

Madden-Julian Oscillation:

Recent Evolution, Current Status and Predictions



Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
1 May 2023

Overview

- Following an active MJO propagation across the Western Hemisphere during mid- to late-April, the RMM-based MJO index has weakened as the signal moved into the Indian Ocean.
- Dynamical models depict the MJO strengthening over the Maritime Continent during the next few days, with quick propagation into the Western Pacific by week-2.
- There are increasing chances for tropical cyclone development over the Bay of Bengal and the western North Pacific during the next 2 weeks associated with the enhanced convective envelope moving across these areas.
- The active MJO over the Maritime Continent may drive a pattern change to warmer temperatures across the central and eastern U.S. by mid-May, although continued eastward propagation of the MJO back into the Western Hemisphere later in the month could result in a return to below normal temperatures over these areas.

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>

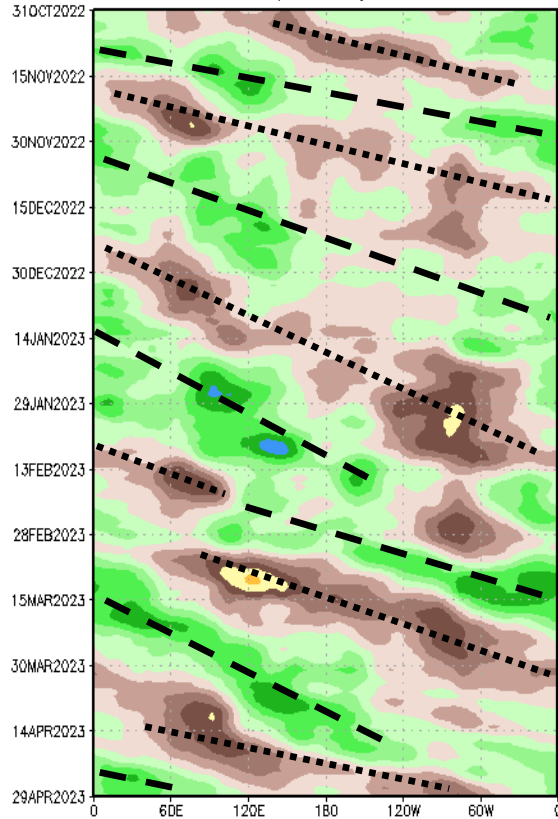
200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

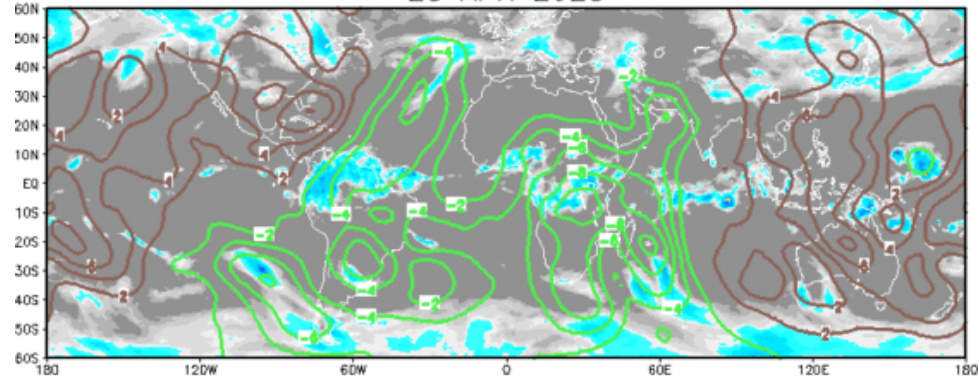
Brown shades: Anomalous convergence (unfavorable for precipitation)

200-hPa Velocity Potential Anomaly: 5N-5S

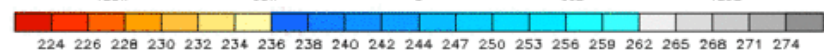
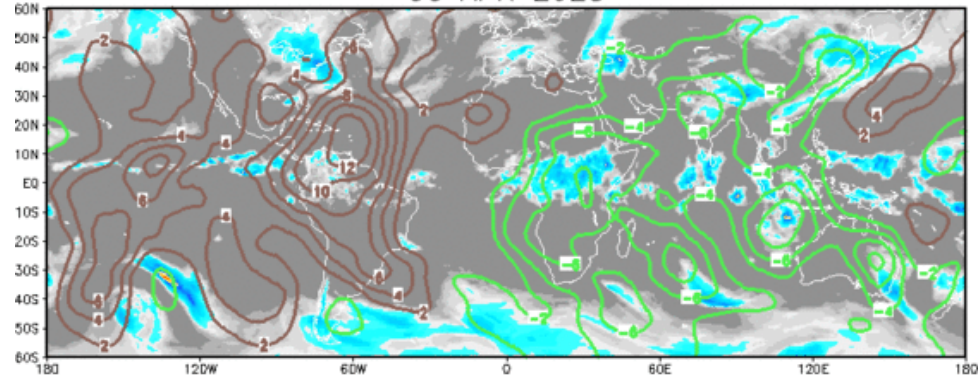
5-day Running Mean



25 APR 2023



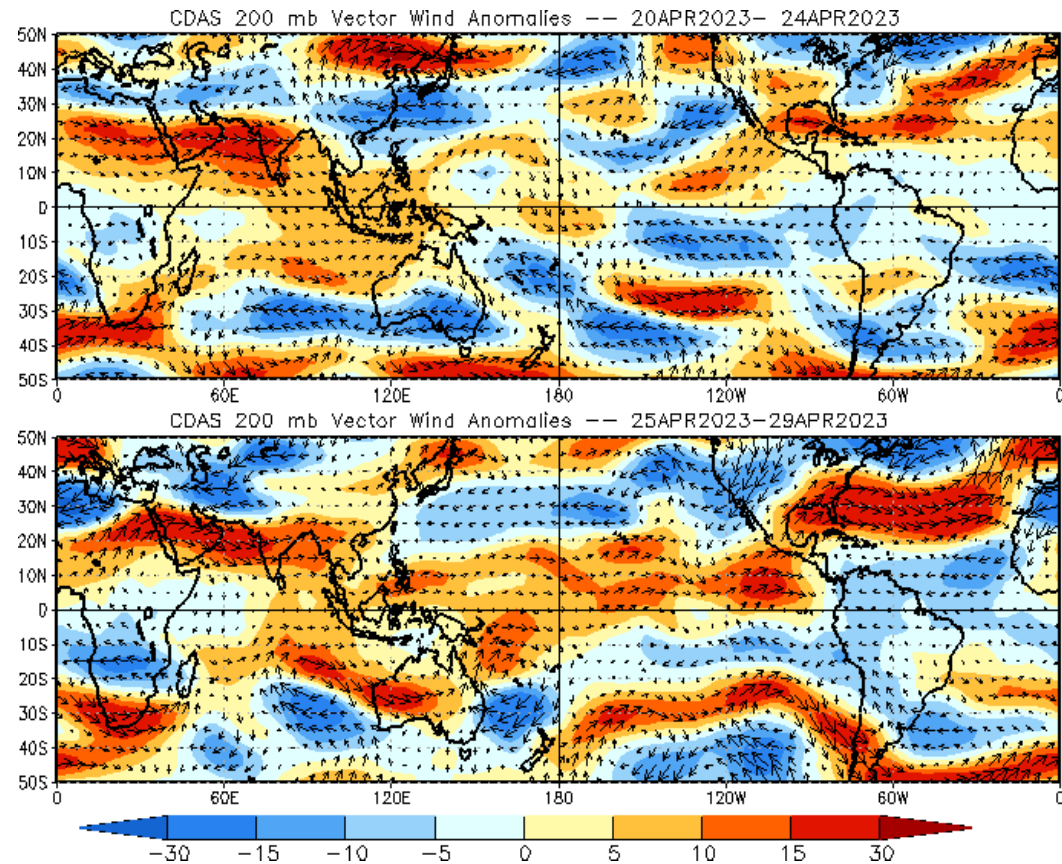
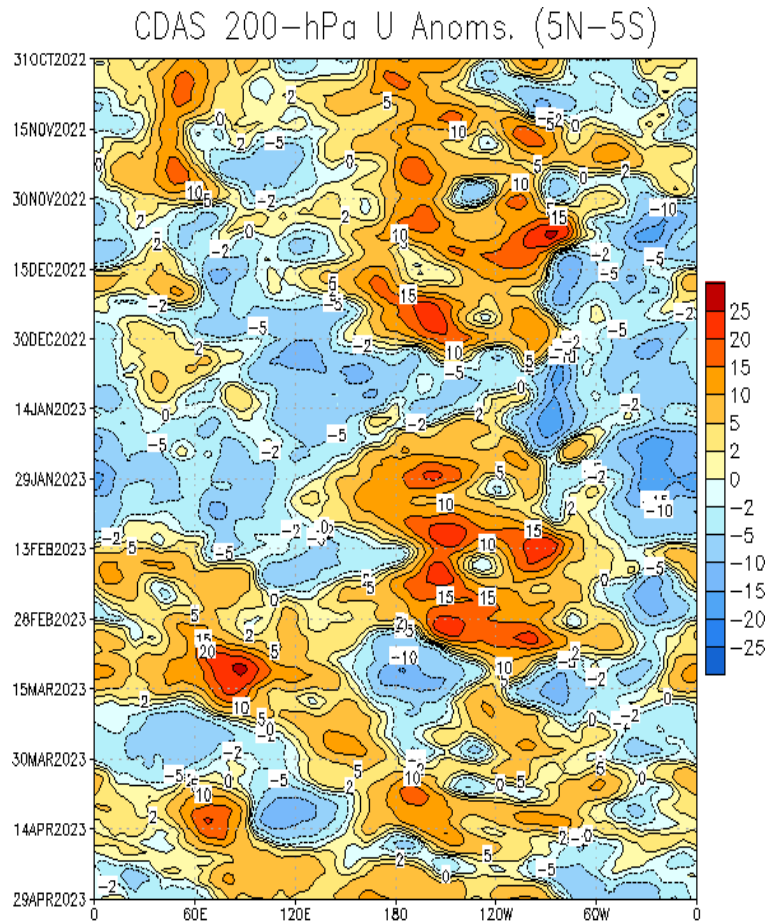
30 APR 2023



- A wave-1 asymmetry pattern is apparent in the spatial upper-level velocity potential field with anomalous divergence (convergence) centered across Africa, the Indian Ocean, and Maritime Continent (much of the Pacific and Americas).
- Alternating periods of anomalous divergence and convergence propagated around the globe during the past few months, suggestive of the MJO superceding ENSO as the dominant mode of variability in the tropics.

200-hPa Wind Anomalies

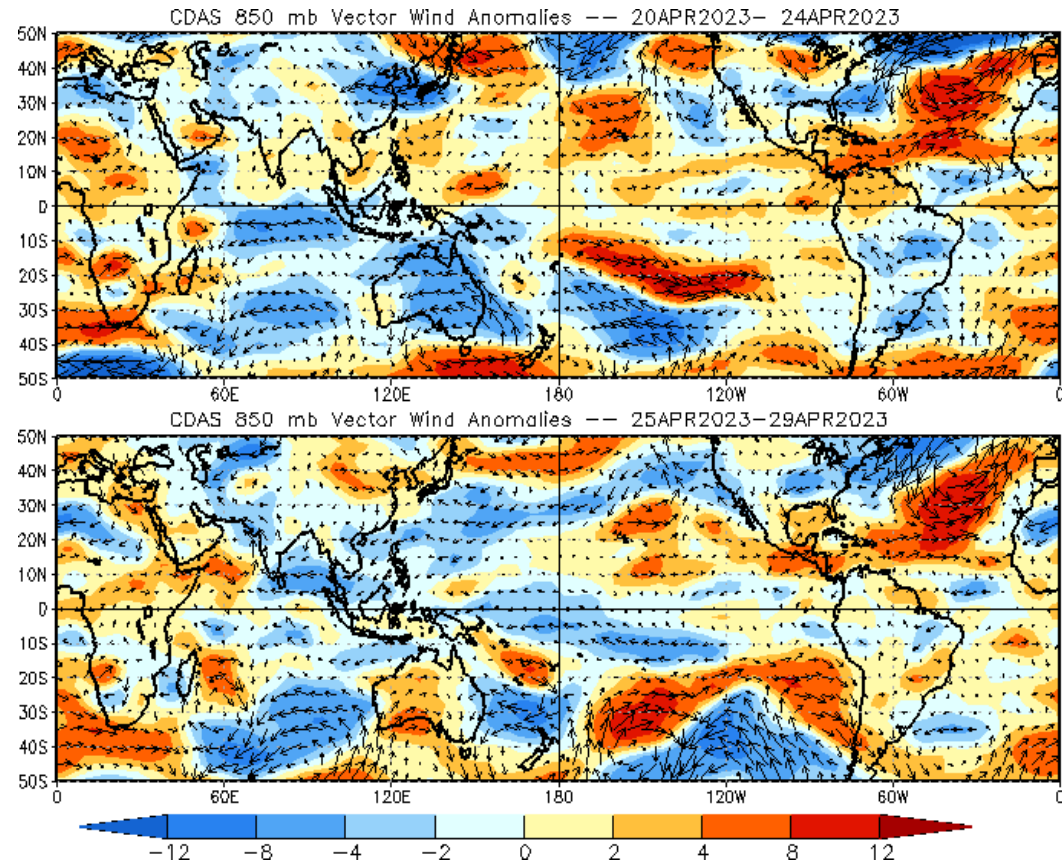
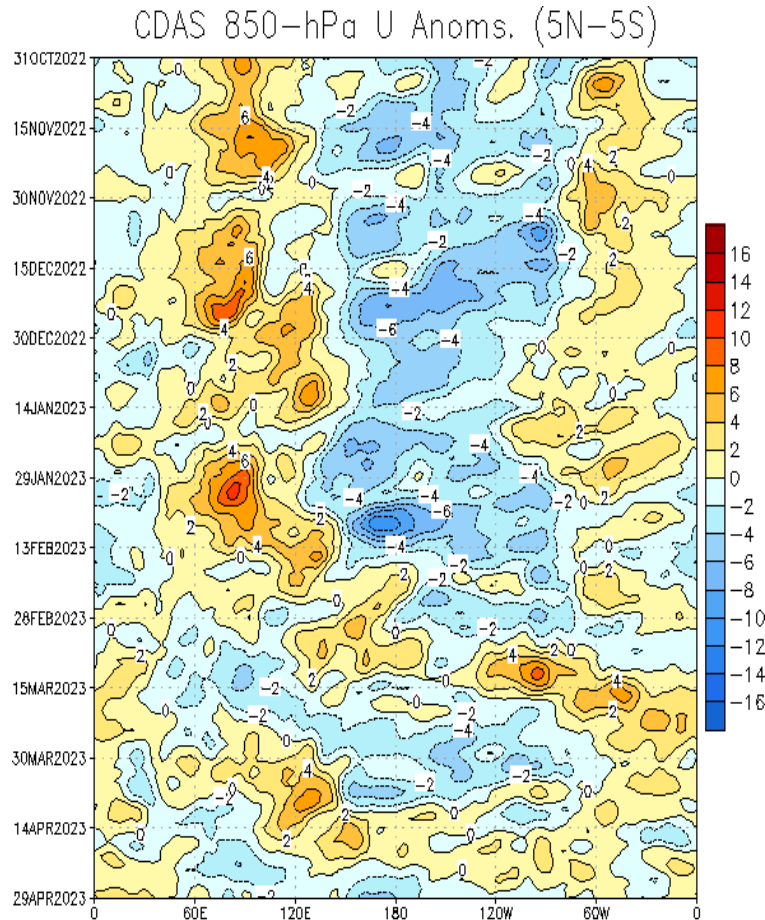
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Anomalous upper-level westerlies have expanded across the Pacific during the past week
- Anomalous easterlies increased across parts of South America and the equatorial Atlantic, with strong upper-level westerlies further north over eastern North America and the north Atlantic.

850-hPa Wind Anomalies

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

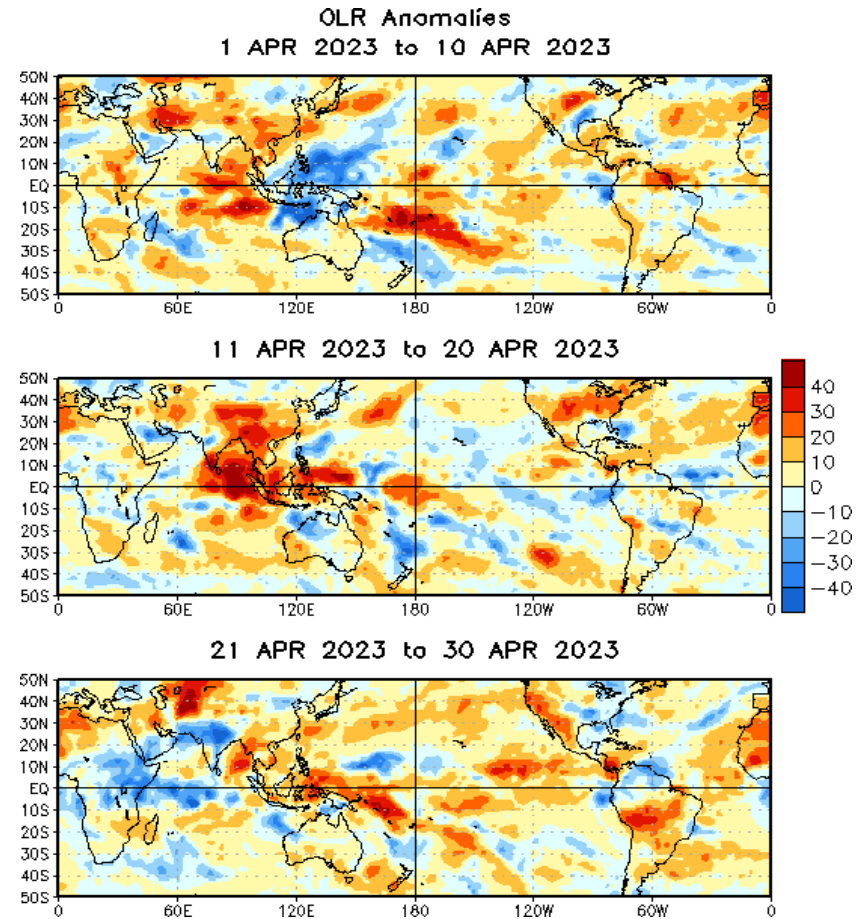
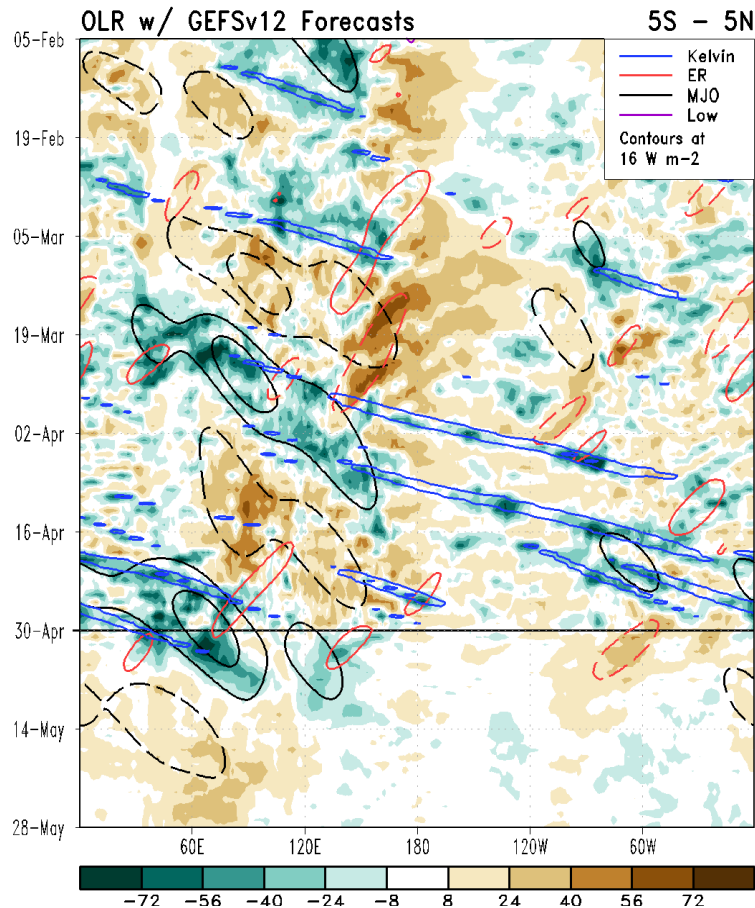


- Low-level equatorial westerly wind increases are seen across the globe during the past few months, with another possibly beginning to take shape over the western Indian Ocean.
- Anomalous easterlies have strengthened across the equatorial Pacific near the Date Line.
- Strong cyclonic circulation exists across the North Atlantic.

Outgoing Longwave Radiation (OLR) Anomalies

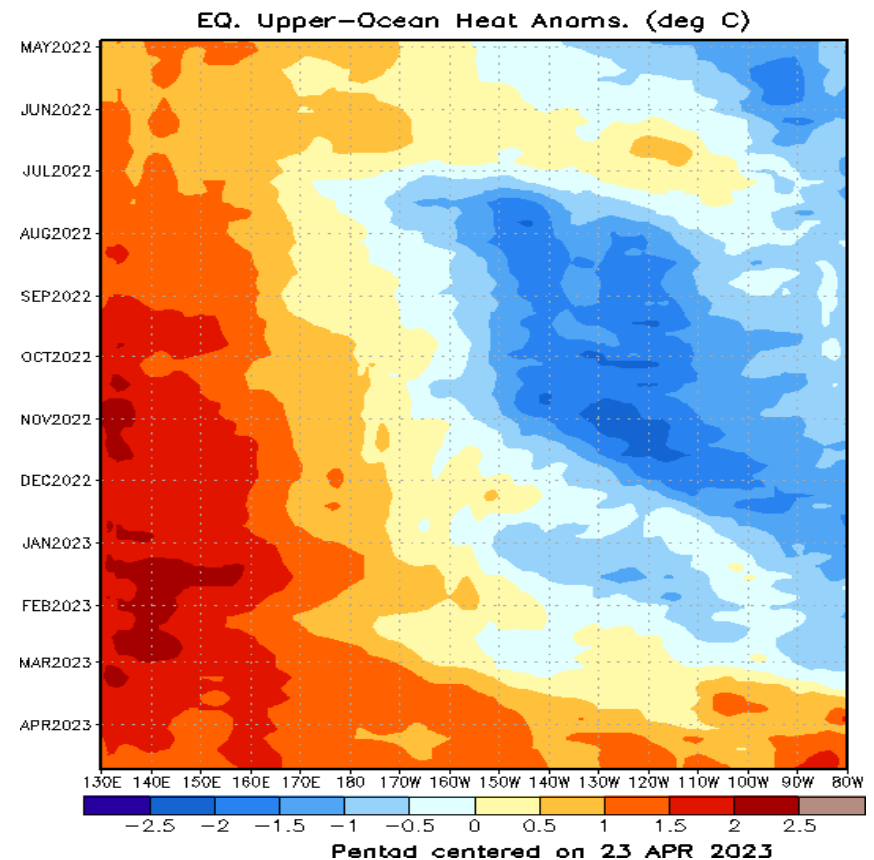
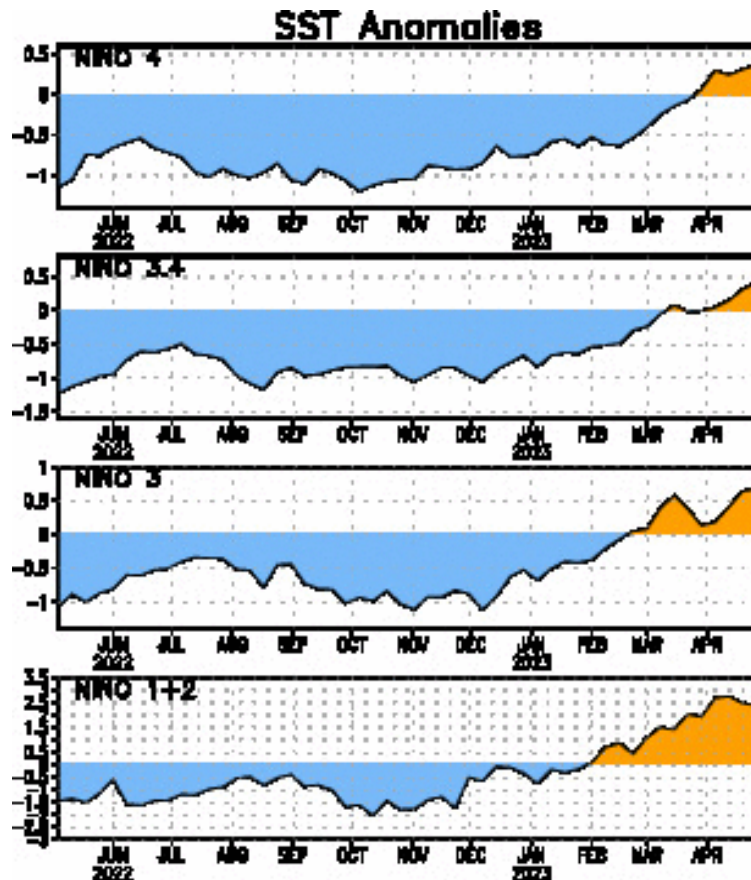
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- The MJO signal is coming through the OLR filtering across the Indian Ocean, with some constructive interference with enhanced Rossby Wave activity.
- Negative OLR anomalies have expanded across parts of Africa and the western Indian Ocean during the past week, with the magnitude of positive OLR anomalies decreasing across the Maritime Continent, suggestive of an eastward propagating MJO.

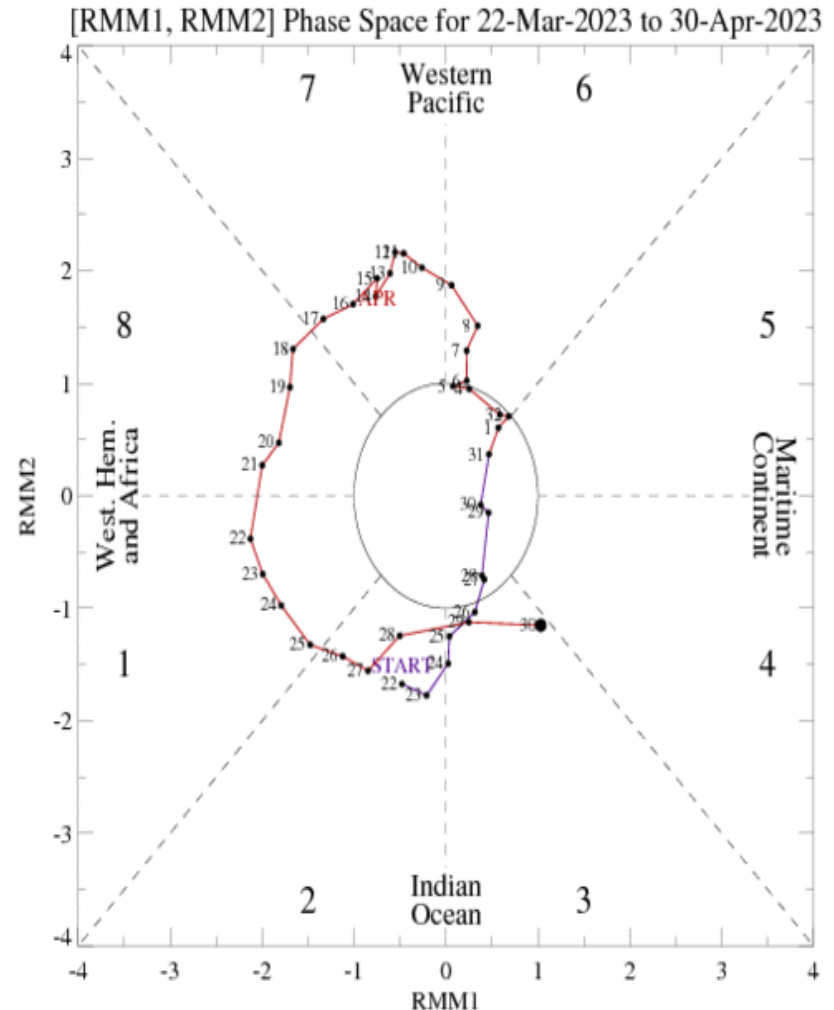
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Positive subsurface temperature anomalies continue to increase across the entire Pacific, driven by multiple MJO events and subsequent oceanic downwelling Kelvin Waves beginning in March.
- SSTs in all of the Niño basins are now above normal and continuing to trend upward across the Central Pacific reflecting the transition from La Niña to ENSO-neutral conditions.

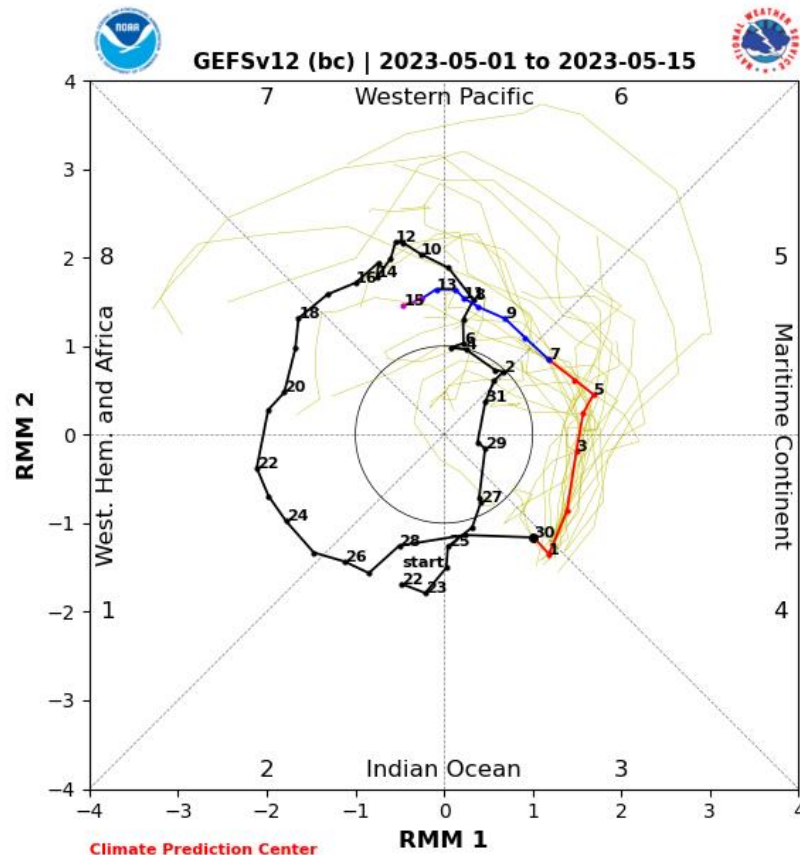
MJO Index: Recent Evolution

- An active MJO continued during the past month, with the RMM-based index completing another full circumnavigation.
- The RMM index shows the MJO weakening during the past week, and is now centered across the eastern Indian Ocean.

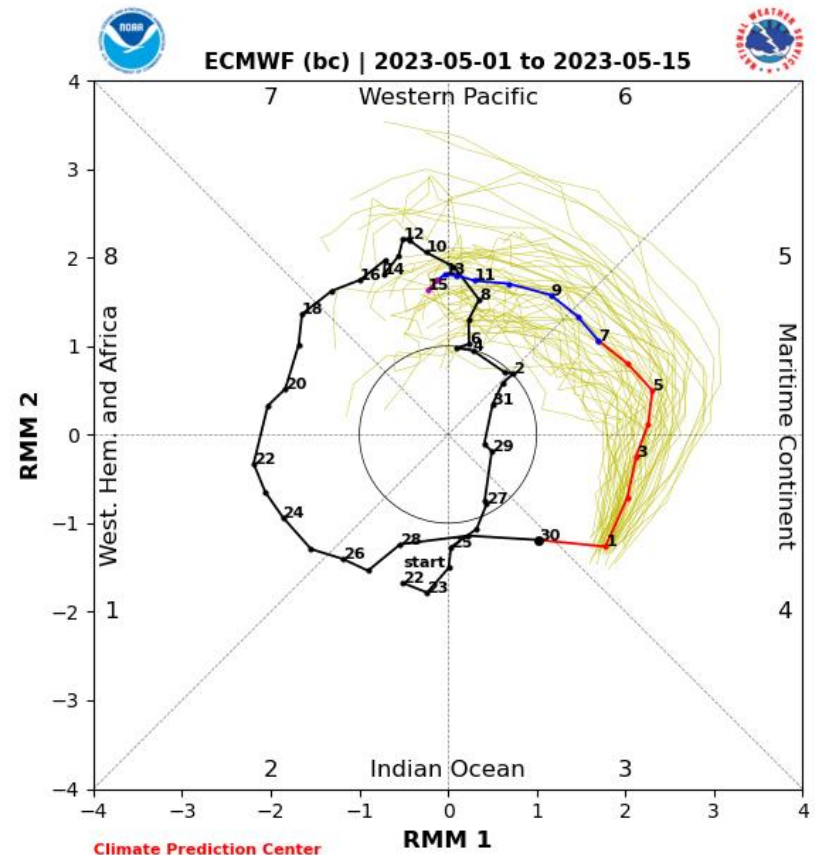


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



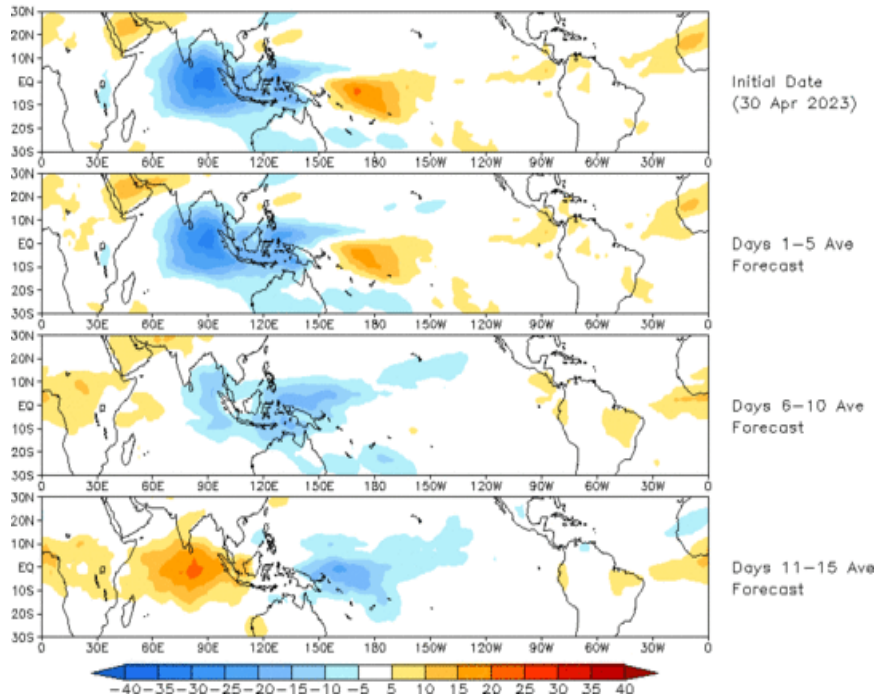
ECMWF Forecast

- Both the GEFS and ECMWF ensembles depict a strengthening of the RMM-based MJO index in the coming days, with a fast propagation across the Maritime Continent and Western Pacific during the next 2 weeks.
- The ECMWF ensemble indicates low variability among individual ensemble members over the Maritime Continent, suggesting higher than normal confidence in a robust MJO event over the region during early May.

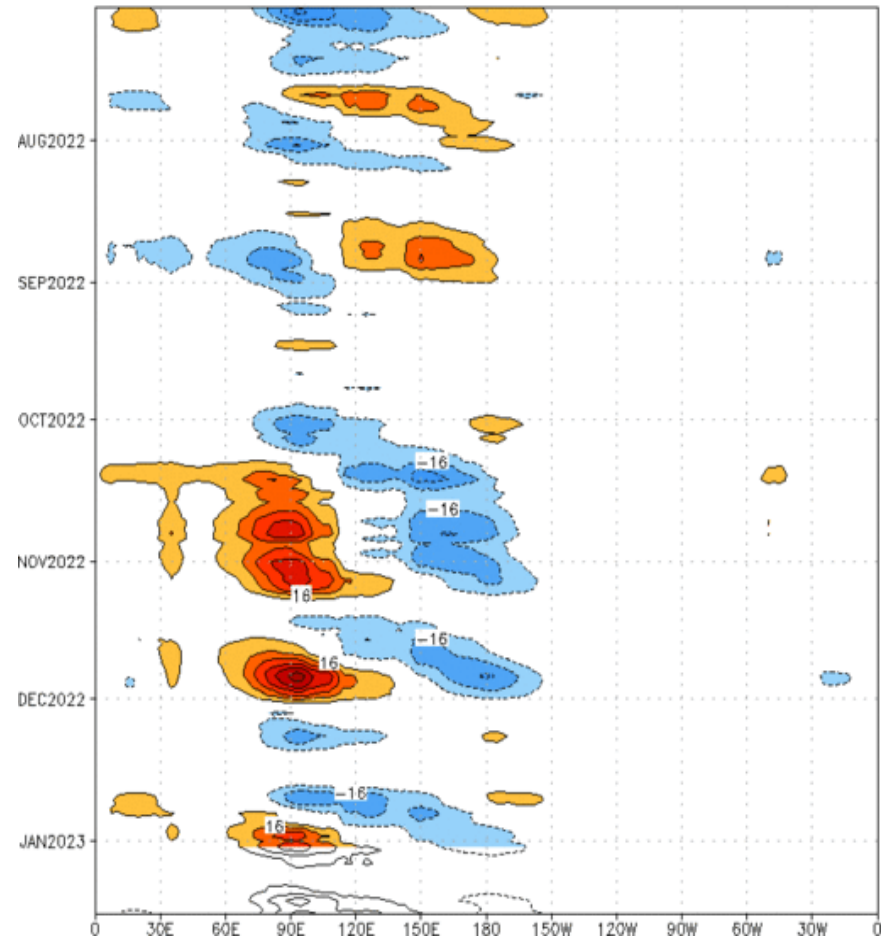
MJO: GEFS Forecast Evolution

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: 30 Apr 2023
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [$7.5^{\circ}\text{S}, 7.5^{\circ}\text{N}$] ($\text{cont: } 4\text{Wm}^{-2}$) Period: 03-Jul-2022 to 02-Jan-2023
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

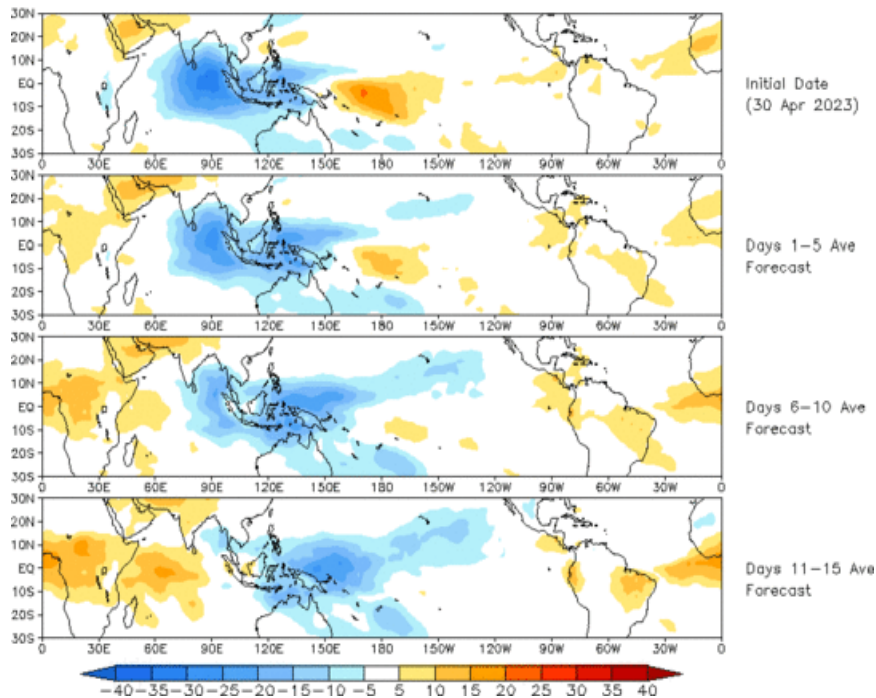


- The GEFS RMM-based forecast depicts negative OLR anomalies (enhanced convection) shifting from the Indian Ocean to the Western Pacific during the next 2 weeks.
- By the end of week-2, positive OLR anomalies (suppressed convection) are forecast across Africa and the Indian Ocean.

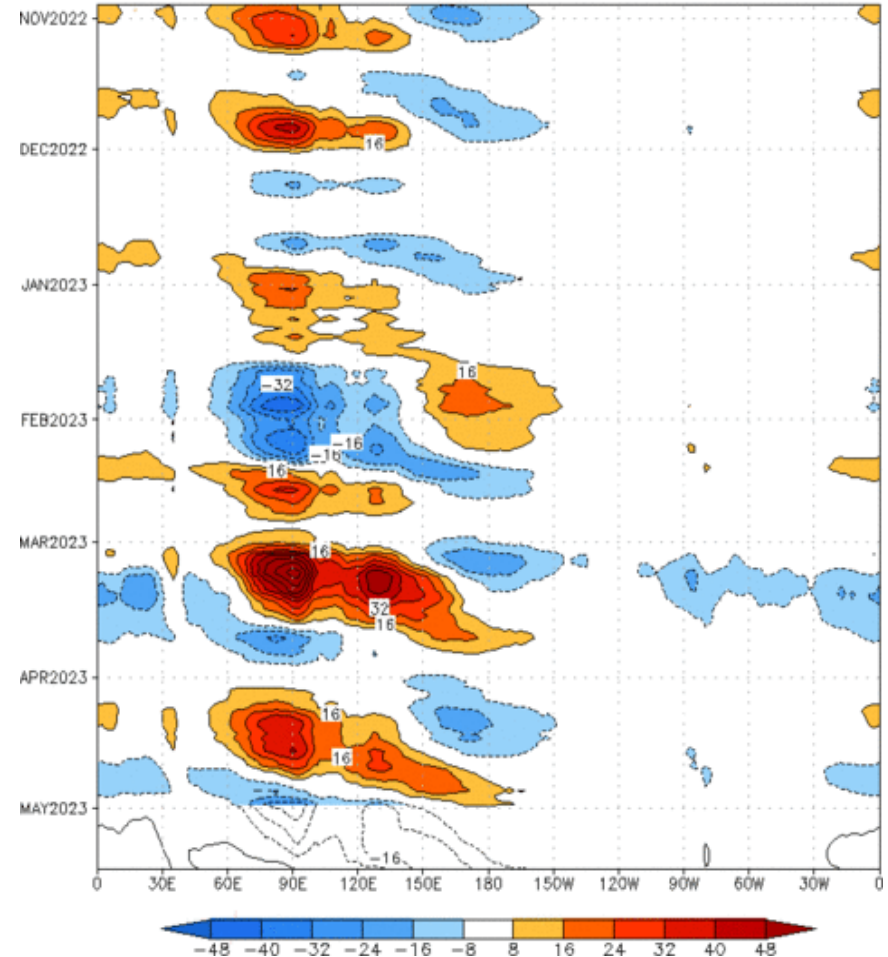
MJO: Constructed Analog Forecast Evolution

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 (30 Apr 2023)



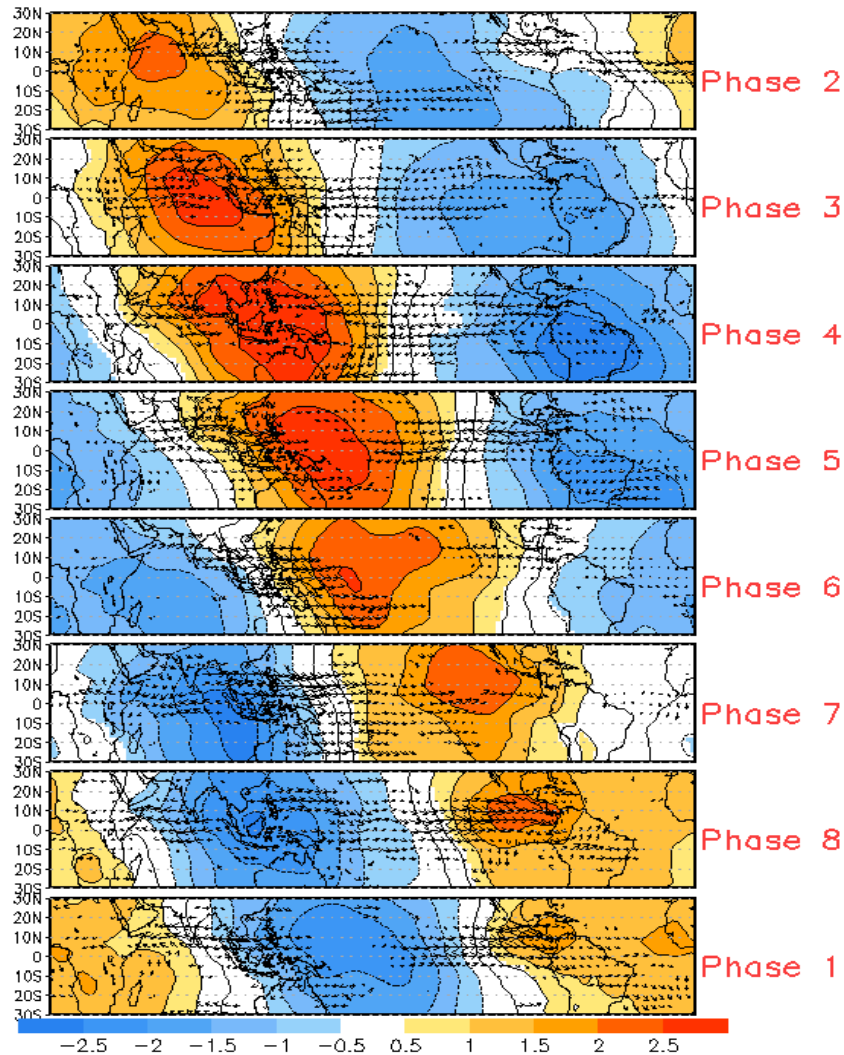
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S, 7.5°N] (cont: 4Wm⁻²) Period: 29-Oct-2022 to 30-Apr-2023. The unfilled contours are CA forecast reconstructed anomaly for 15 days



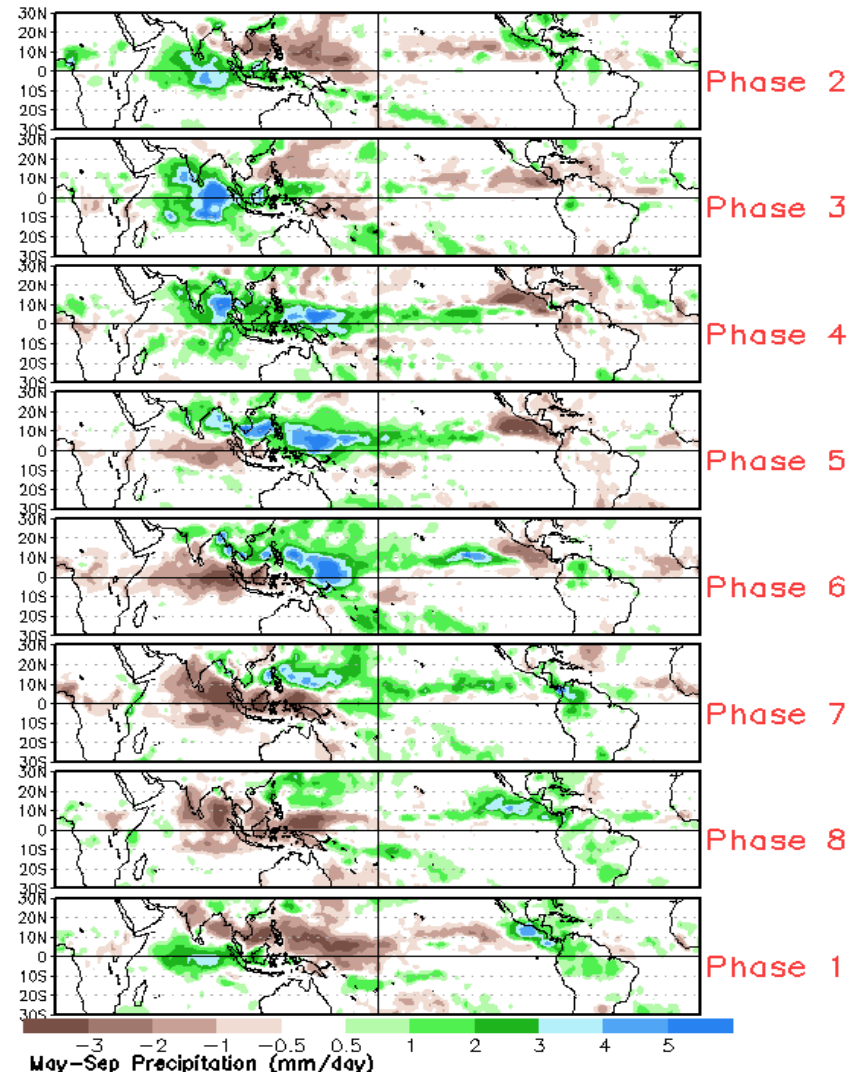
- The constructed analog RMM-based forecast is in agreement with the GEFS forecast, indicative of MJO propagation from the Indian Ocean to the Western Pacific during the next 2 weeks.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and
Wind Anomalies



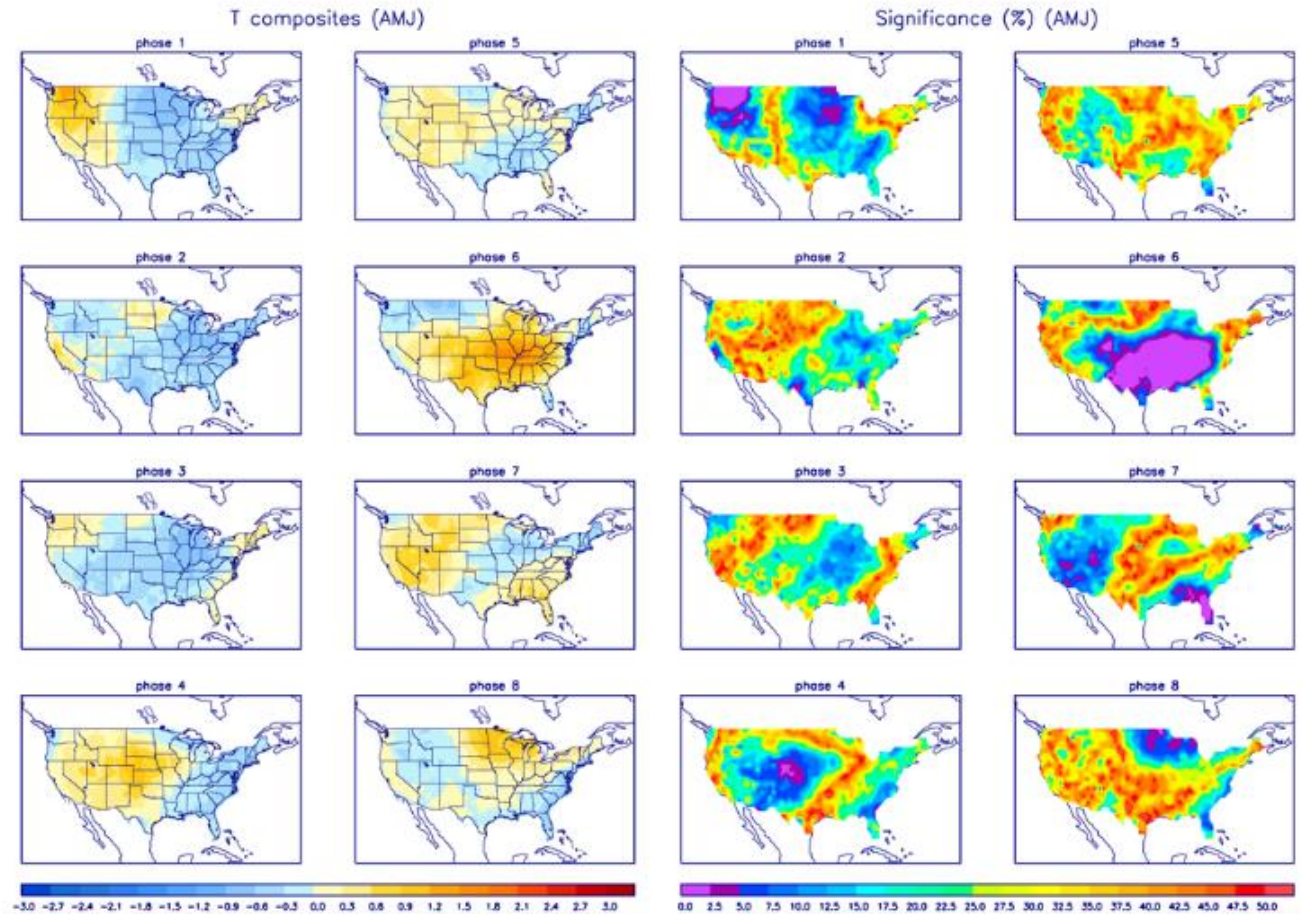
Precipitation Anomalies



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.

