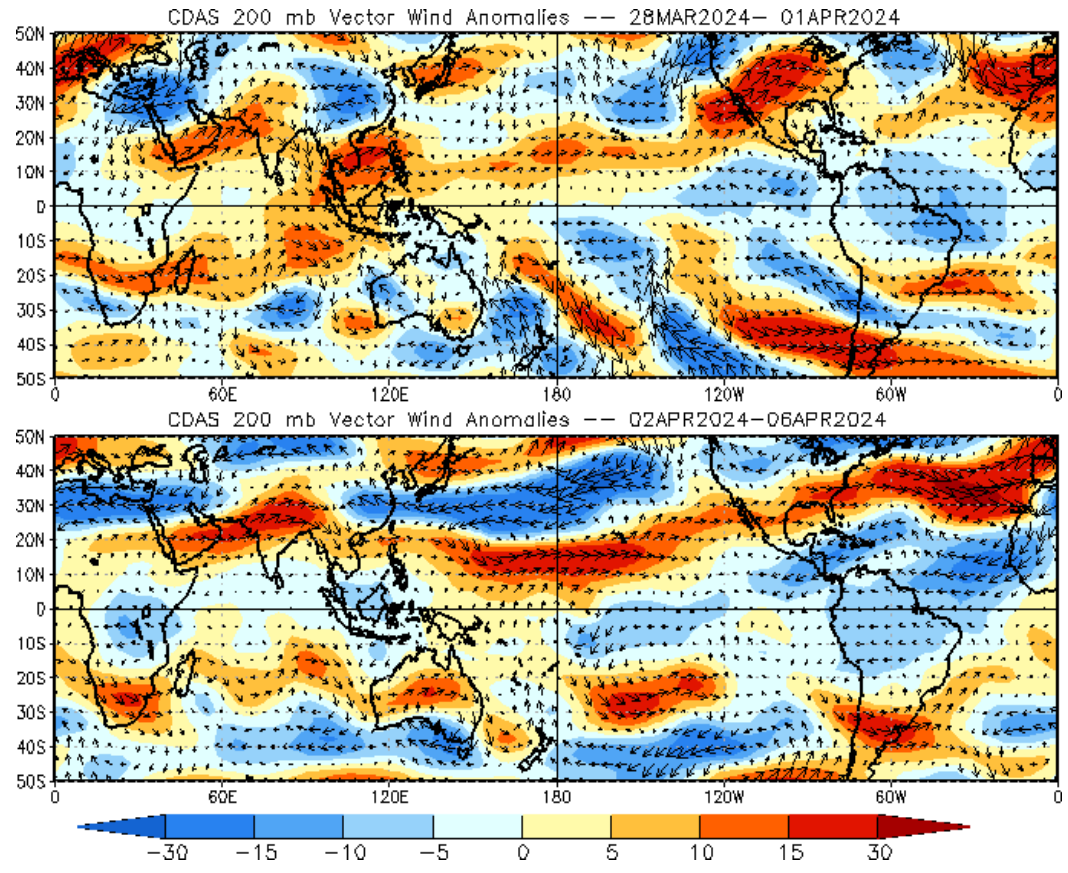
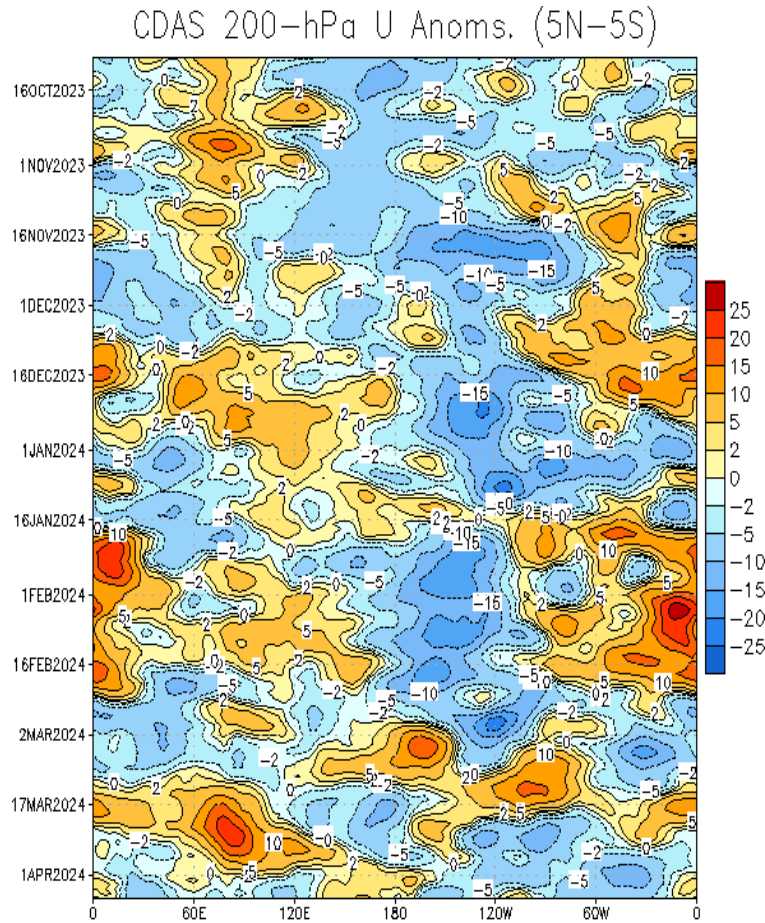
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- Continued eastward propagation of a wave-1 pattern is evident in the time-longitude plot, consistent with MJO activity, albeit on the fast side of the phase speed spectrum.
- However, spatial maps reveal a separation of the main divergence envelope into two centers of action over the eastern Hemisphere; one located over the Maritime Continent likely tied to the MJO, and another fixed over Africa and the western Indian Ocean, suggestive of an emerging low frequency response.

200-hPa Wind Anomalies

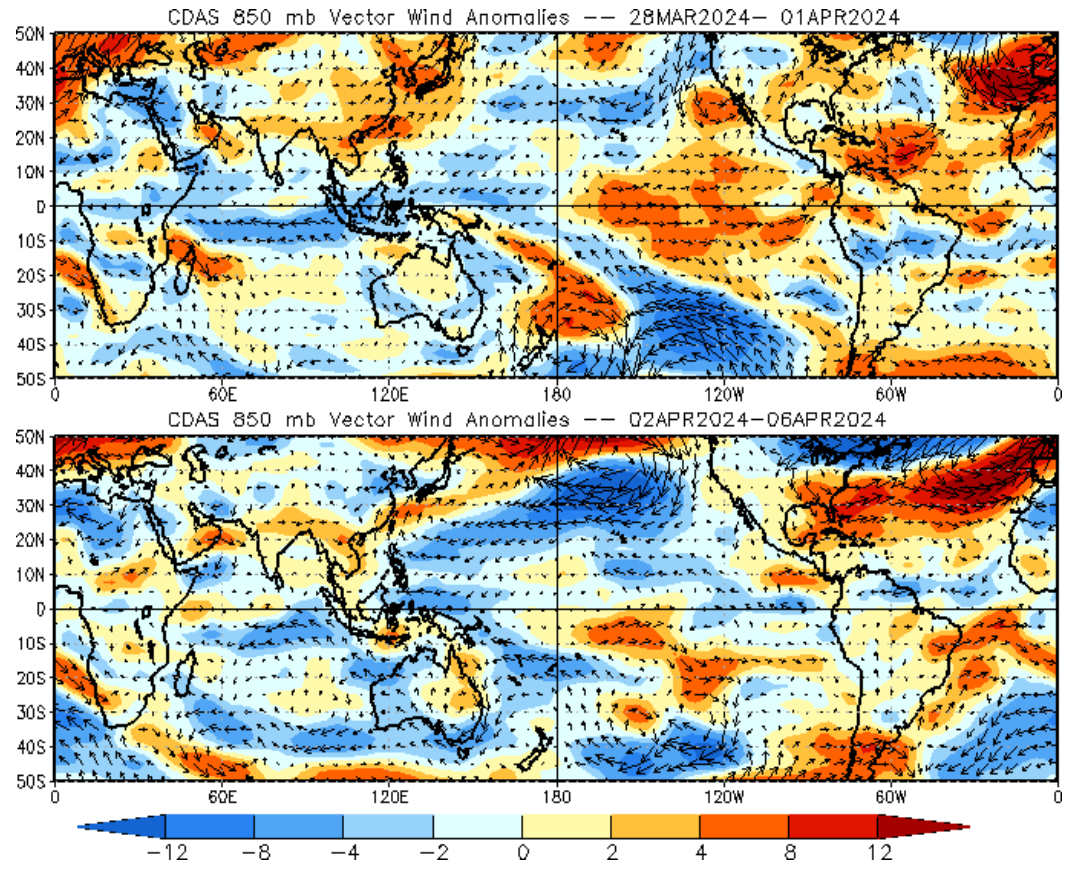
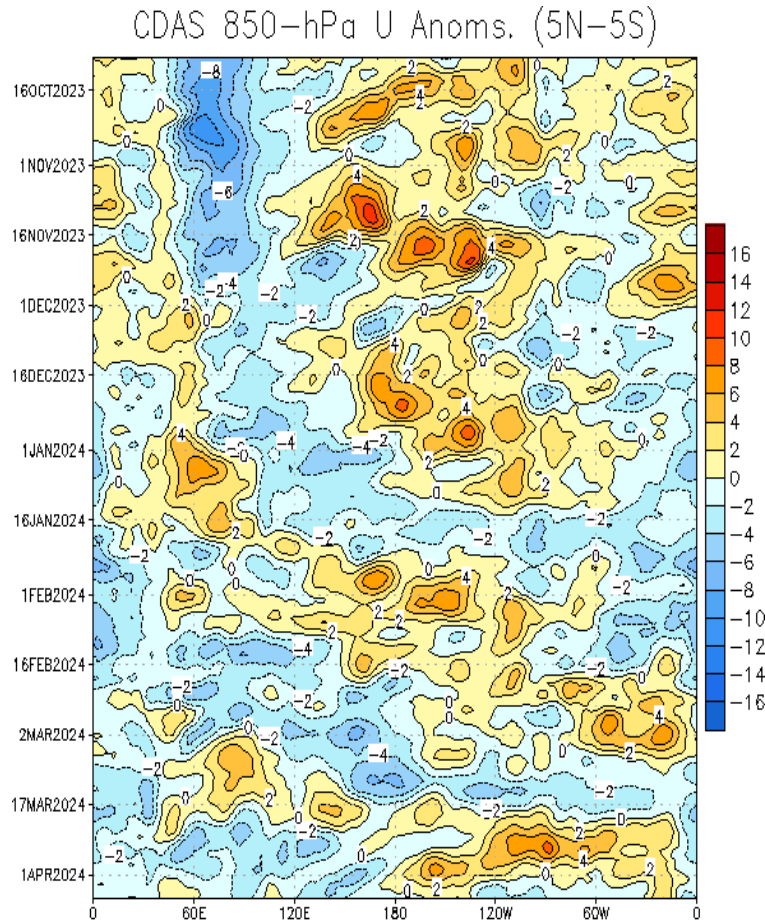
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- The easterly phase of the MJO became established over the Indian Ocean, however the persistence of weak westerlies and associated divergence aloft remain present in the western part of the basin south of the equator.
- The subtropical jet remains active across southern North America, with anomalous anticyclonic flow to the south that is reinforcing anomalous easterlies over the equatorial eastern Pacific and Atlantic.

850-hPa Wind Anomalies

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

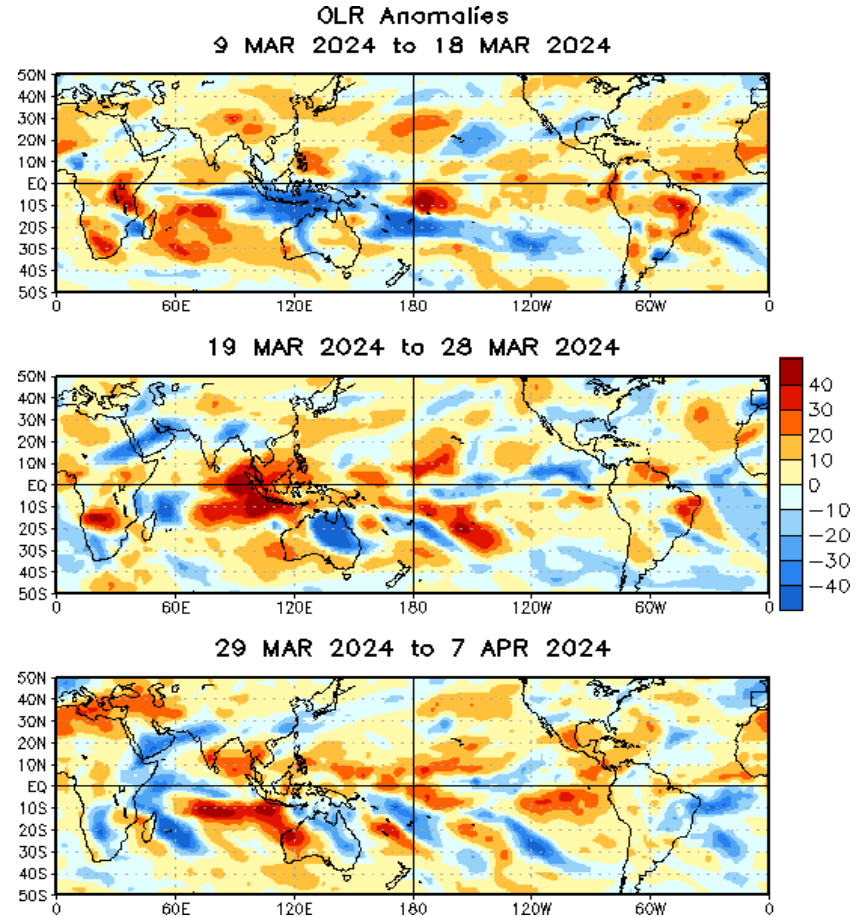
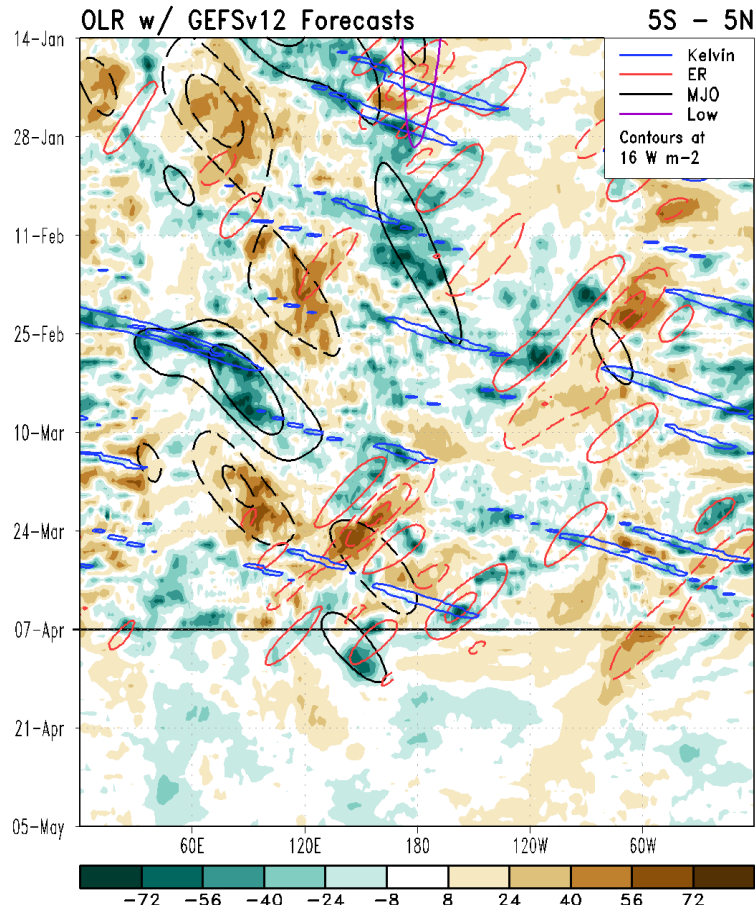


- Tied to the MJO, anomalous low-level westerlies surfaced over the Indian Ocean but appear less spatially coherent compared to previous passages in the basin, as trades remain firmly enhanced mostly south of the equator.
- Since late March, a westward shifting feature is evident over the equatorial Pacific, likely associated with equatorial Rossby Wave activity destructively interfering with the easterly phase of the MJO.

Outgoing Longwave Radiation (OLR) Anomalies

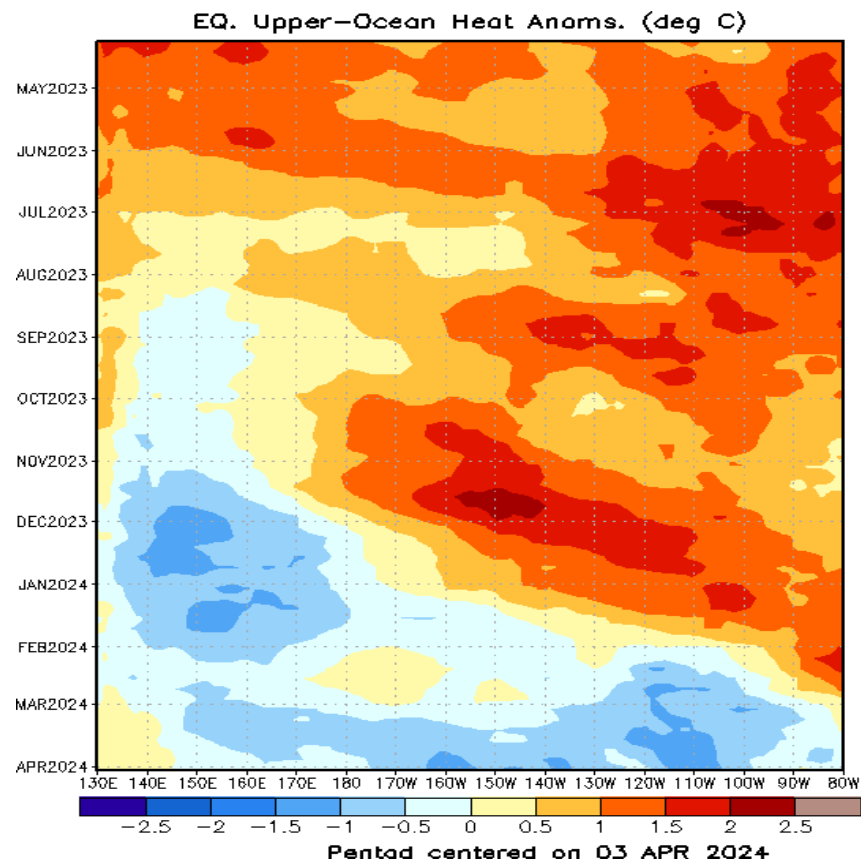
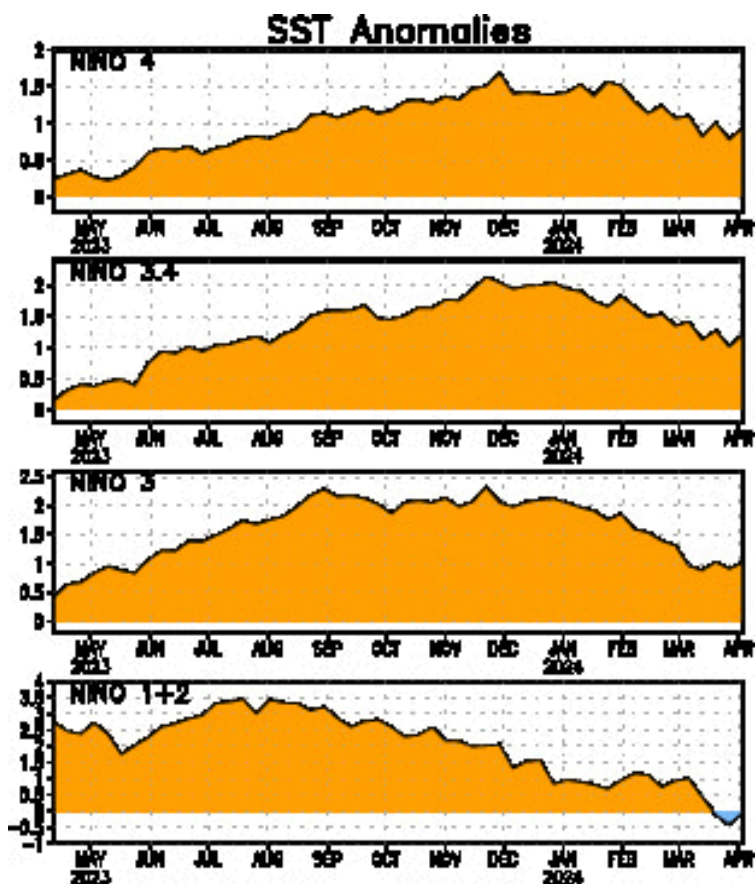
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- Enhanced convection returned over eastern Africa and parts of the Indian Ocean along and off the equator.
- Suppressed convection became more widespread over the equatorial Pacific on both sides of the Date Line.
- Some MJO activity coming through the filtering in the OLR forecasts, but the persistence of enhanced convection over Africa and the western Indian Ocean is favored through the end of April, with another convective envelope featured over the western Pacific.

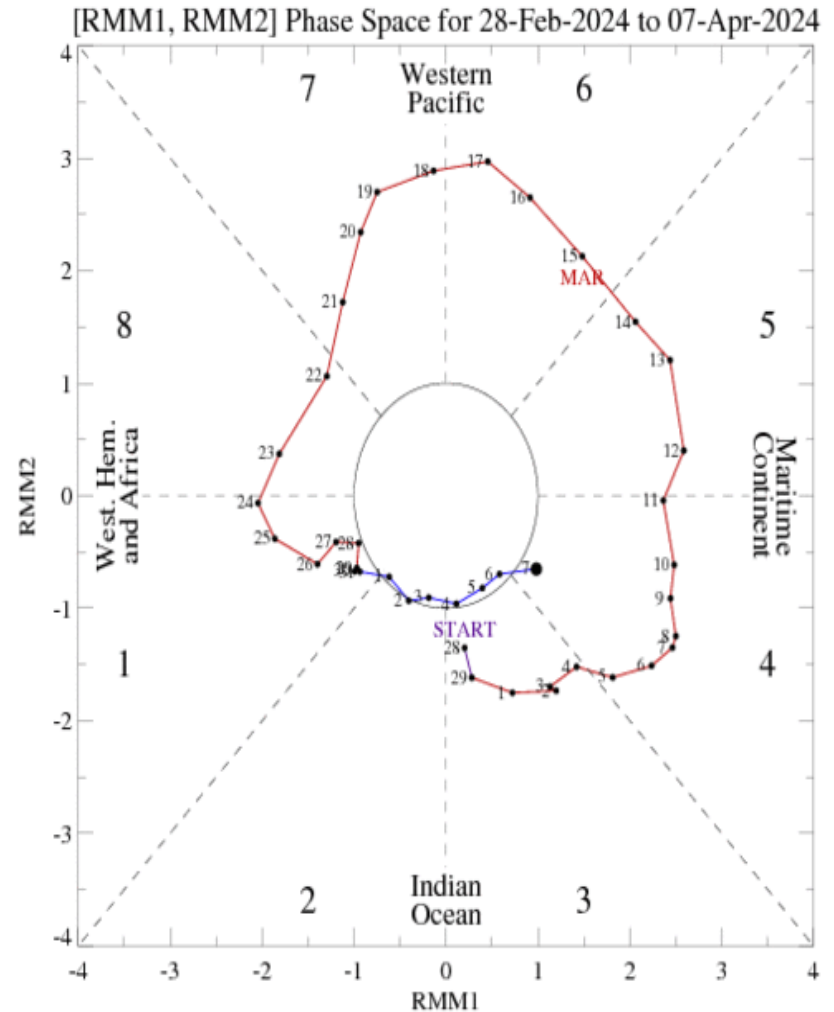
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- 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.

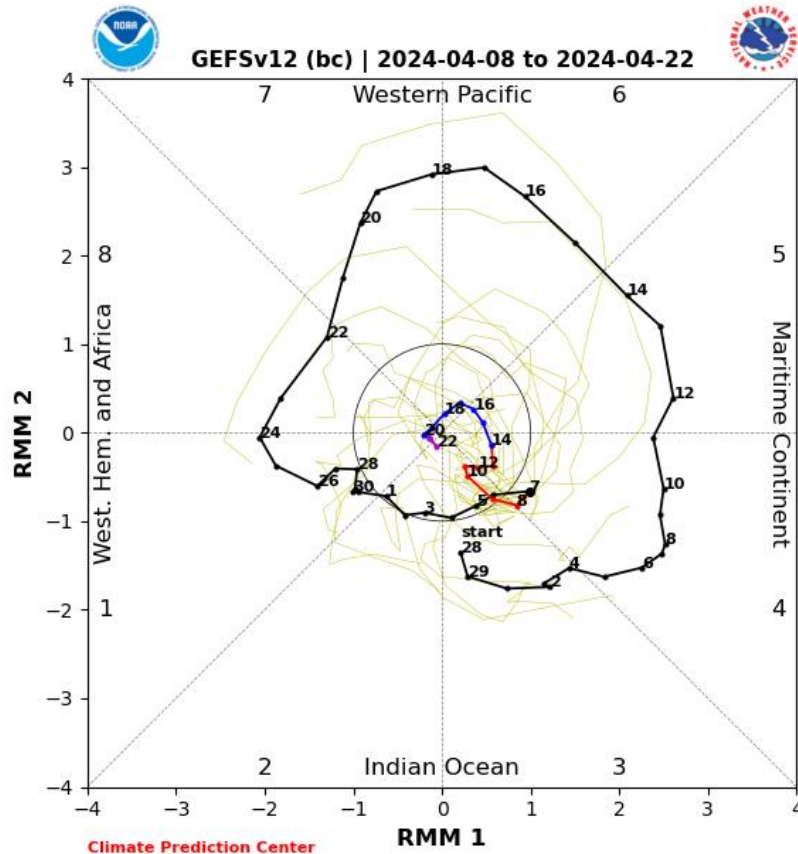
MJO Index: Recent Evolution

- Since late March, the RMM-based MJO index has considerably slowed down and weakened, but maintained its eastward propagation across the Indian Ocean, having just entered the Maritime Continent.
- Based on zonal winds and OLR, this behavior appears to be tied to destructive interference with a strong equatorial Rossby wave, with its enhanced (suppressed) phase propagating westward over the equatorial Pacific (Indian Ocean) counteracting that of the MJO.

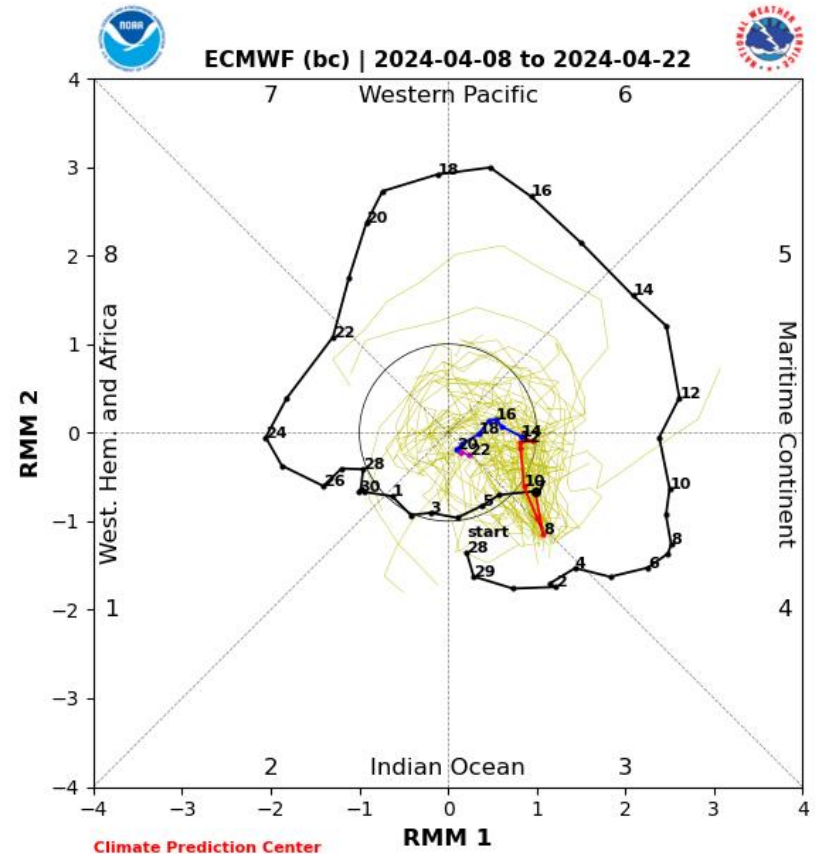


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



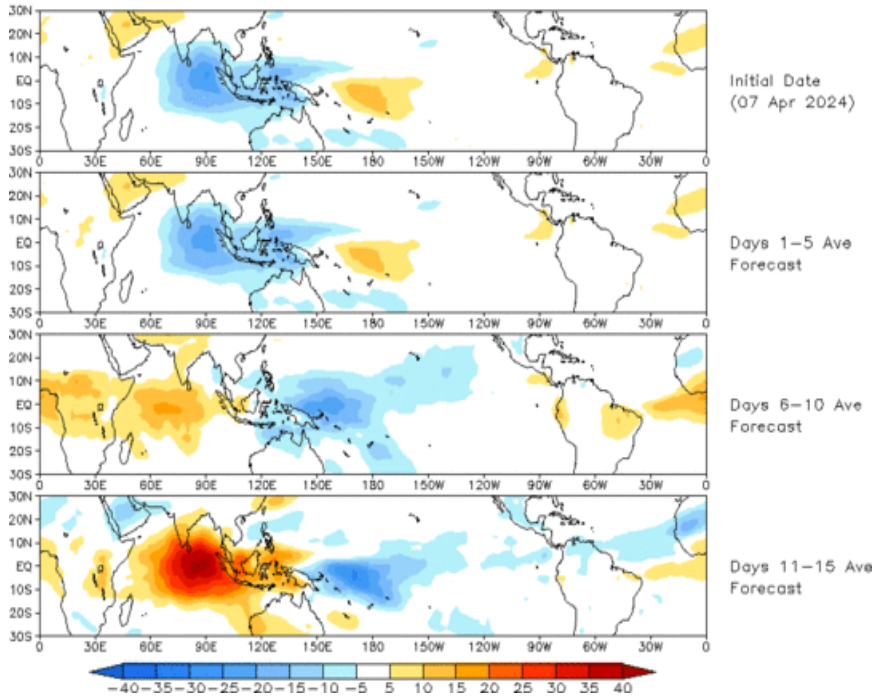
ECMWF Forecast

- A weakened MJO is generally favored in the RMM forecasts, though some ensemble members favor continued eastward propagation at a higher amplitude into the western Pacific
- With the MJO propagating into the western Pacific, its suppressed phase overspreading the Indian Ocean is likely to destructively interfere with the low frequency convective footprint that has emerged in the basin, which may help explain the low amplitude, weakened forecasts.

MJO: GEFS Forecast Evolution

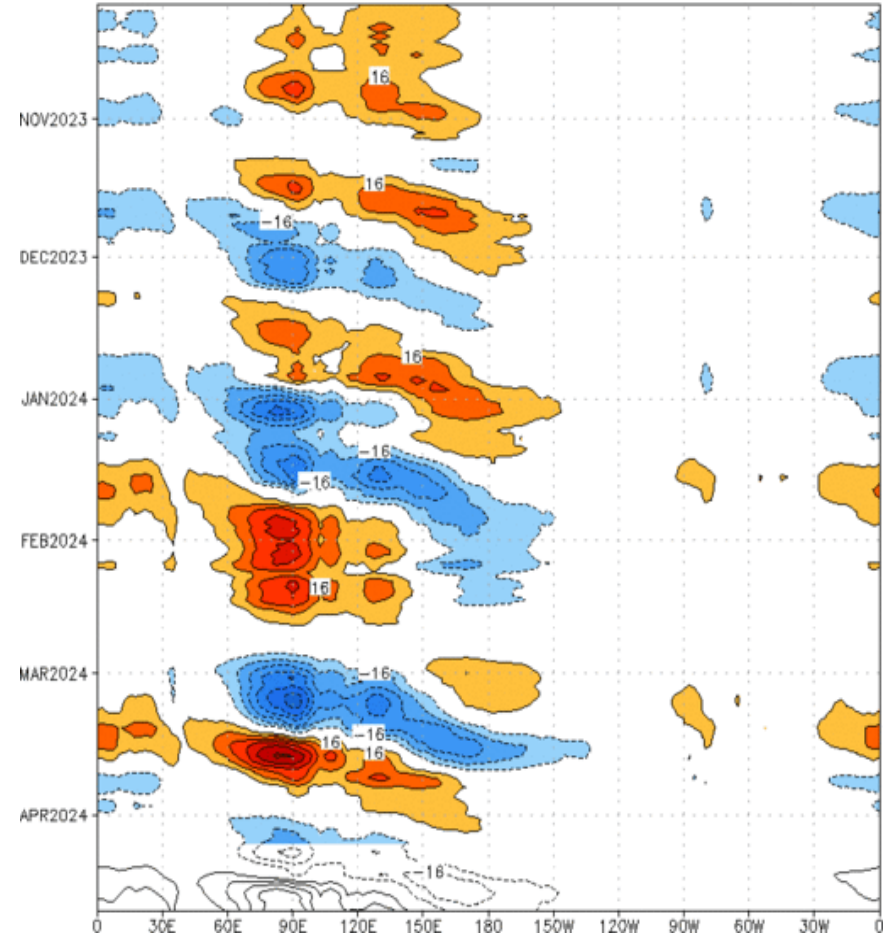
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

Prediction of MJO-related anomalies using GEFS operational forecast
Initial date: 07 Apr 2024
OLR



- The GEFS RMM-based tool reveals a heathier MJO outlook with enhanced (suppressed) convection and shifting eastward into the western Pacific (Indian Ocean) by week-2.

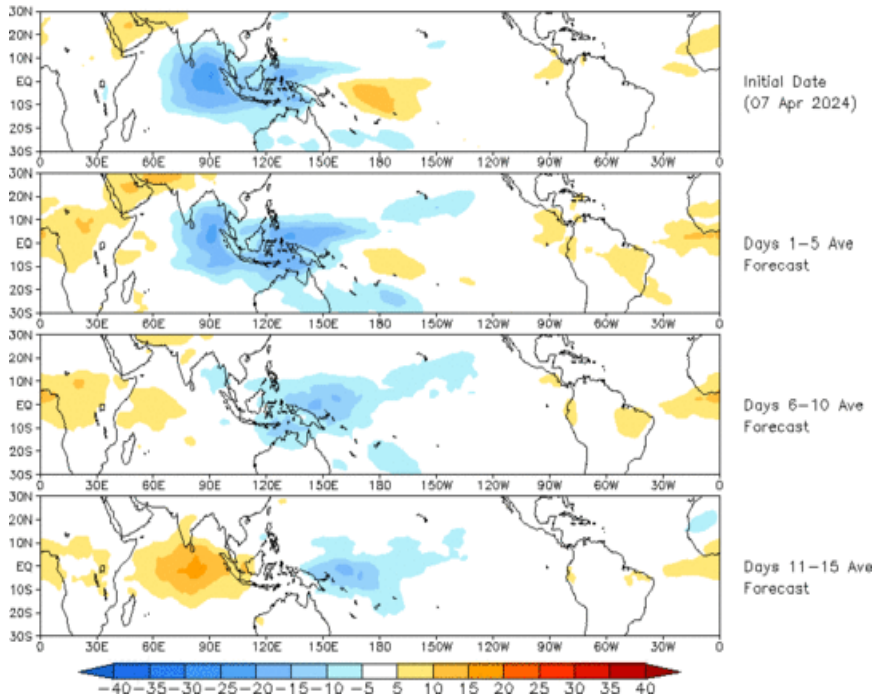
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [$7.5^{\circ}\text{S}, 7.5^{\circ}\text{N}$] (cint: 4Wm^{-2}) Period:07-Oct-2023 to 07-Apr-2024
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days



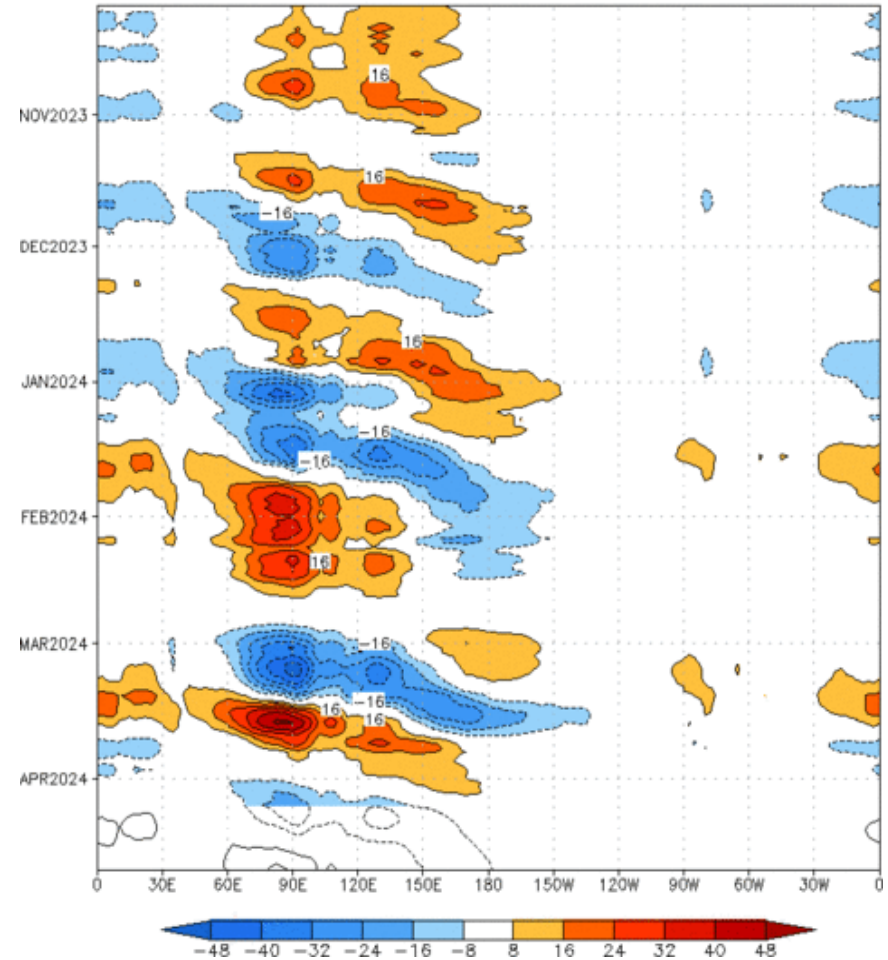
MJO: Constructed Analog Forecast Evolution

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 (07 Apr 2024)



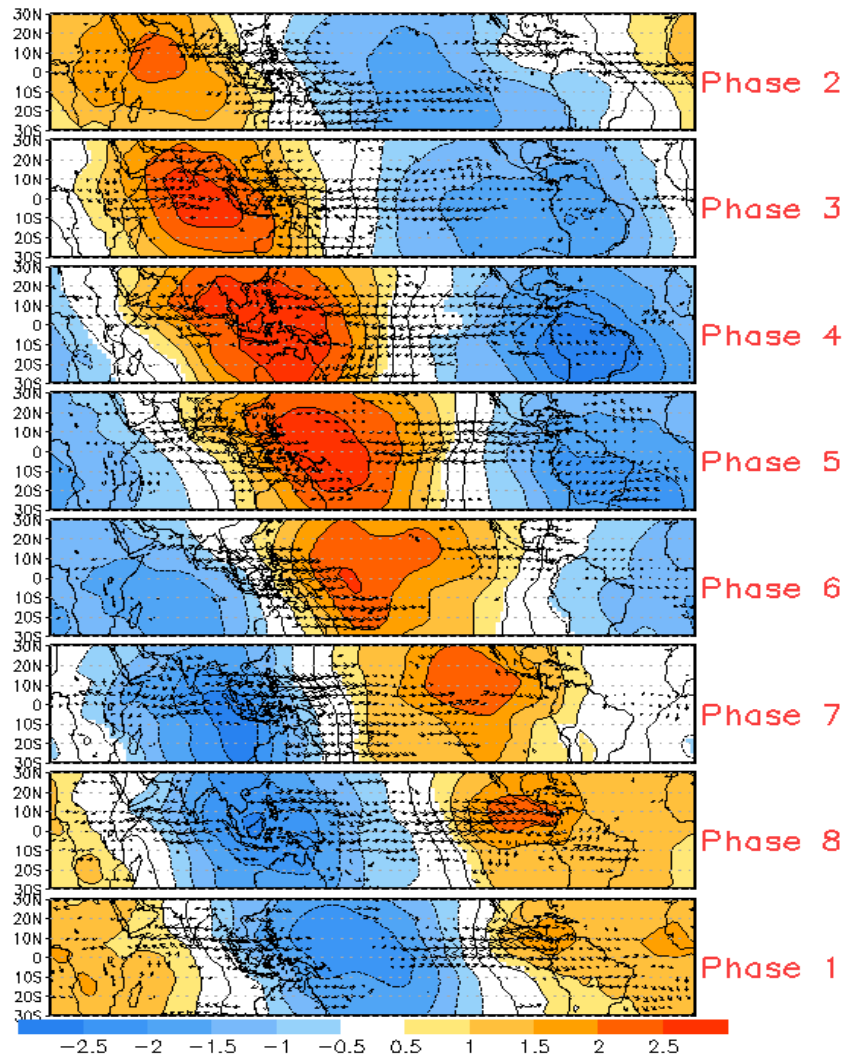
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:07–Oct–2023 to 07–Apr–2024
The unfilled contours are CA forecast reconstructed anomaly for 15 days



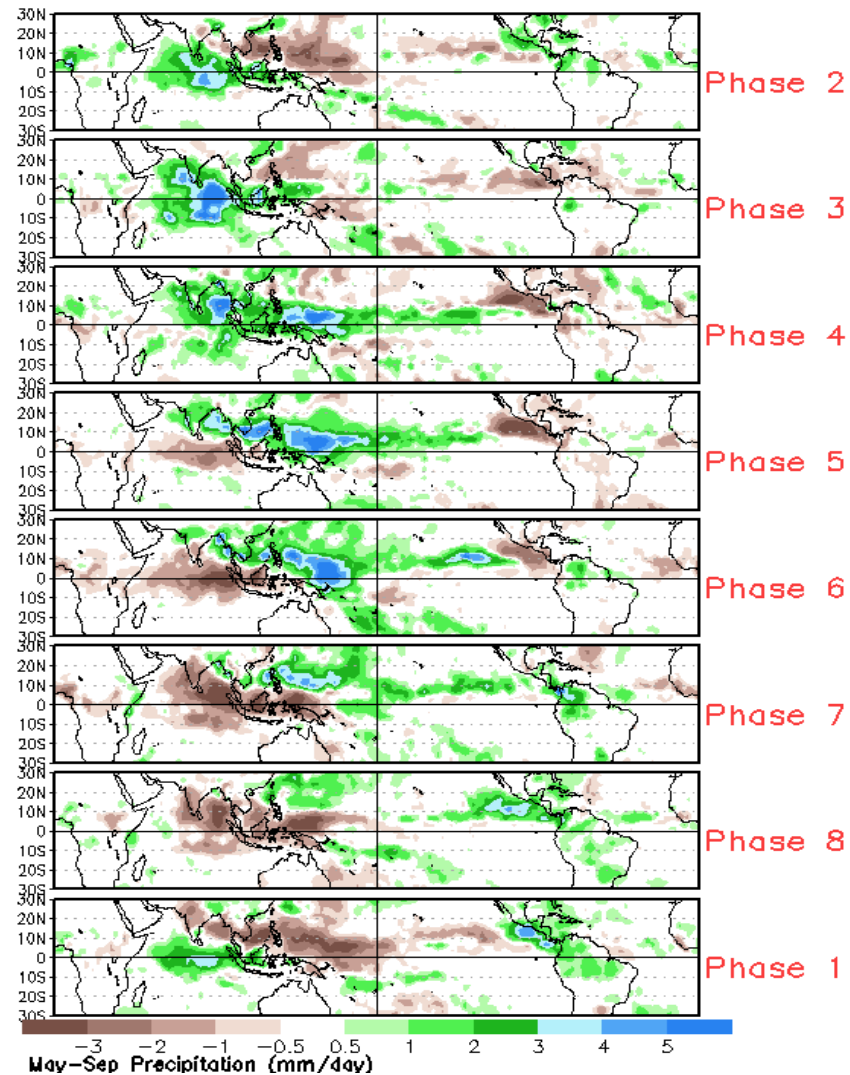
- The constructed analog tool is fairly consistent with the GEFS, but features a convective dipole that is slightly less progressive and weaker in strength.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



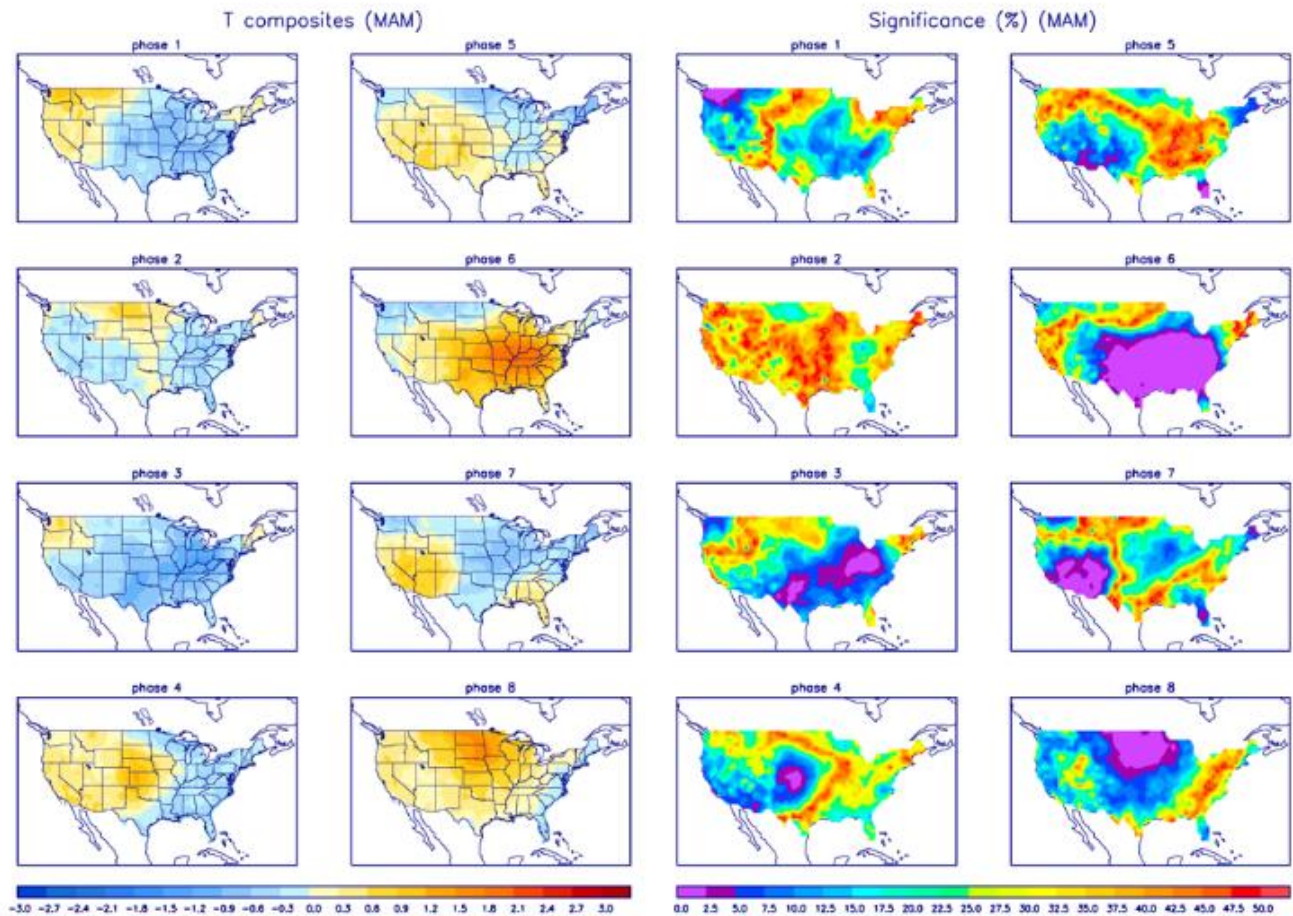
Precipitation Anomalies



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.

