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

Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
26 February 2024

Overview

- RMM-based observations depict the MJO weakening into the unit circle during the past week.

- However, removal of the 120-day running mean may be skewing the RMM-based plots to the right, and the observed upper-level velocity potential anomaly fields are more indicative of an active MJO crossing into the Eastern Hemisphere.

- There is good agreement in the dynamical model guidance that the MJO will propagate through the Indian Ocean and into the Maritime Continent during the next 2 weeks, with some uncertainty in its amplitude due to the aforementioned bias correction in the RMM-based forecasts.

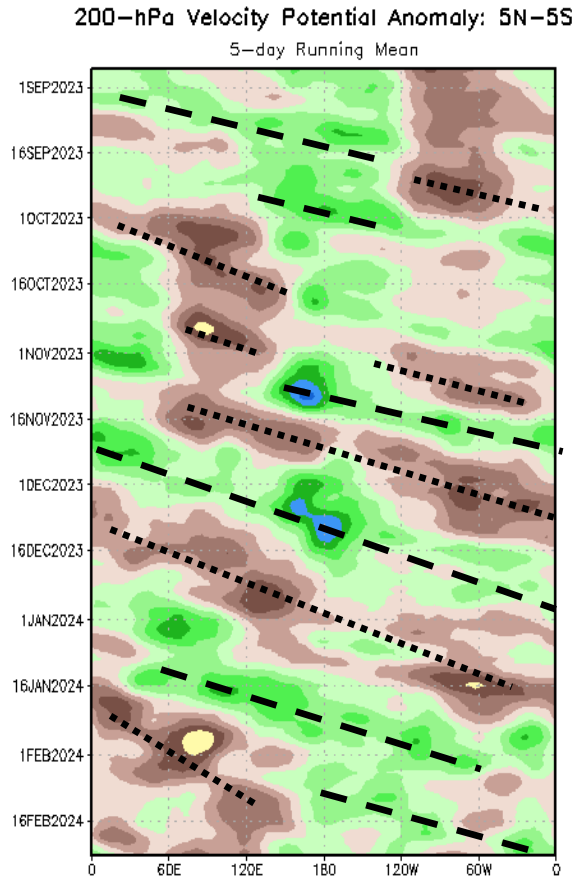
- Given the MJO evolution, chances for tropical cyclone (TC) development are forecast to increase across the Indian Ocean during week-2, and shift eastward toward northern Australia by week-3.

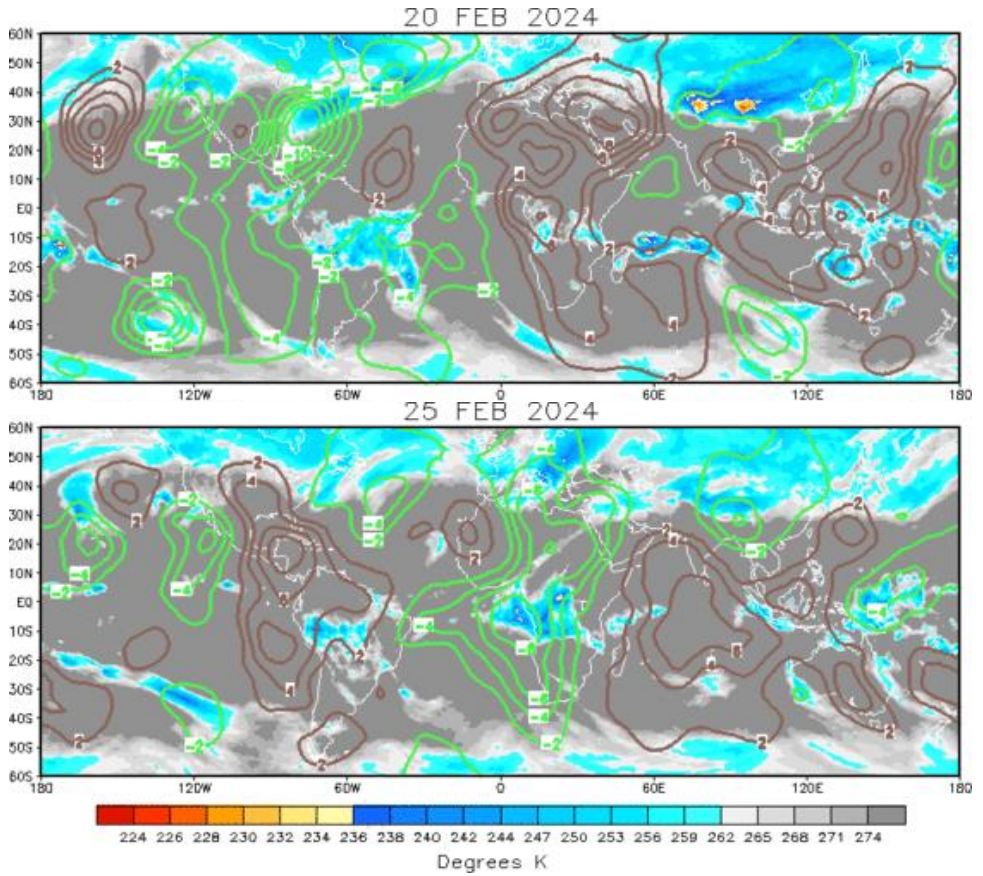
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

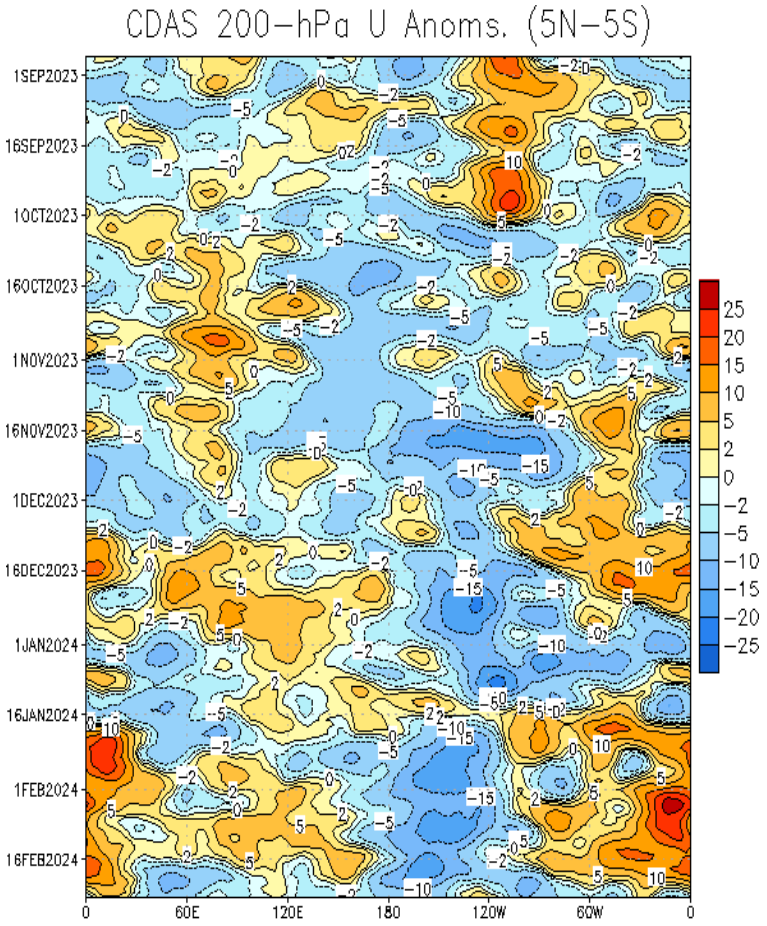


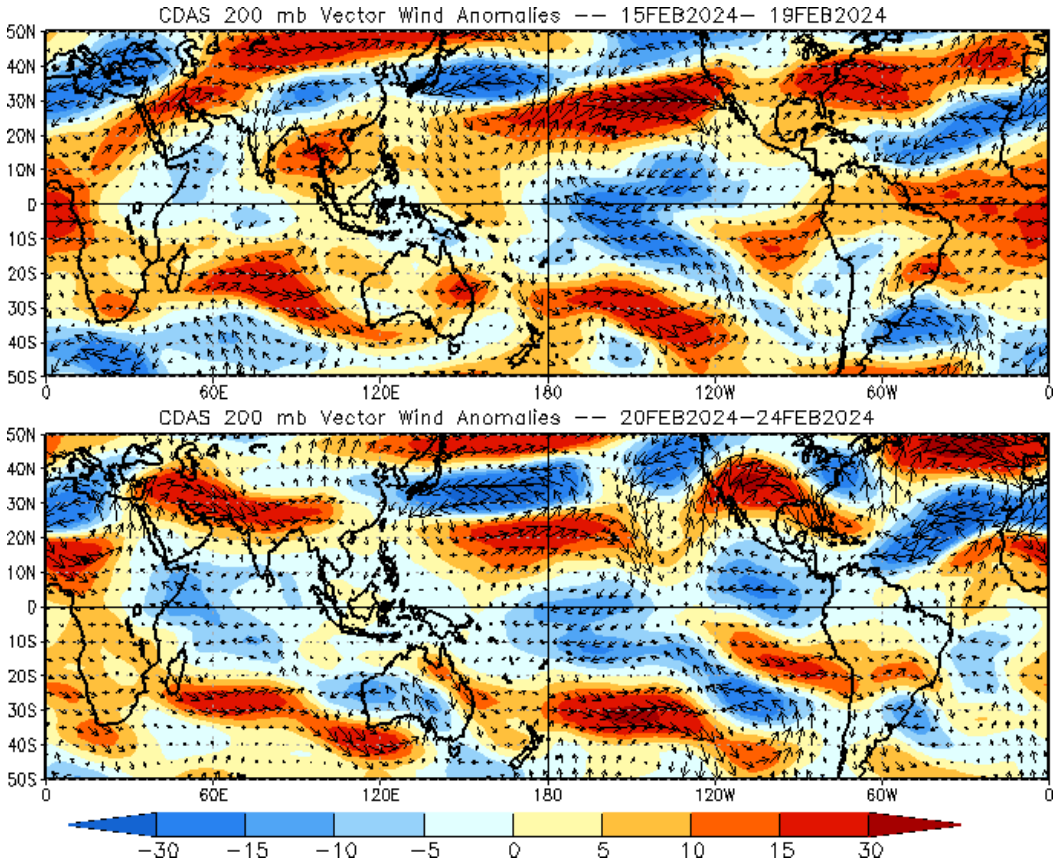


- Continued eastward MJO propagation is apparent on the time-lon velocity potential plot.
- The upper-level velocity potential anomaly fields indicate anomalous divergence centered across Africa, consistent with the MJO location.
- Currently, the overall global pattern resembles a wave-2 asymmetry with areas of anomalous convergence across the Americas and Indian Ocean, and some anomalous divergence over parts of the Pacific.

200-hPa Wind Anomalies

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

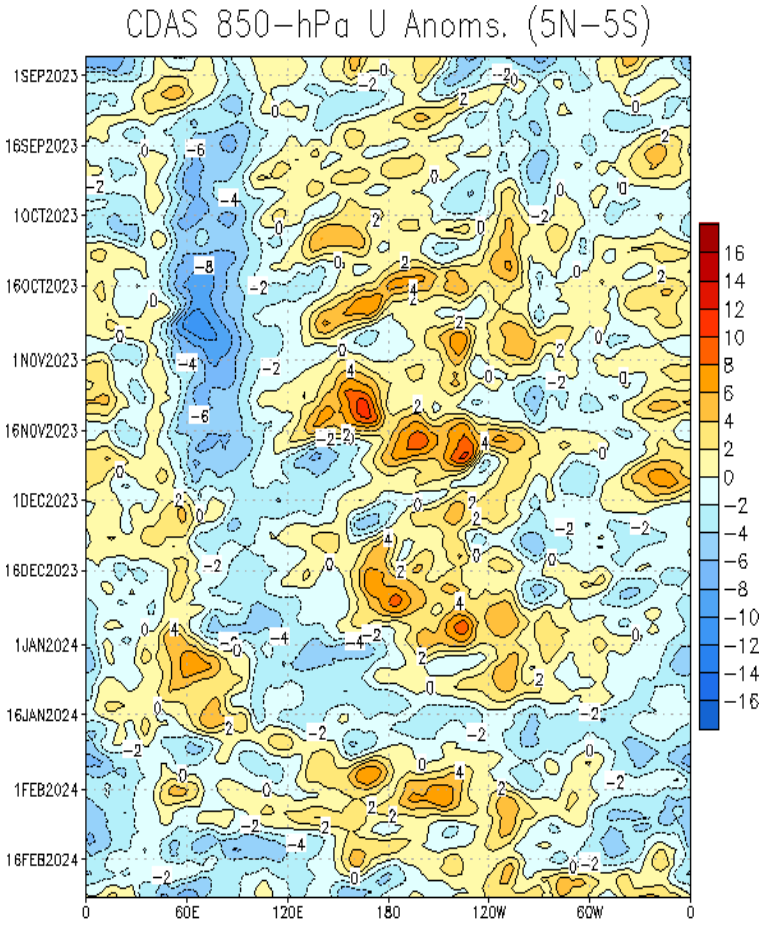


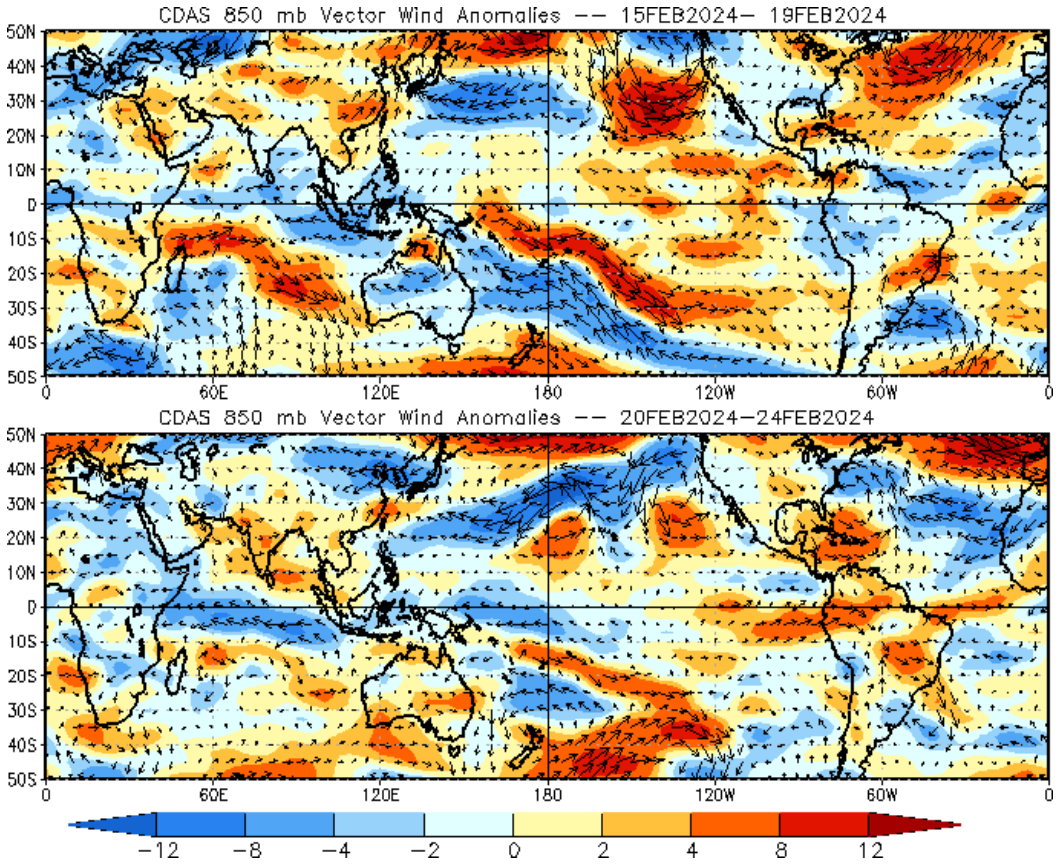


- A strong subtropical jet is noted across much of the Pacific, associated with continued enhanced moisture advection into the southwestern U.S.
- Anomalous upper-level westerlies are depicted across the equatorial Atlantic and Africa associated with the MJO propagation.
- Anomalous upper-level easterlies have increased across the equatorial Pacific following the departure of the MJO and remaining under the influence of the El Niño base state.

850-hPa Wind Anomalies

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

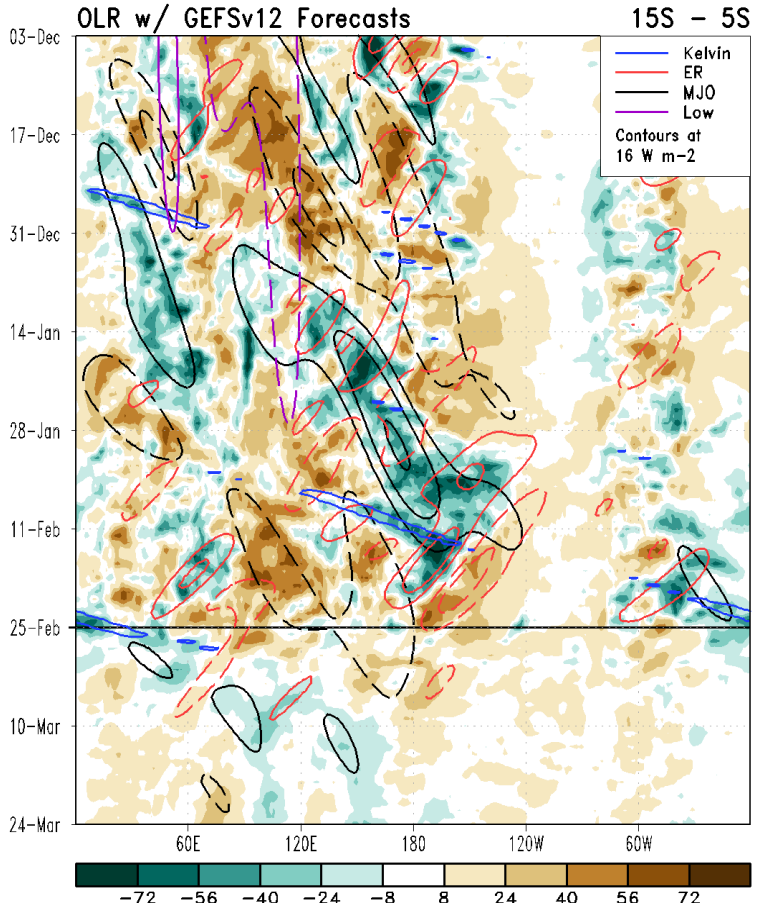


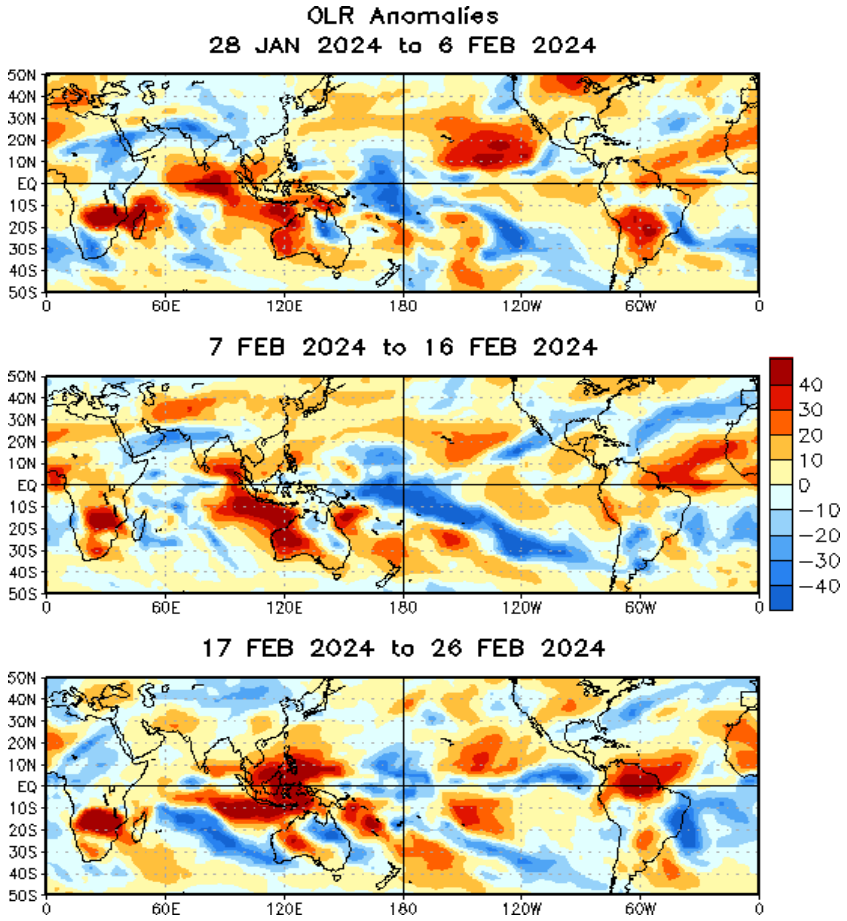


- There has been a clear eastward propagation of anomalous low-level westerlies across the equator tied to the MJO.
- Anomalous low-level easterlies have increased across the equatorial Indian Ocean leading to enhanced convergence across Africa.
- Cyclonic flow across the northeastern Pacific has weakened compared to last week.

Outgoing Longwave Radiation (OLR) Anomalies

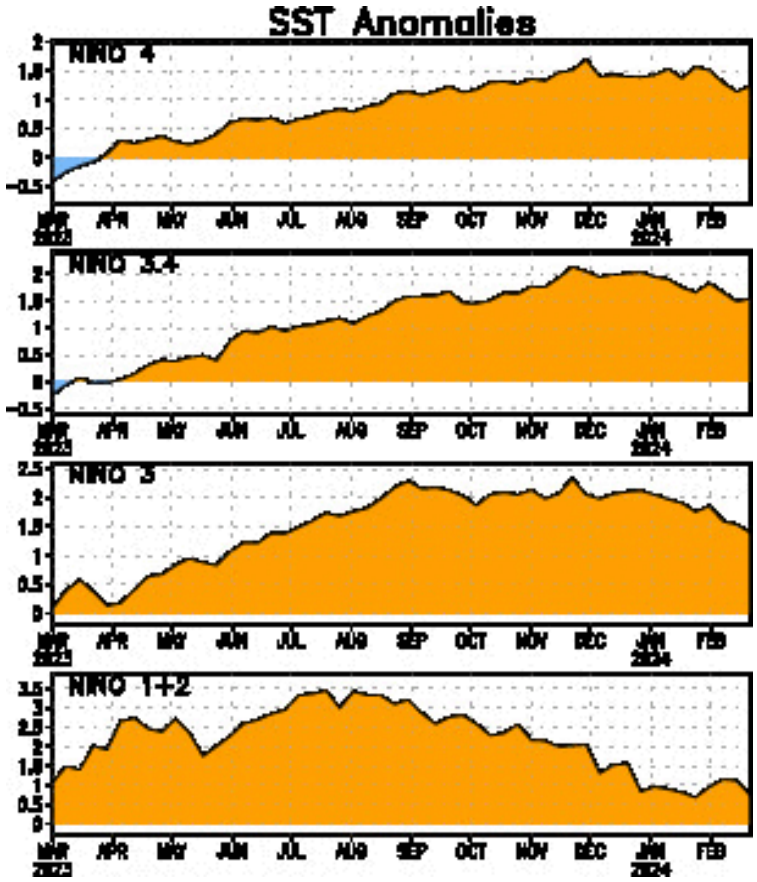
Green shades: Anomalous convection (wetness)
Brown shades: Anomalous subsidence (dryness)

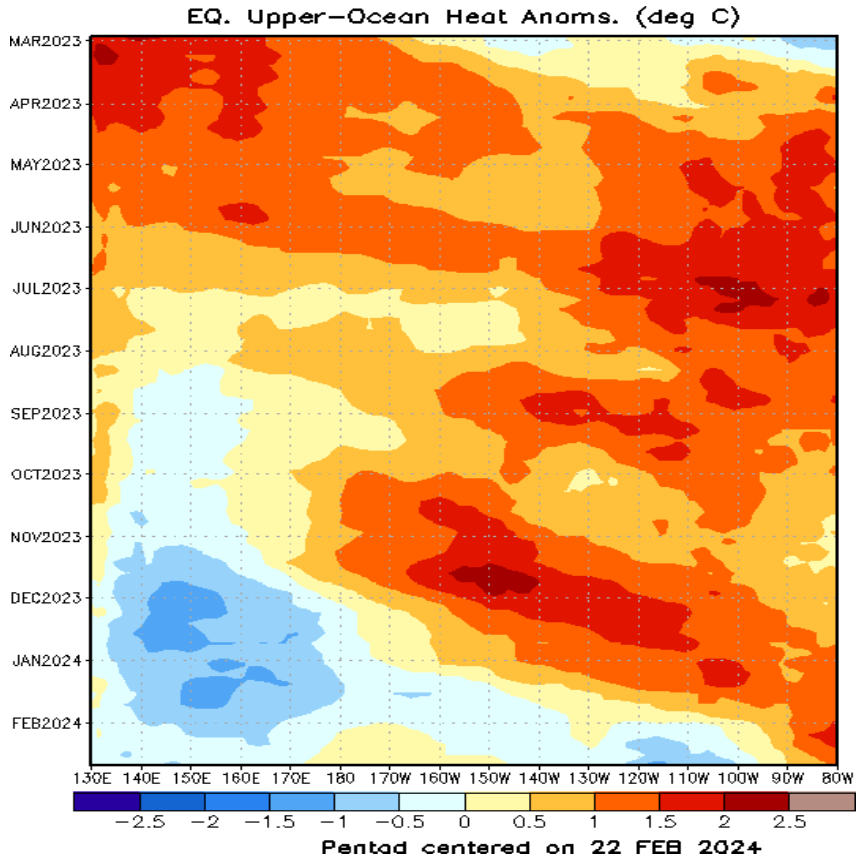




- Spatial OLR fields depict the strongest negative OLR anomalies across the South Atlantic during the past week (Note formation of Tropical Storm Akara near southern Brazil on 2/16).
- MJO signal is coming through the OLR filtering around 0-30°W, along with some constructive interference from enhanced Rossby Wave activity in that region.
- Time-lon OLR forecasts depict a continued propagation of this enhanced signal into the Indian Ocean and eventually into the Western Pacific during the first half of March.

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

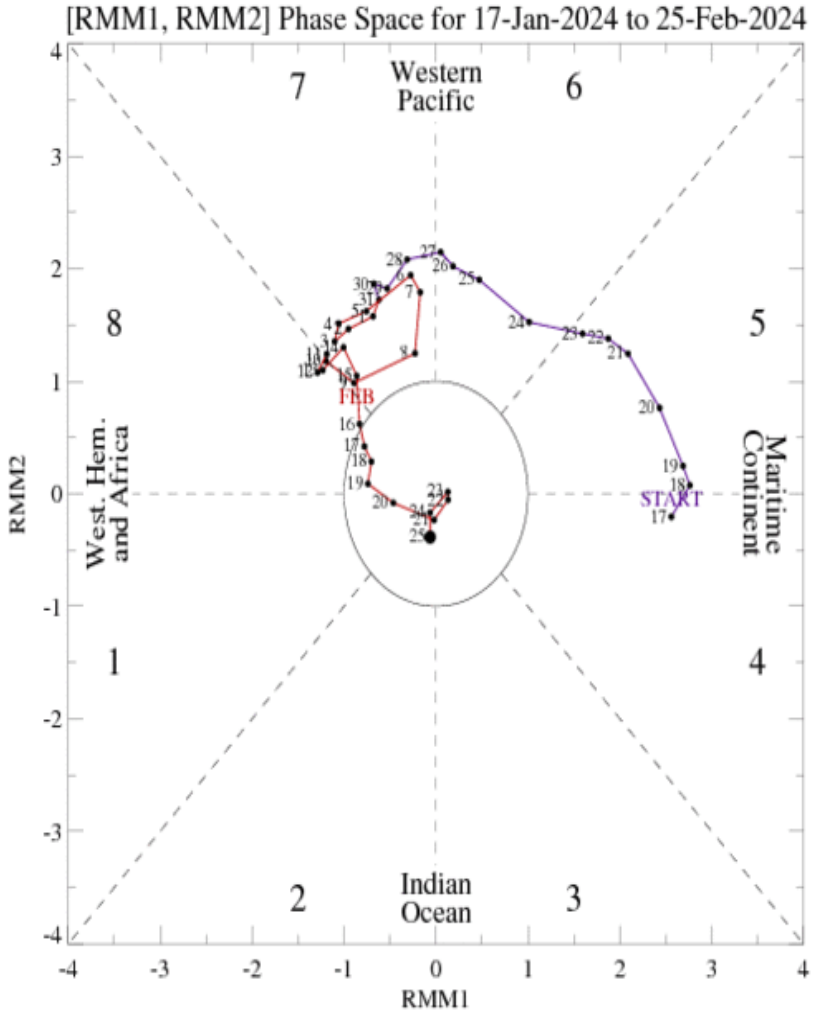




- There has been a notable downward trend in SST anomalies in all NINO regions during the past month suggestive of a weakening El Niño.
- Since the early February, subsurface anomalies have flipped sign over the central and eastern equatorial Pacific.

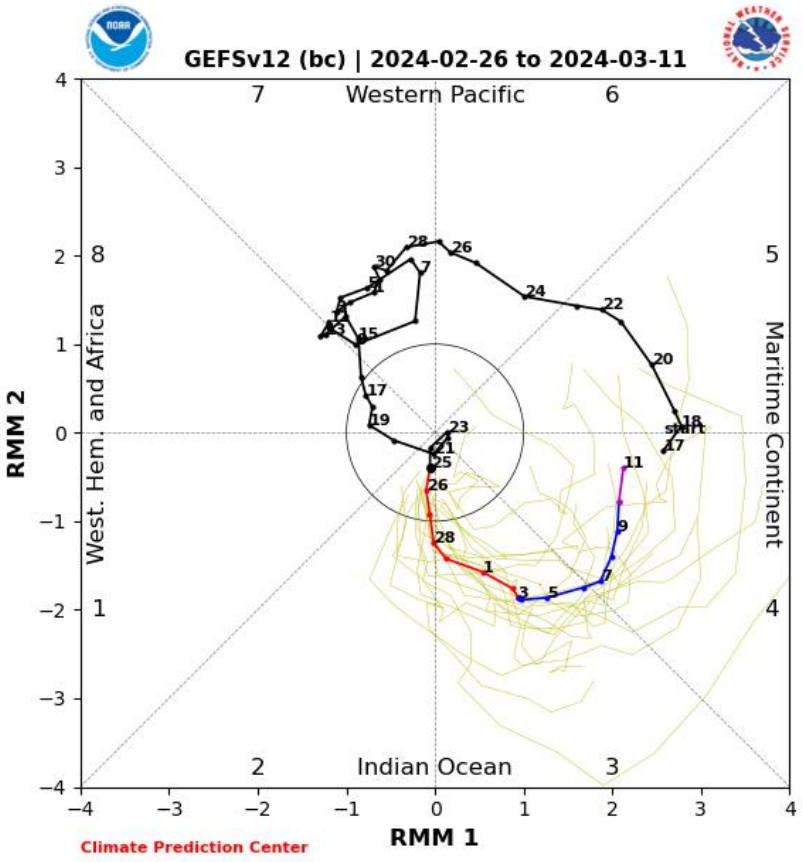
MJO Index: Recent Evolution

- During the past week, the RMM-based MJO index has returned to the unit circle.
- However, the removal of the 120-day running mean in the RMM-computation favors a rightward bias, and the velocity potential pattern is more indicative of an active MJO crossing the Prime Meridian.

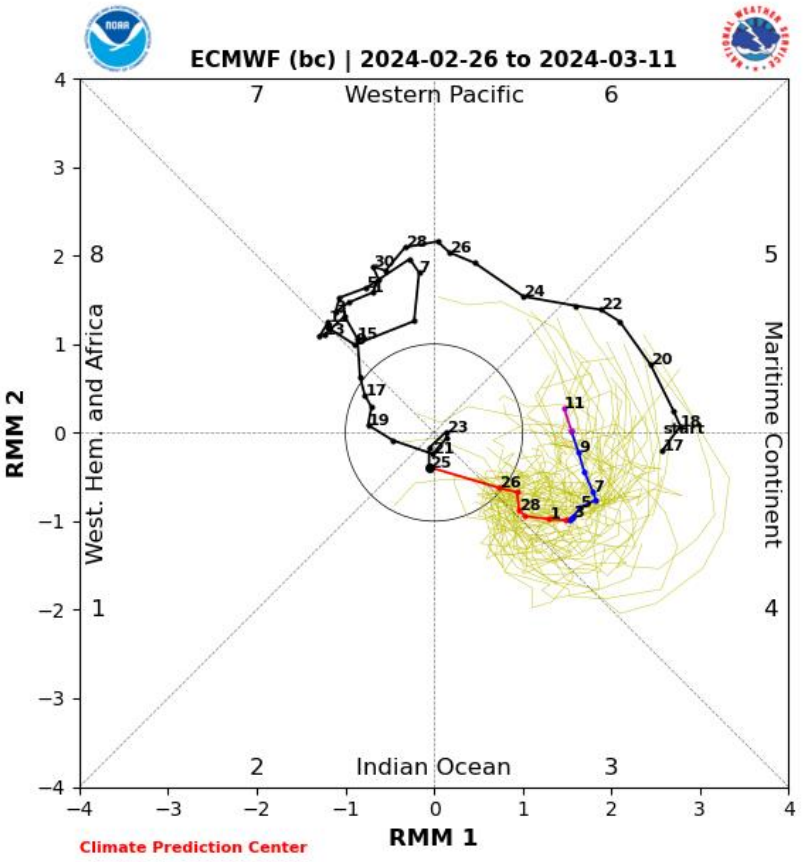


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast

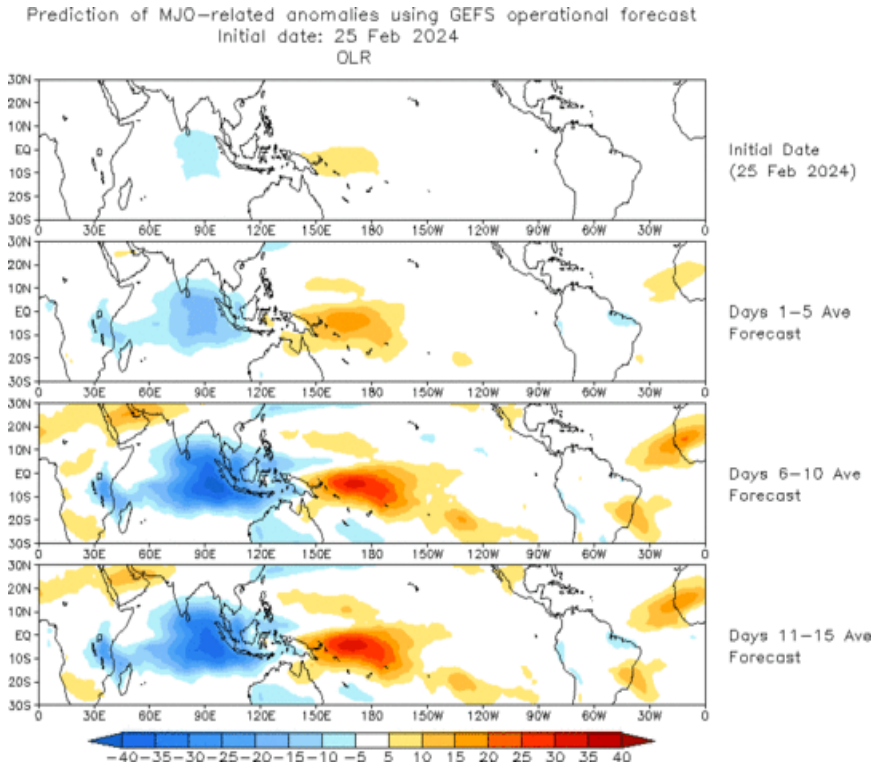


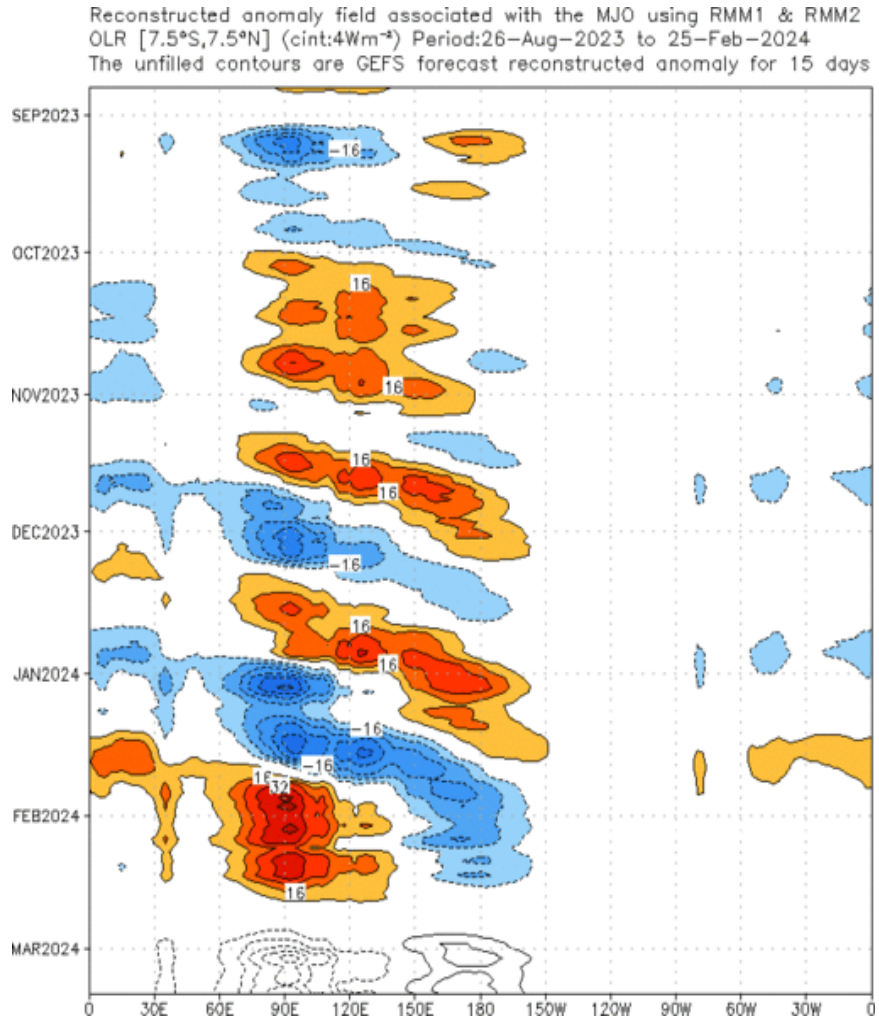
ECMWF Forecast

- Both the GEFS and ECMWF RMM-based forecasts indicate a continued eastward propagation of the MJO into the Indian Ocean and Maritime Continent during the next 2 weeks.
- A removal of the 120-day running mean in RMM computation may be resulting in a rightward shift in the RMM-based forecasts, suggesting that the current forecast may be over-amplifying the MJO signal.

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.)

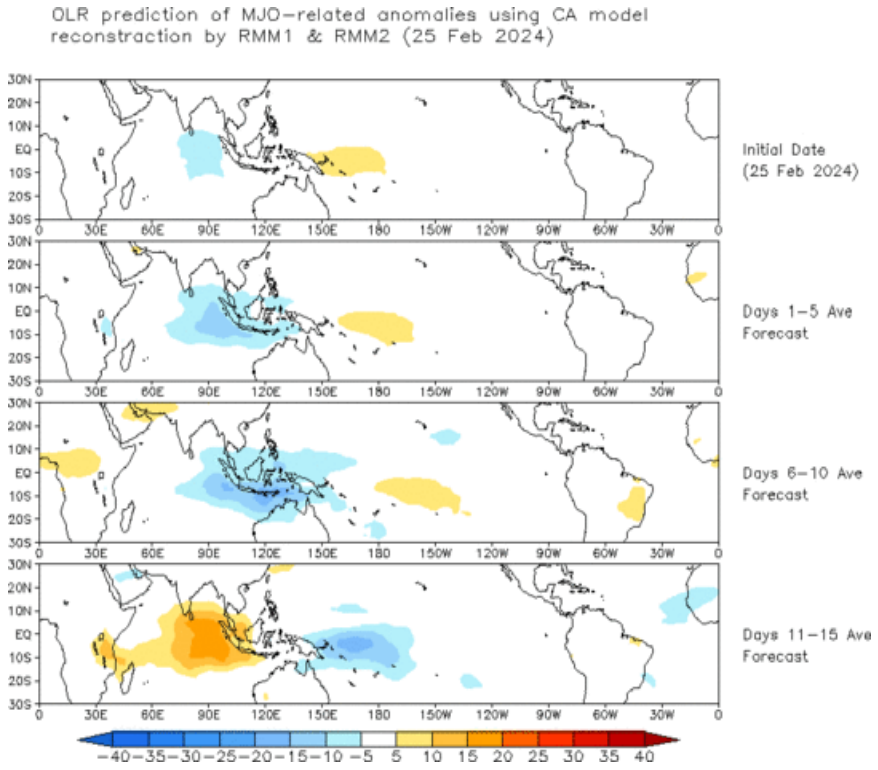


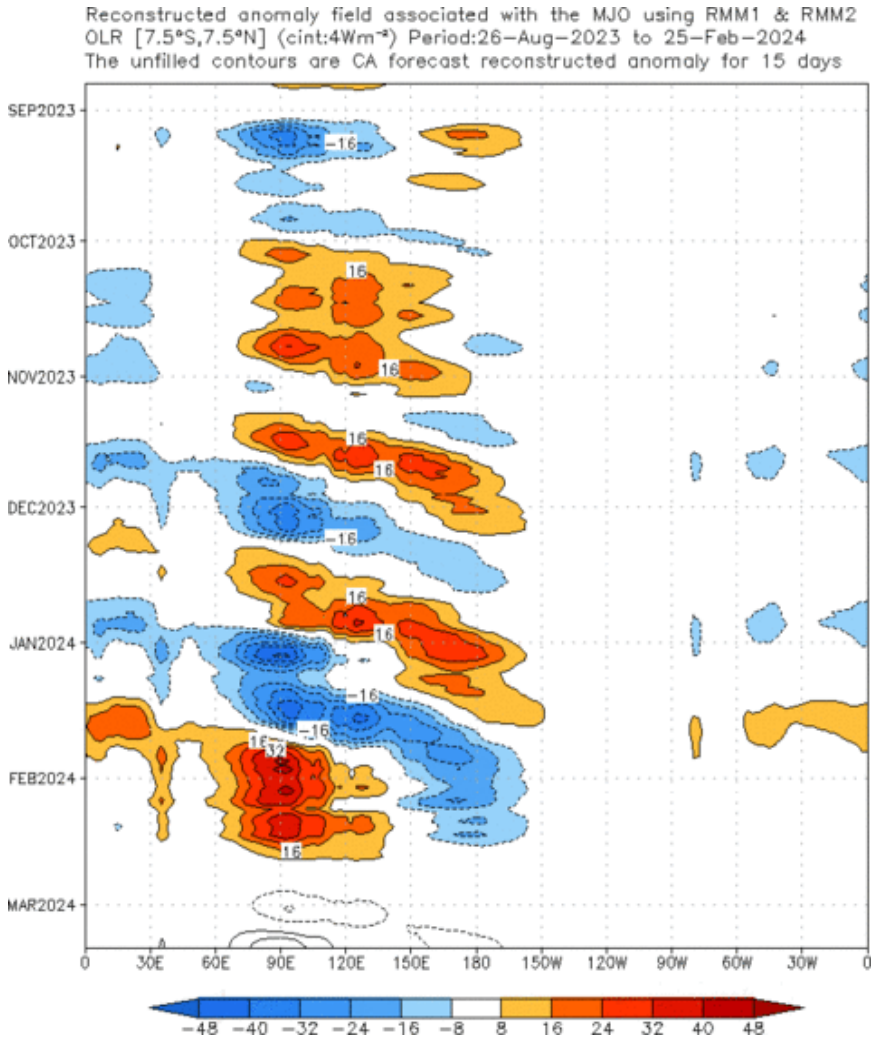


- The GEFS RMM-based tool depicts negative OLR anomalies (enhanced convection) building across the Indian Ocean, and positive OLR anomalies (suppressed convection) increasing over the west-central Pacific.

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.)

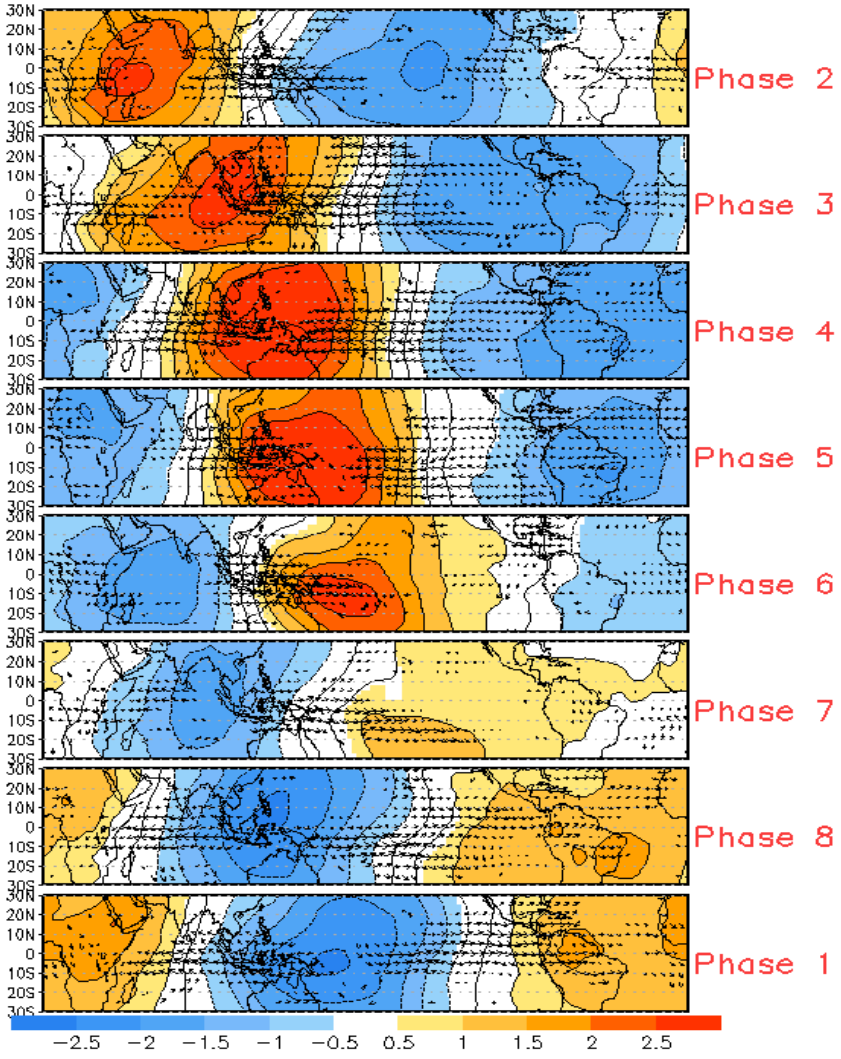




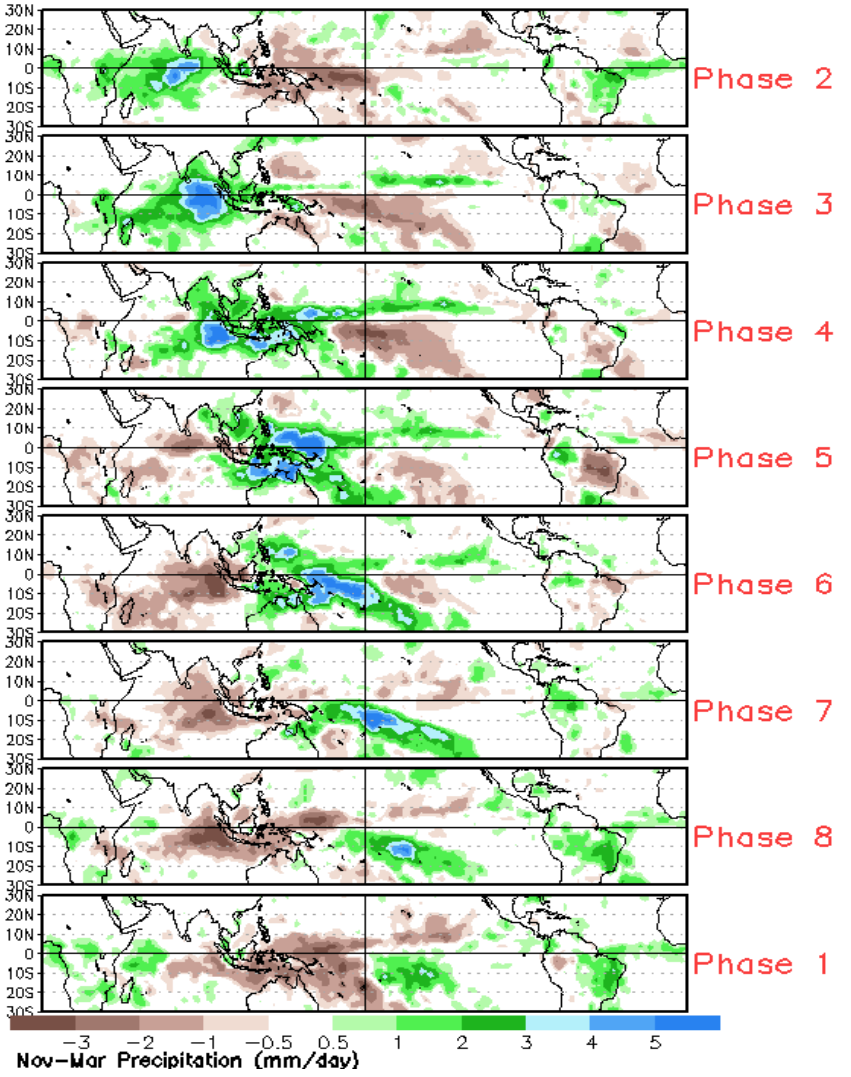
- The constructed analog tool depicts a faster progression of the MJO compared to the GEFS, with negative OLR anomalies (enhanced convection) reaching the western Pacific during week-2, and a transition to positive OLR anomalies (suppressed convection) over the Indian Ocean by the end of week-2.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



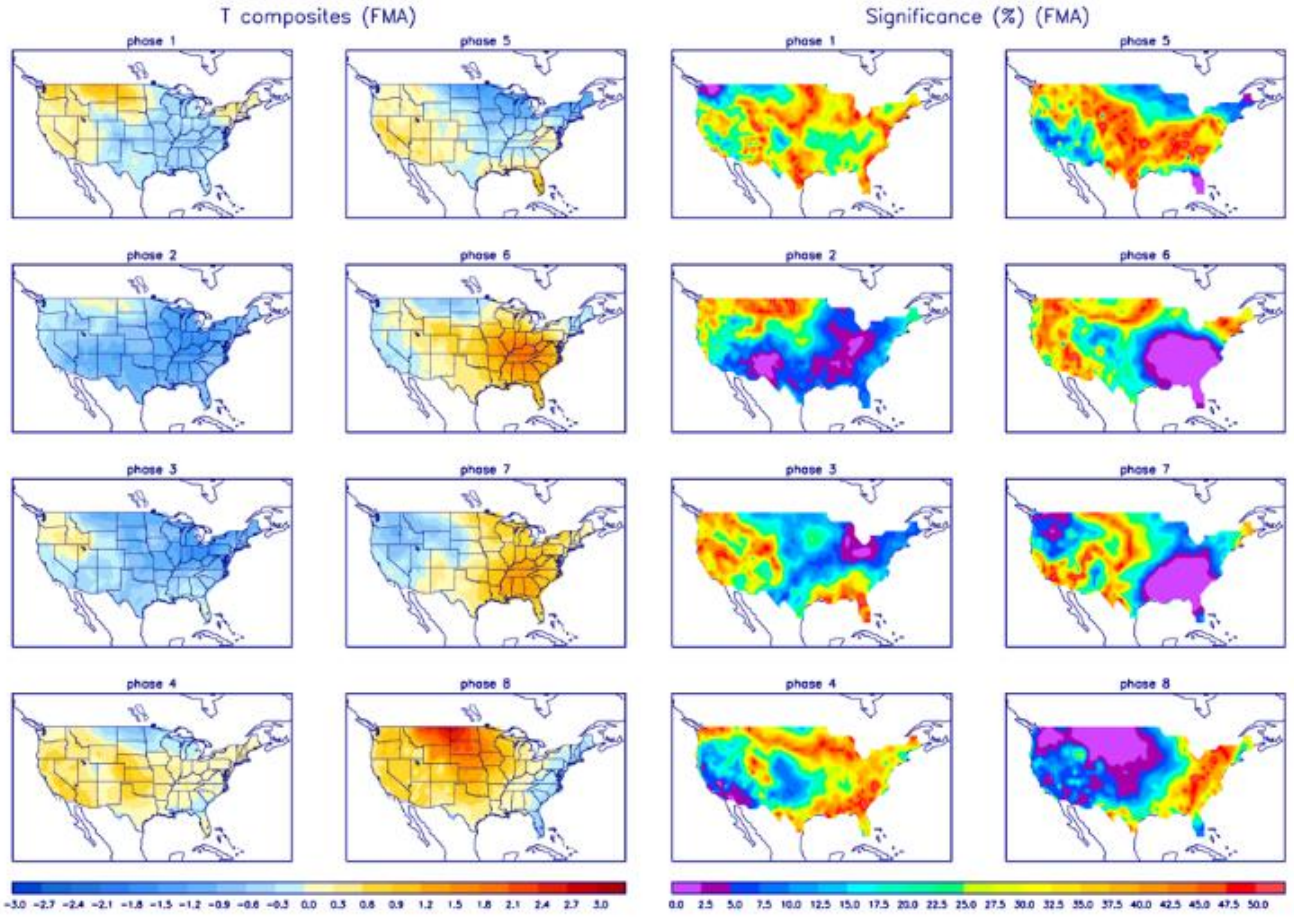
Precipitation Anomalies



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.

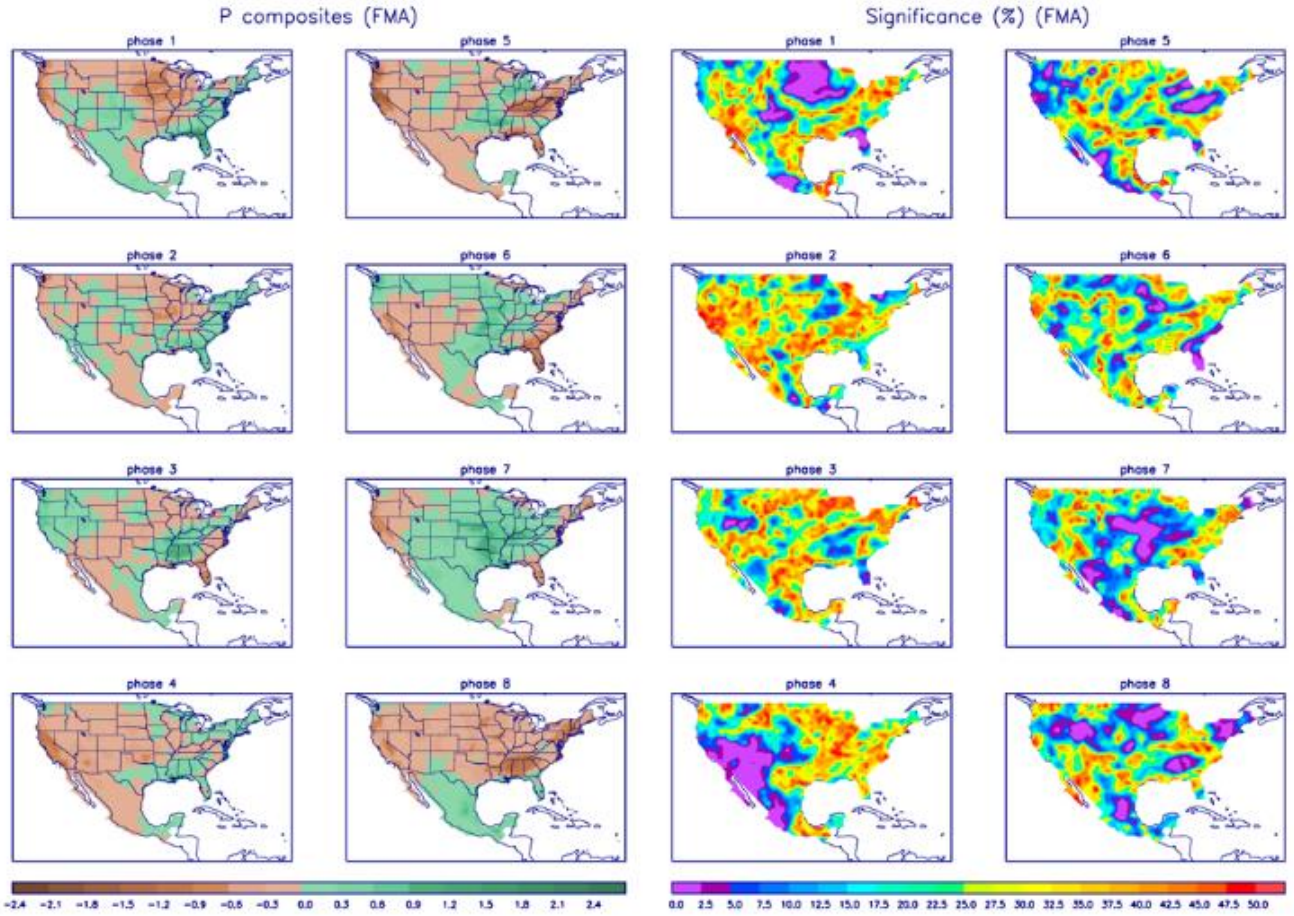


More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

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.



More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml