

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



**Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
6 May 2024**

Overview

- According to the RMM-based index, the MJO strengthened over the Indian Ocean and propagated eastward to Maritime Continent during the beginning of May.
- Dynamical model forecasts favor a fast-moving MJO along with a Kelvin wave propagating east from the Pacific to the Indian Ocean during the next two weeks.
- Based on this fast-moving MJO or Kelvin wave, there is a slightly elevated chance of an early season tropical cyclone (TC) in the East Pacific. Elsewhere, dynamical models support at least a 20 percent chance of TC development across the West Pacific and Bay of Bengal from May 15 to 21. The favored TC area for the West Pacific expands west to include the South China Sea from May 22 to 28.

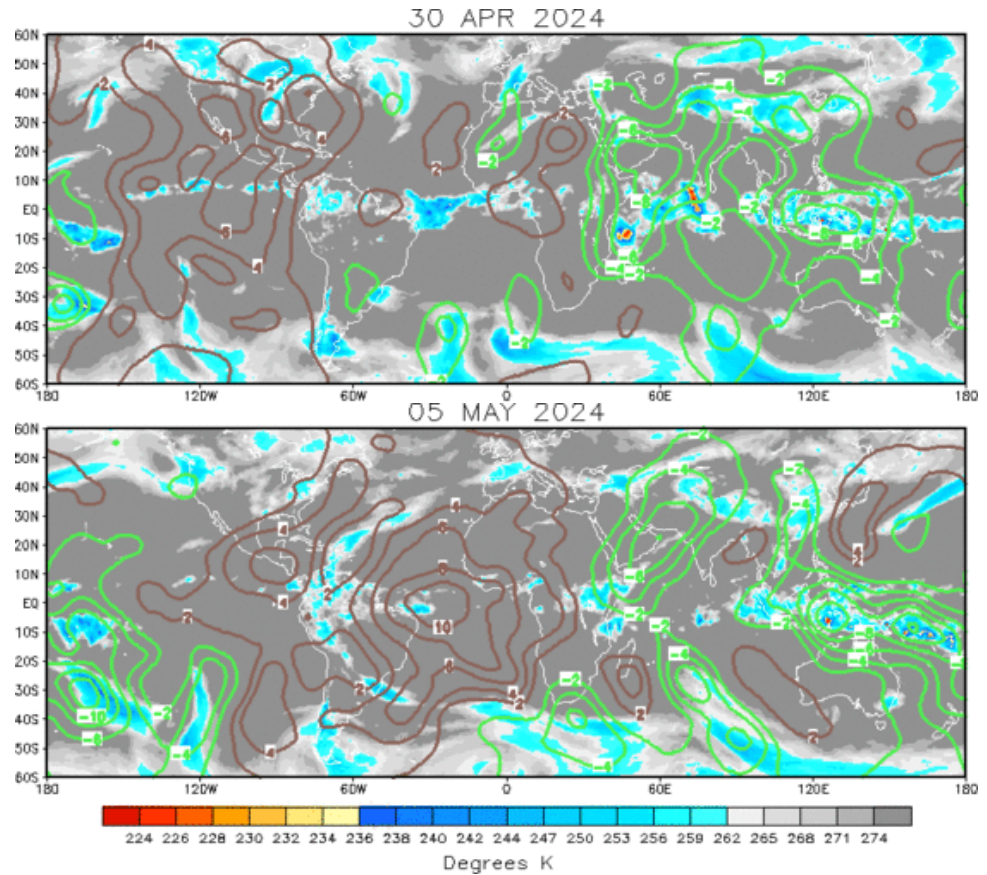
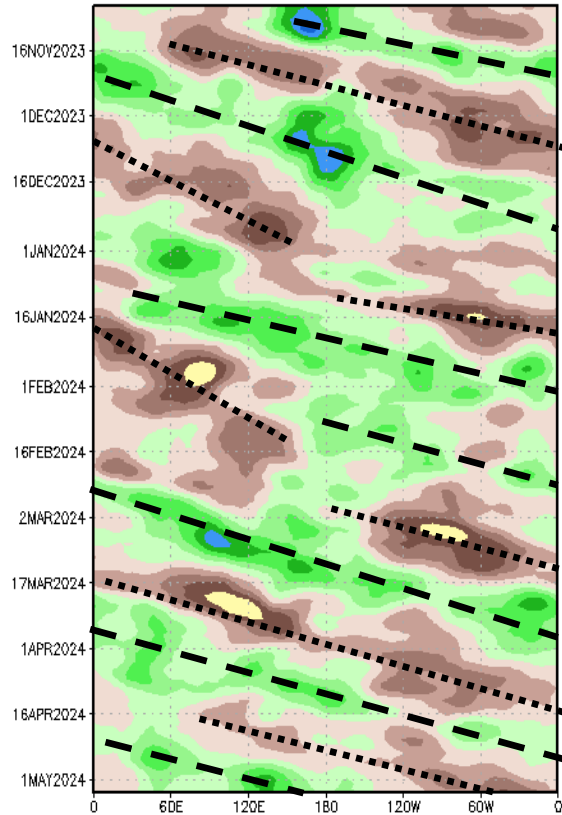
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

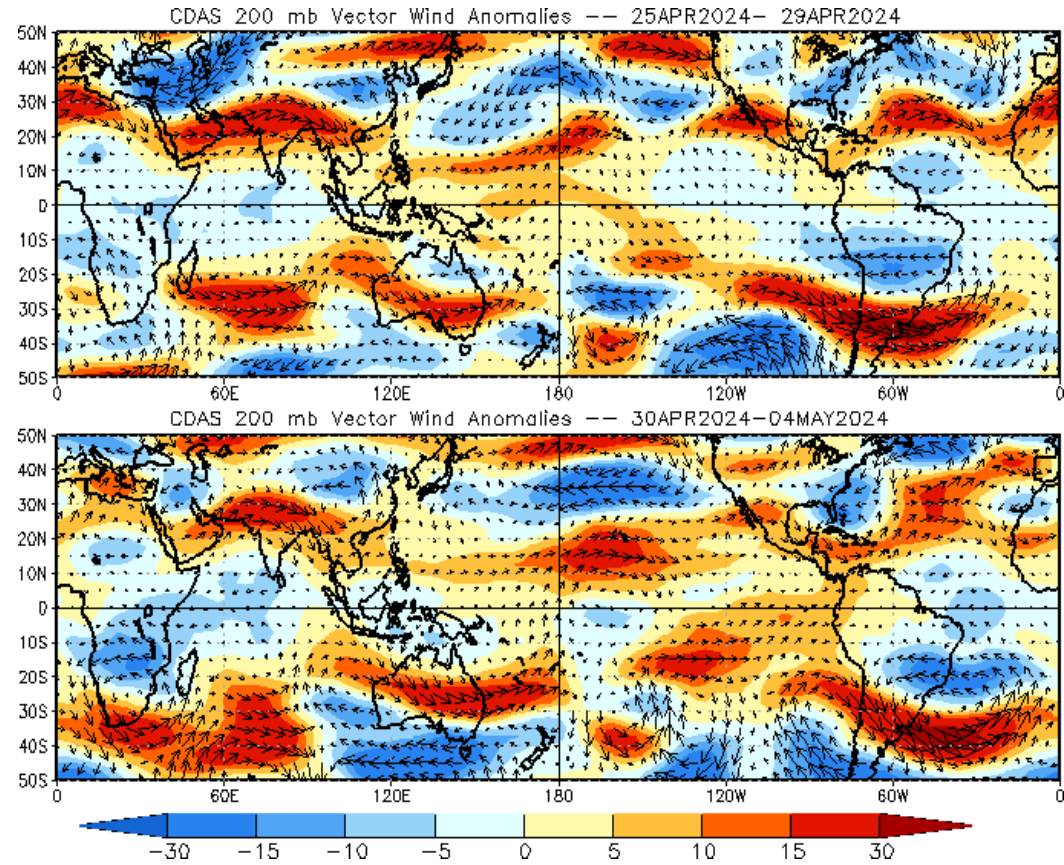
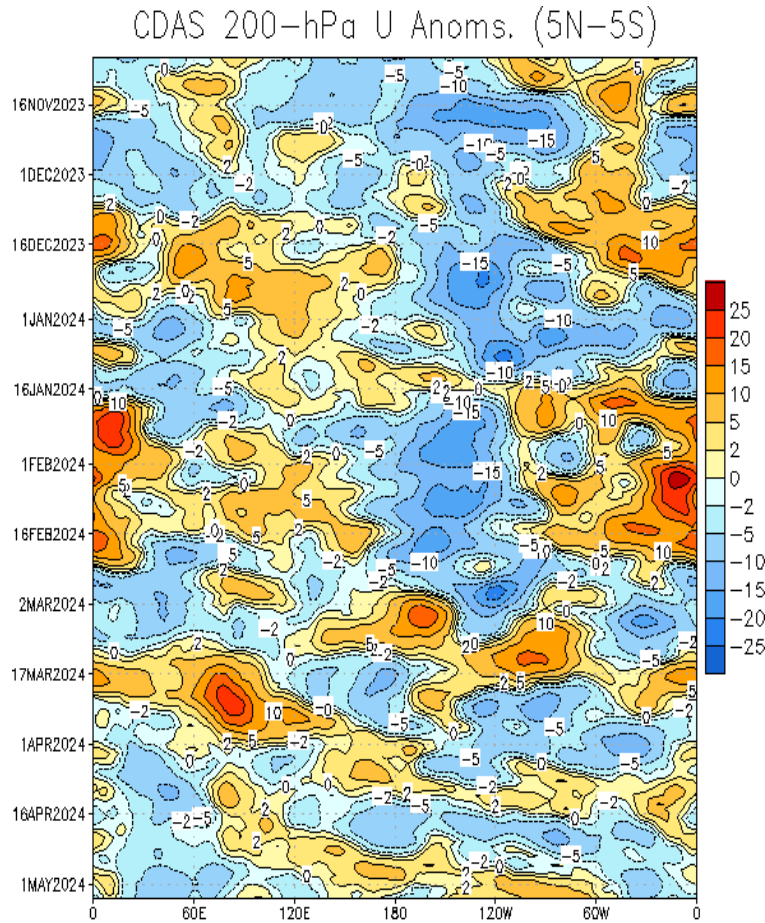
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- During late April, anomalous upper-level divergence strengthened across eastern Africa and the Indian Ocean consistent with the MJO and low-frequency convective signal.
- A more coherent wave-1 pattern developed by the beginning of May with anomalous upper-level divergence expanding east to the central Pacific and anomalous upper-level converged centered over the tropical Atlantic.

200-hPa Wind Anomalies

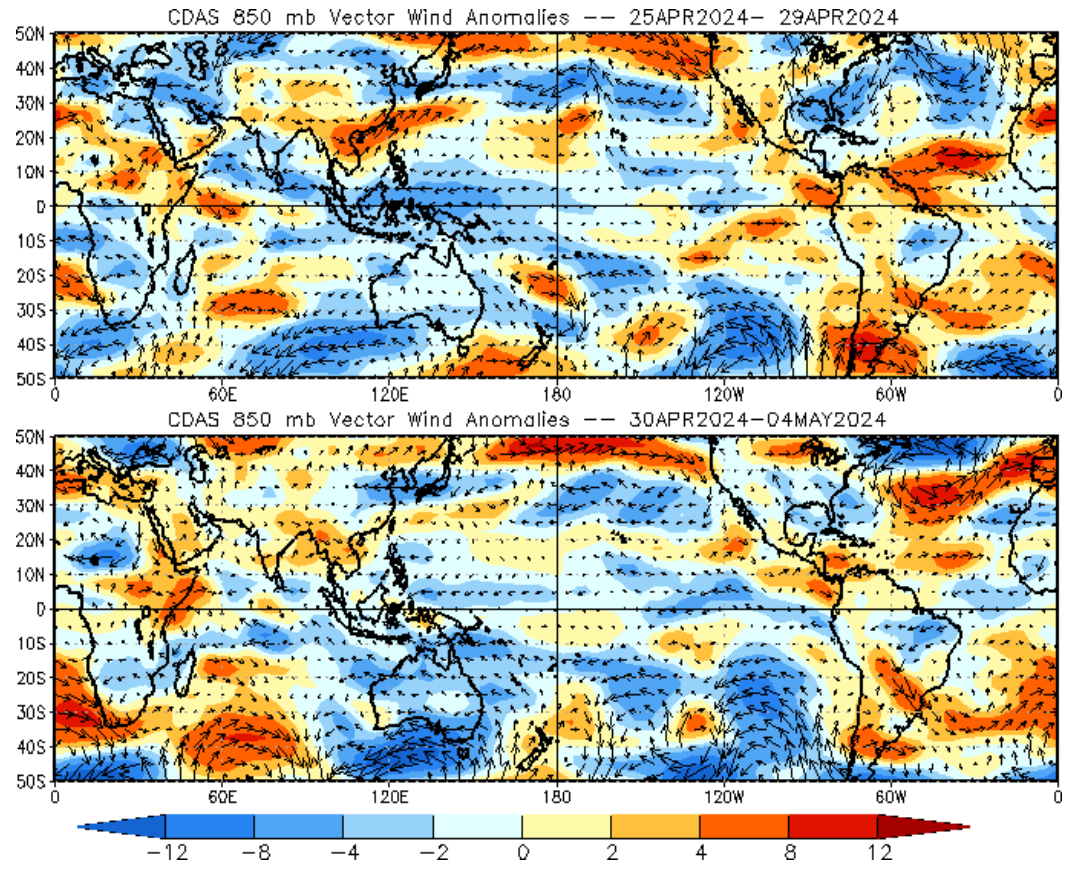
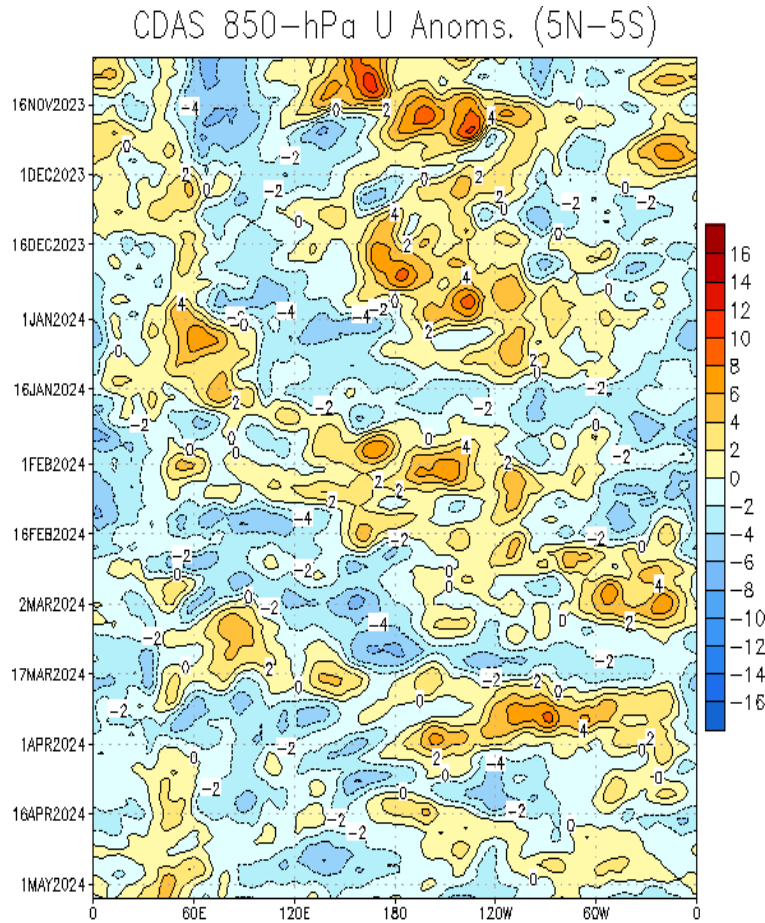
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- An enhanced subtropical jet remained evident across the South Asia and from the central Pacific to southern North America.
- Strong upper-level anti-cyclonic flow was observed across South America.
- From late April to early May, upper-level westerly anomalies shifted rapidly east across the Pacific.

850-hPa Wind Anomalies

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

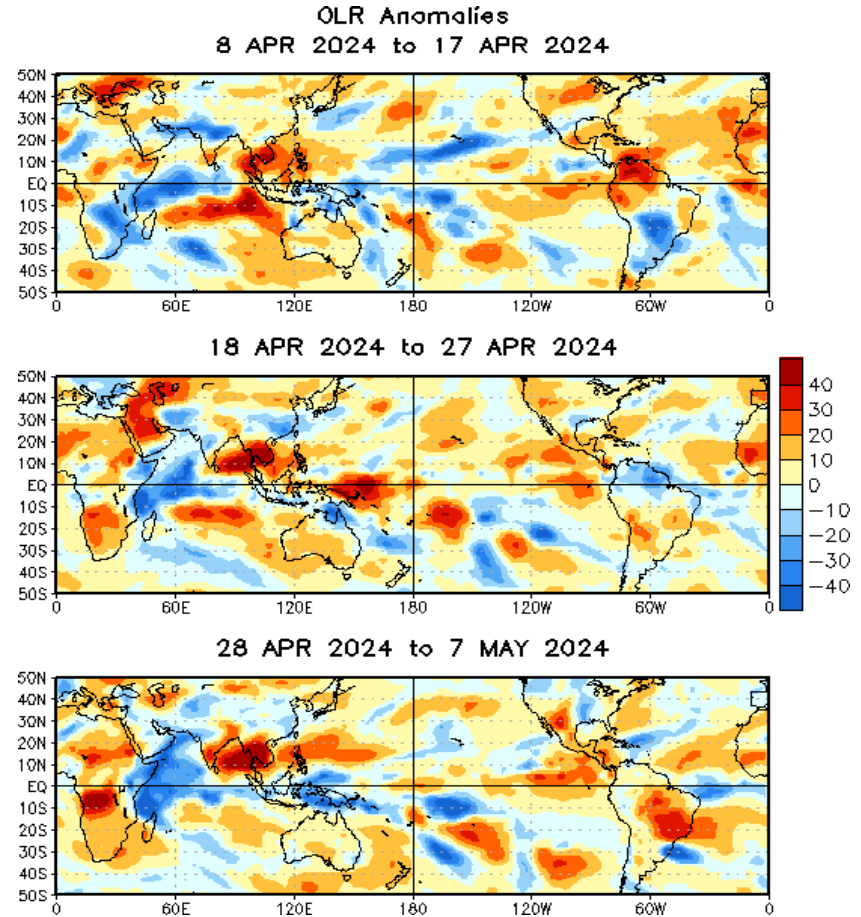
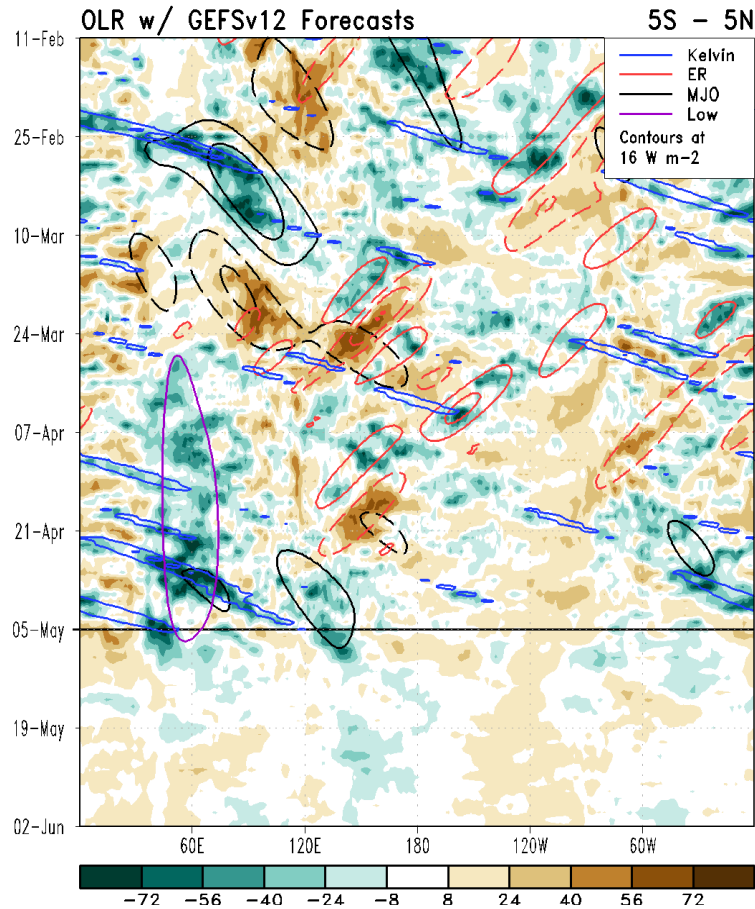


- Anomalous low-level westerlies (easterlies) continued to persist over eastern Africa (Indian Ocean).
- During late April into the beginning of May, enhanced southerly flow from the Gulf of Mexico into the south-central United States occurred and contributed to heavy rainfall and flooding.

Outgoing Longwave Radiation (OLR) Anomalies

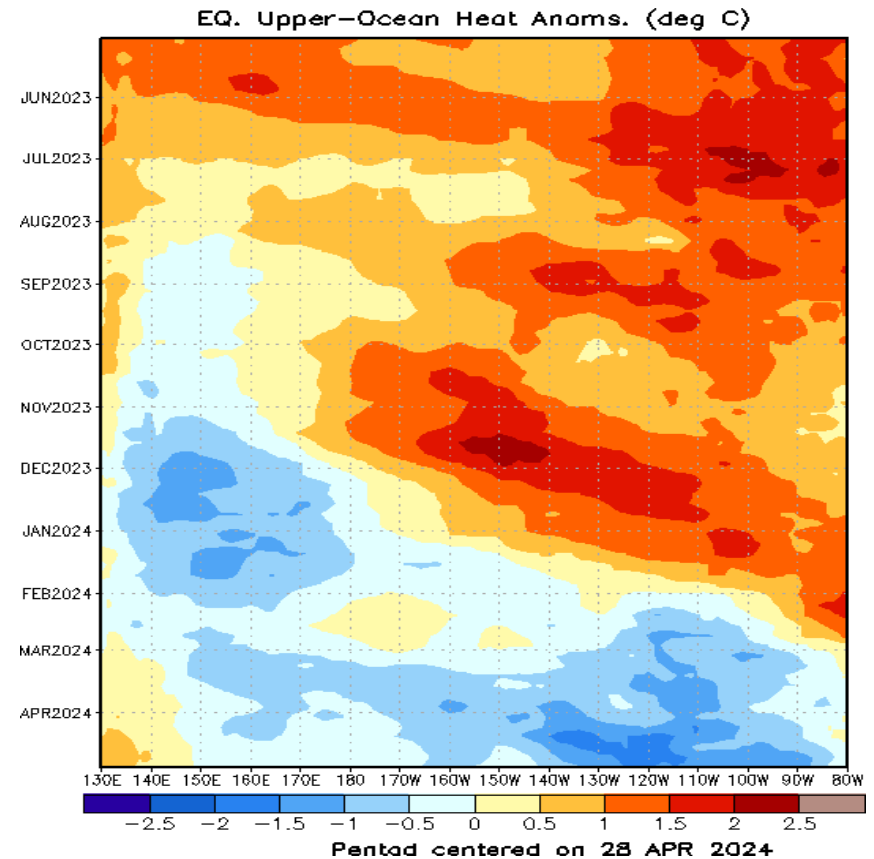
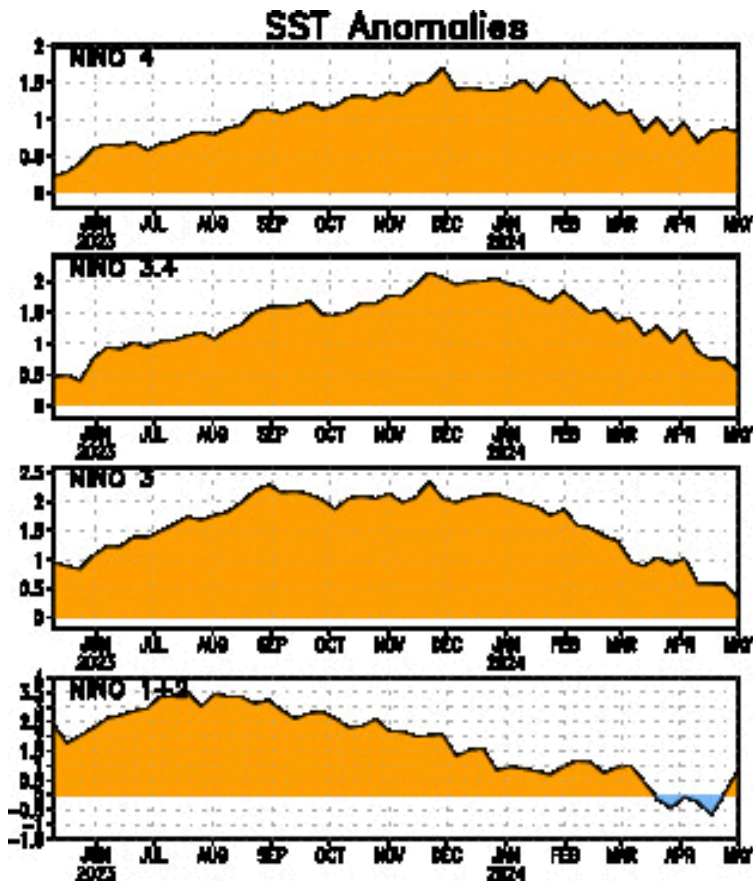
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- Constructive interference between low frequency activity over eastern Africa and the western Indian Ocean and the MJO has led to strongly negative OLR anomalies across the region.
- The GEFS forecast depicts a weakening of the enhanced convection across the western Indian Ocean.
- Elsewhere, the spatial OLR anomaly field is less coherent, with positive OLR anomalies across many areas.

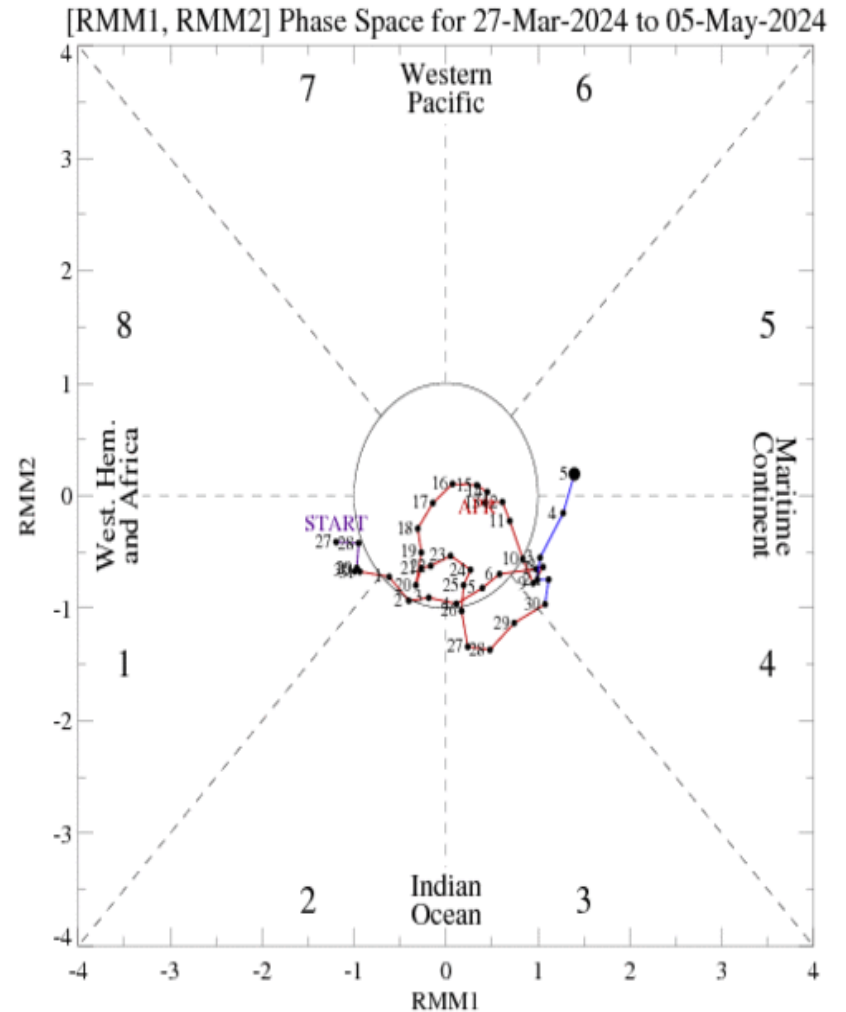
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- SSTs in all NINO regions have trended downward since February. This is indicative of a decaying El Niño.
- Negative subsurface temperature anomalies continue to be observed across nearly the entire Pacific, with increasing negative anomalies across the eastern Pacific.

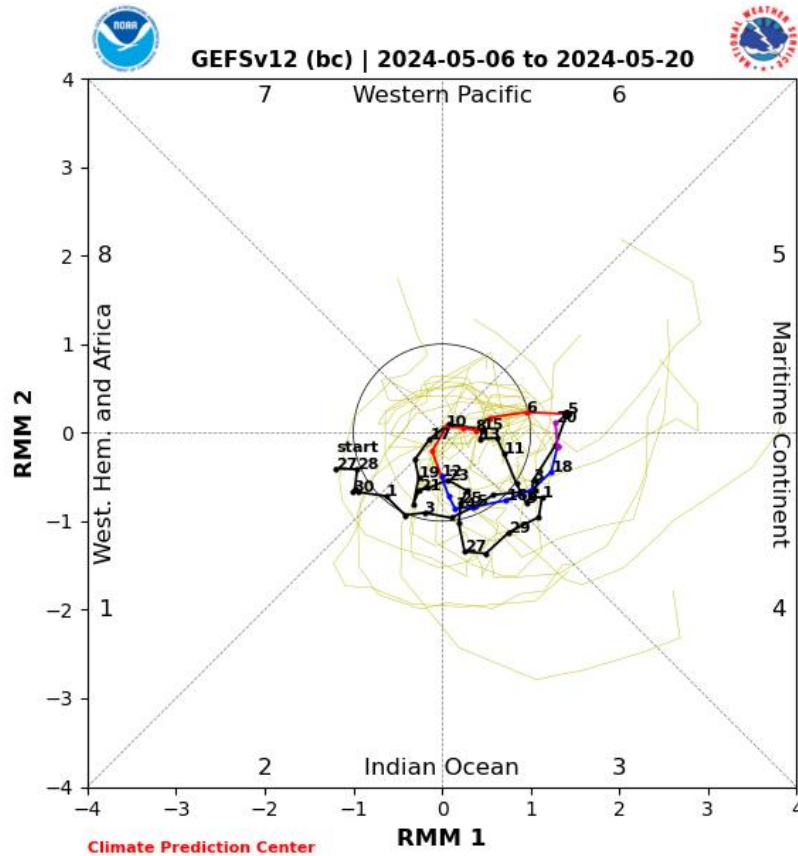
MJO Index: Recent Evolution

- During the beginning of May, the RMM-based MJO index gained amplitude outside the unit circle.
- This is consistent of a resurgence of the MJO across the Indian Ocean and eastward propagation to the Maritime Continent.

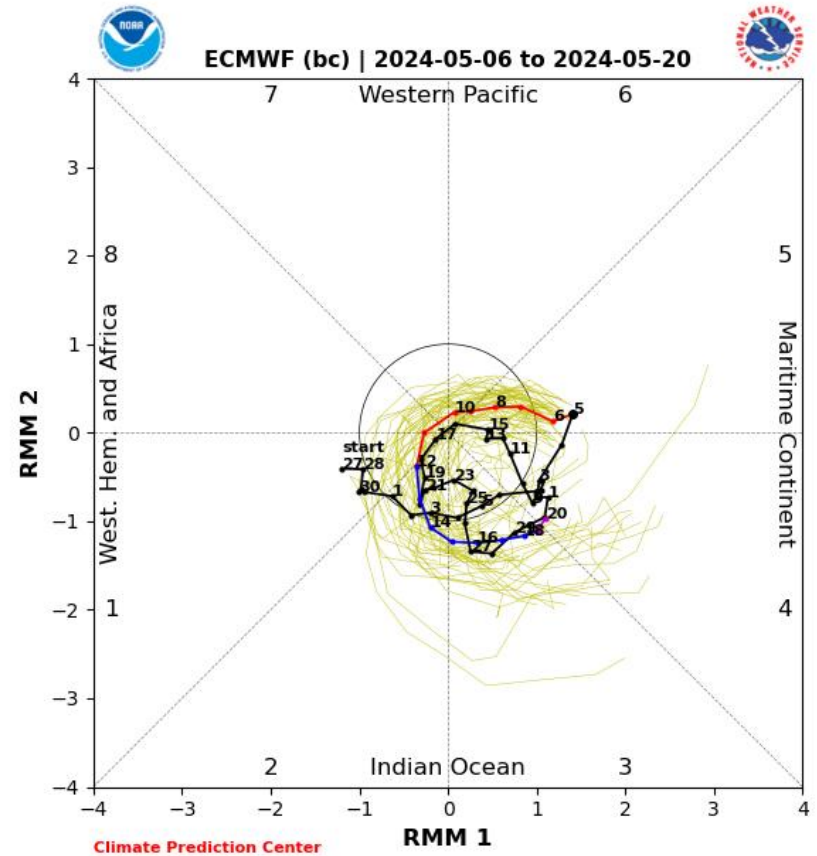


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



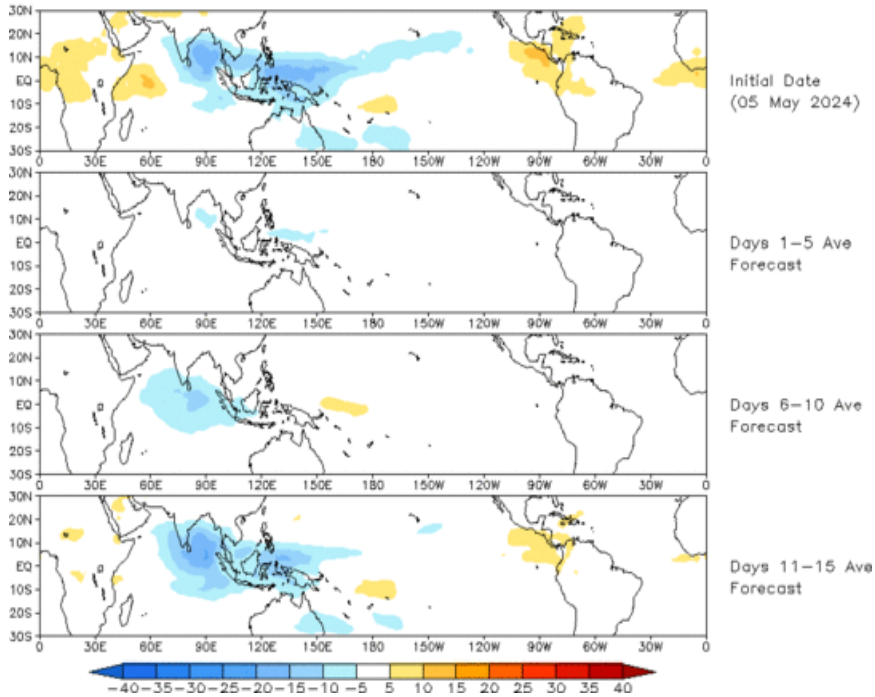
ECMWF Forecast

- The GEFS and ECMWF ensemble means depict either a fast-moving MJO or a Kelvin wave rapidly propagating from the Pacific to the Indian Ocean during the next two weeks.

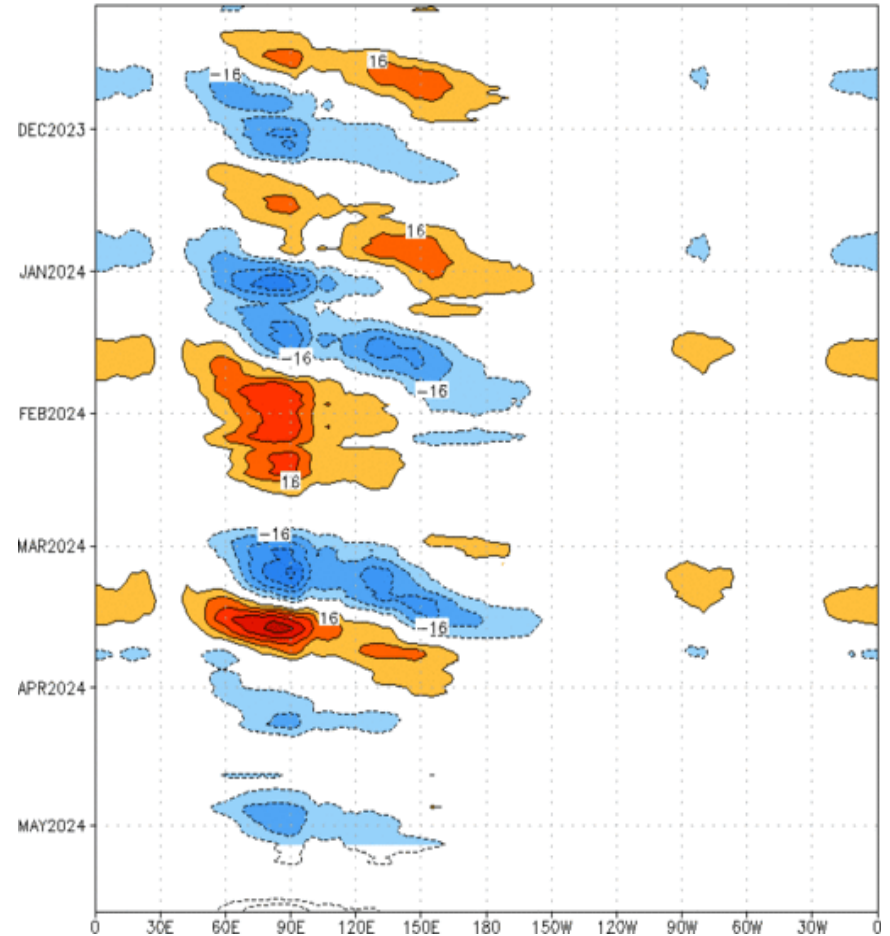
MJO: GEFS Forecast Evolution

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: 05 May 2024
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [$7.5^{\circ}S, 7.5^{\circ}N$] (cont: $4Wm^{-2}$) Period: 04-Nov-2023 to 05-May-2024
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

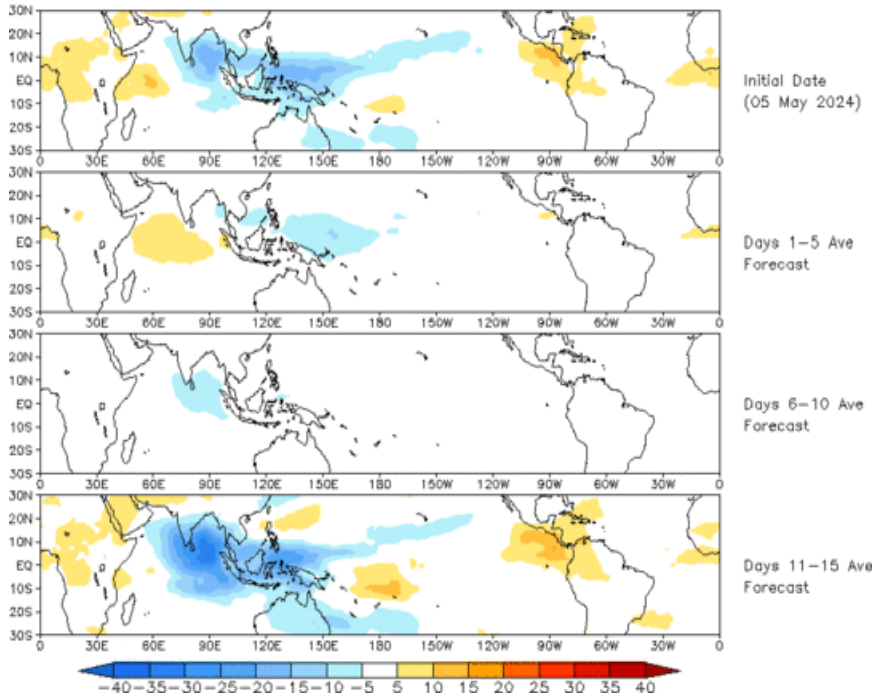


- The GEFS depicts negative OLR anomalies (enhanced convection) over the Indian Ocean and Maritime Continent during the next two weeks.
- Positive OLR anomalies (suppressed convection) are predicted to periodically continue across Central America.

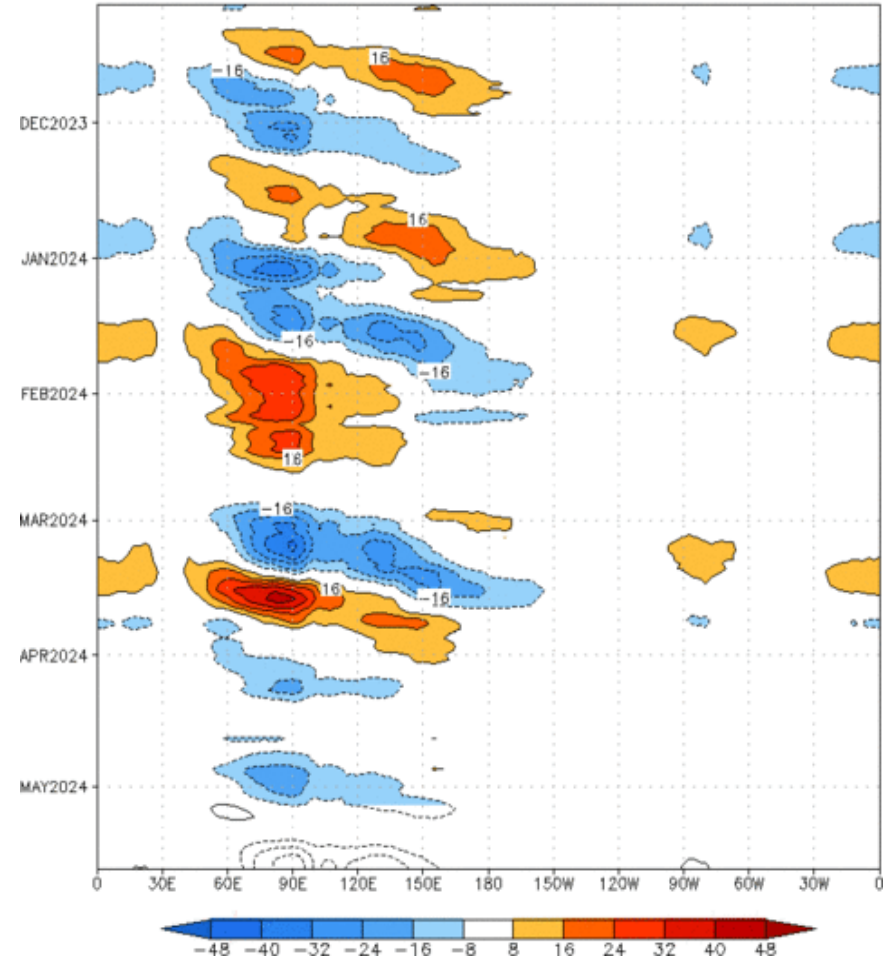
MJO: Constructed Analog Forecast Evolution

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 (05 May 2024)



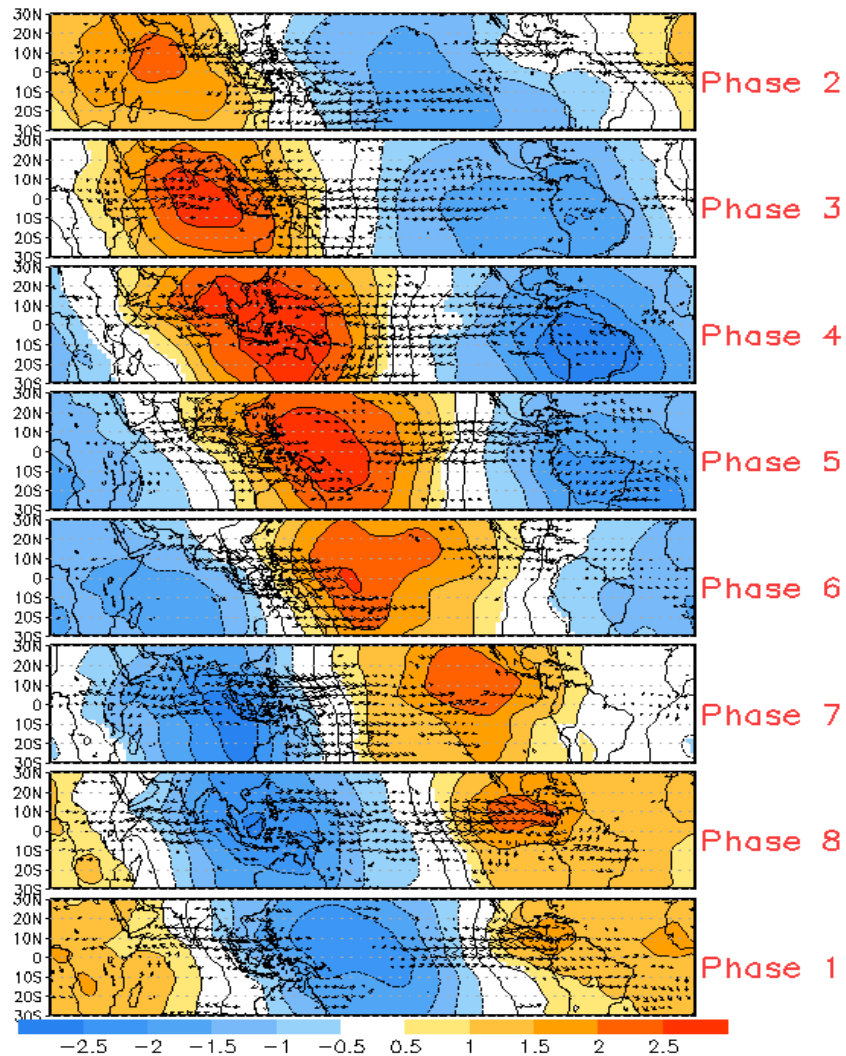
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:04–Nov–2023 to 05–May–2024
The unfilled contours are CA forecast reconstructed anomaly for 15 days



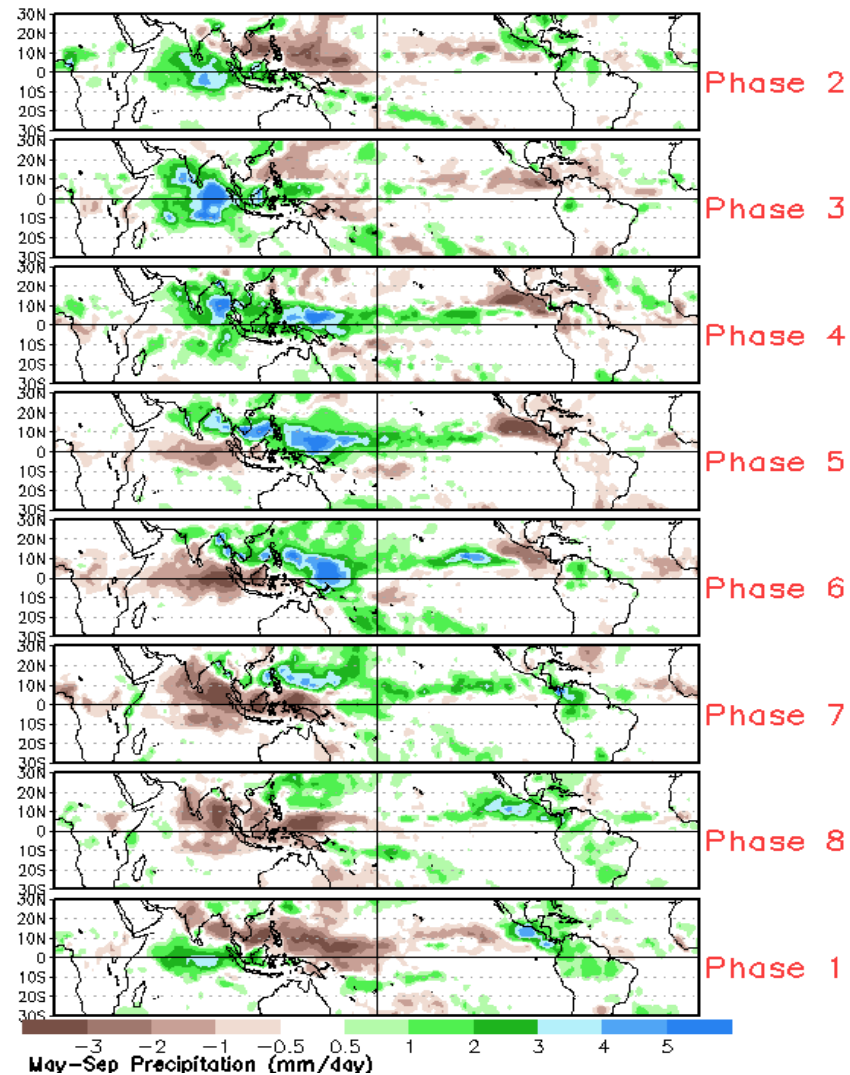
- The constructed analog tool depicts a similar outcome with enhanced convection diminishing over the Indian Ocean and Maritime Continent during the next ten days by returning strongly later in week-2.
- Positive OLR anomalies are predicted to return to Central America.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



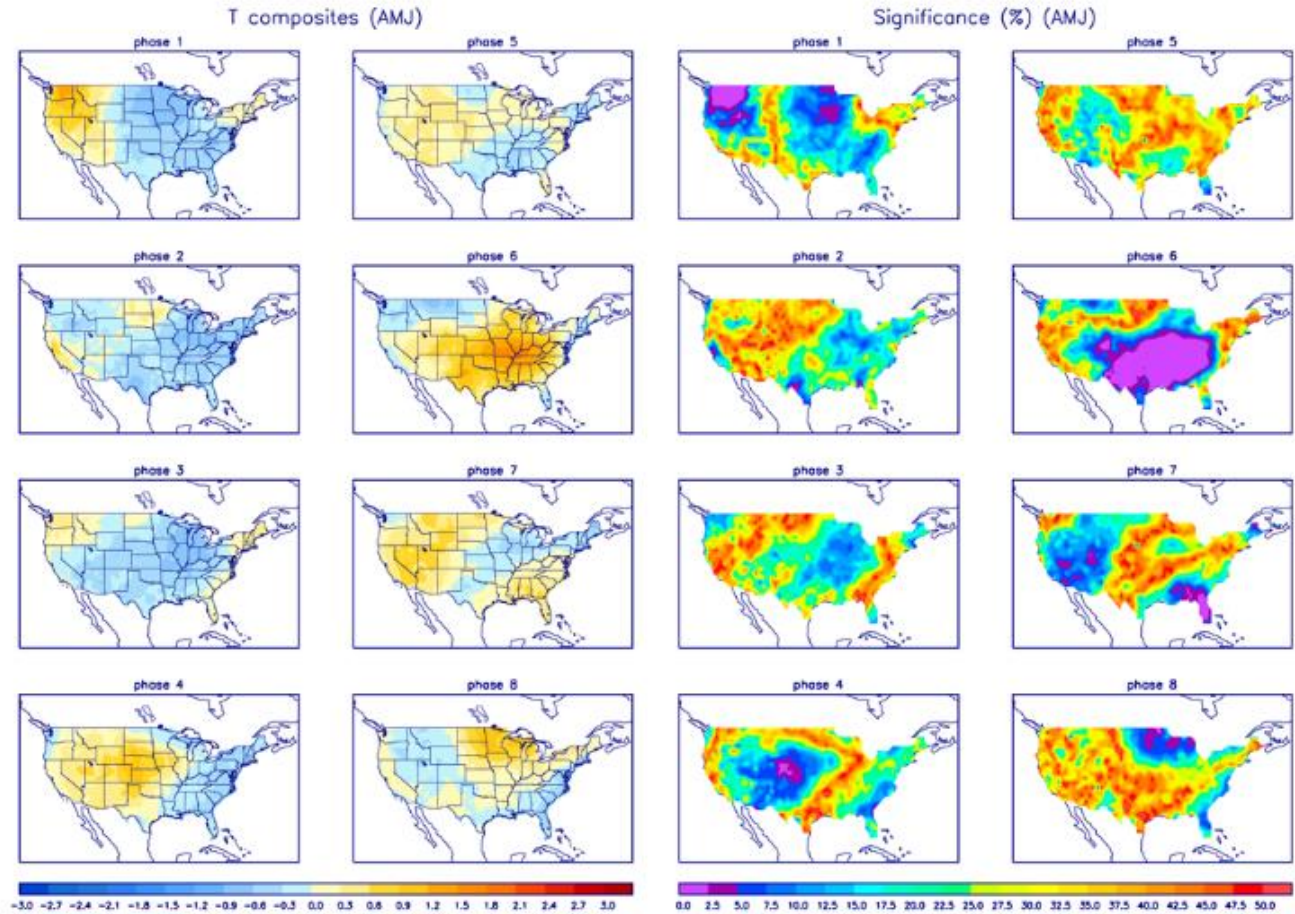
Precipitation Anomalies



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.

