

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



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

Overview

- RMM observations show a westward retreat of the MJO signal over the Western Pacific earlier this month, but the MJO has since resumed its eastward propagation and has moved into phase 8 (Western Hemisphere) in RMM space.
- Consistent with model guidance since last week, a much weakened MJO is generally favored in the RMM forecasts, with model solutions showing the signal mostly remaining within the unit circle during the next two weeks.
- However, there is some question as to whether this weakening is reflective of a disorganizing MJO or the removal of the 120-day mean which is strongly skewing the MJO signal to the right in RMM space. Upper-level velocity potential anomaly and OLR forecasts suggest the latter, which depict a more coherent MJO moving forward.
- Anomalous westerlies continue to enhance probabilities for tropical cyclone (TC) activity for the southwestern Indian Ocean through early March.

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

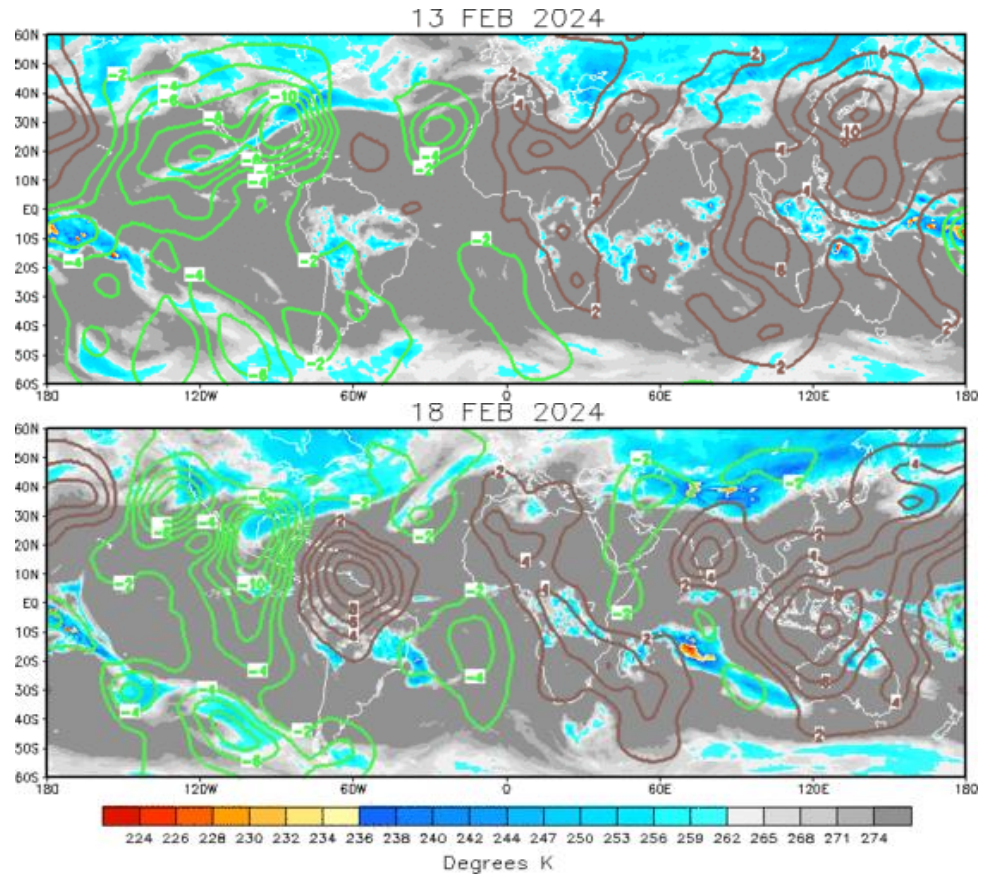
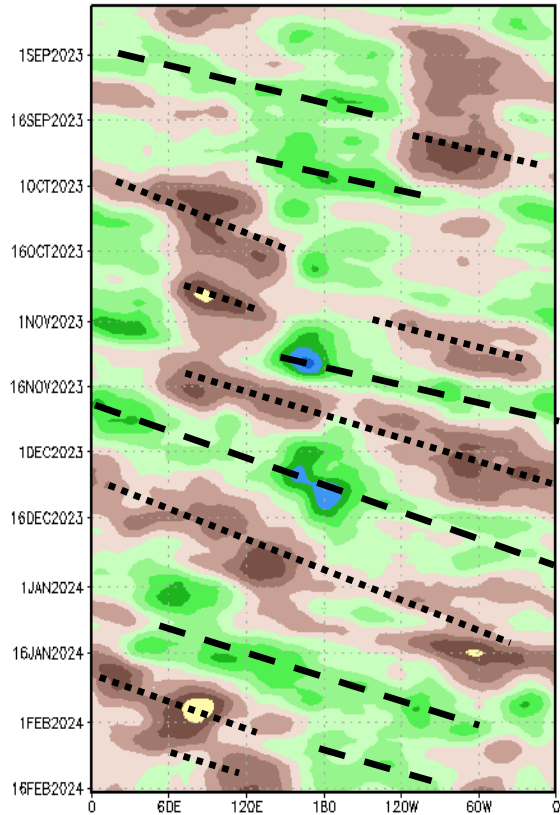
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

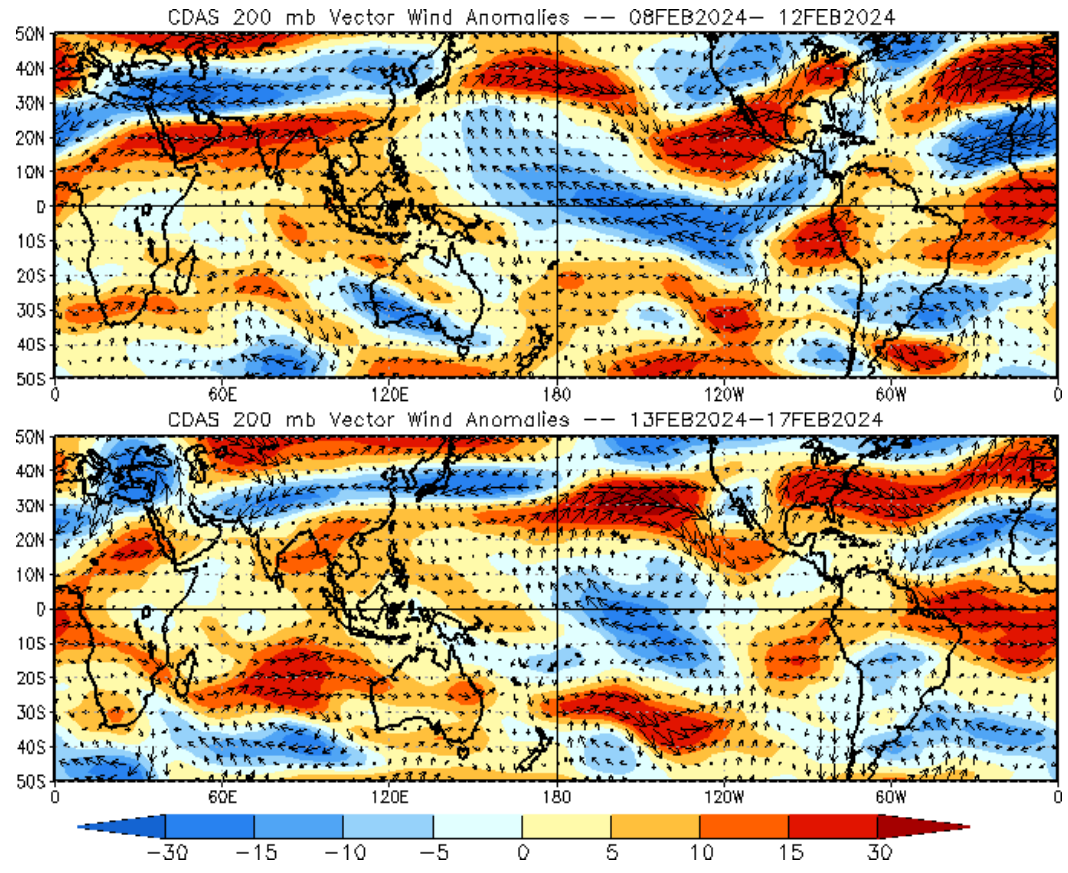
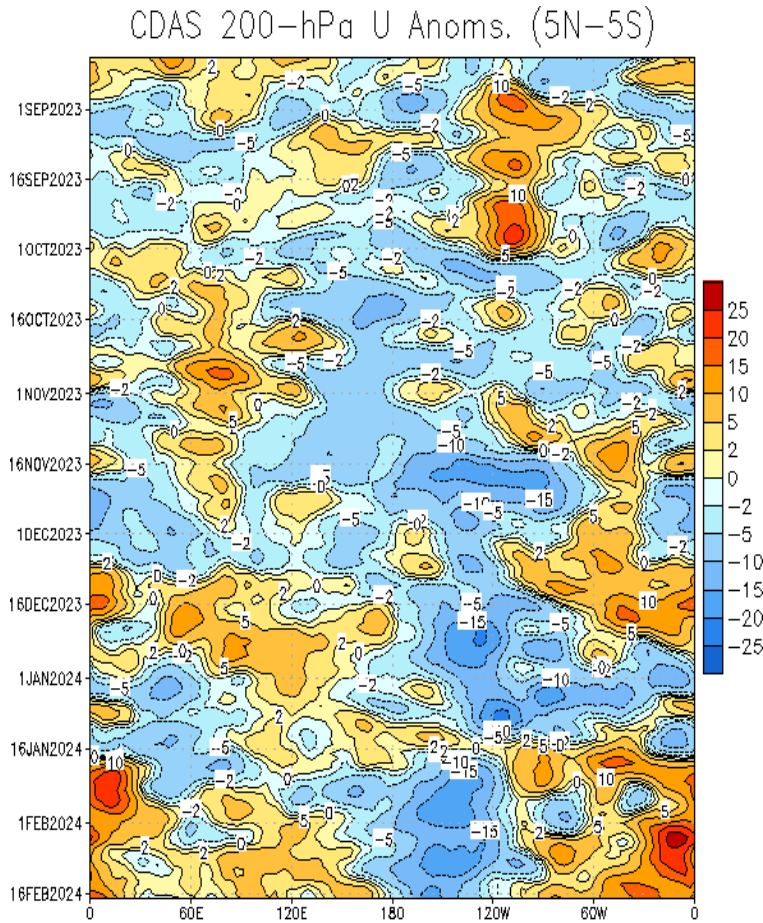
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- The upper-level velocity potential anomaly fields show continued MJO activity, although slight breaks in a clean wave-1 symmetry continue from last week.
- Eastward propagation of the enhanced convective envelope continues, which is currently centered over the Americas. The leading edge appears a little ragged with patchy anomalous convergence mixed in.

200-hPa Wind Anomalies

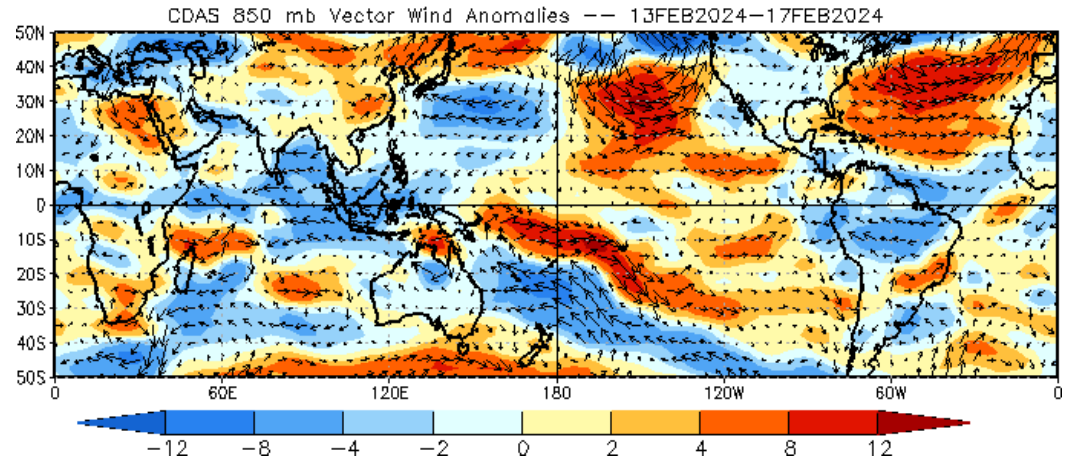
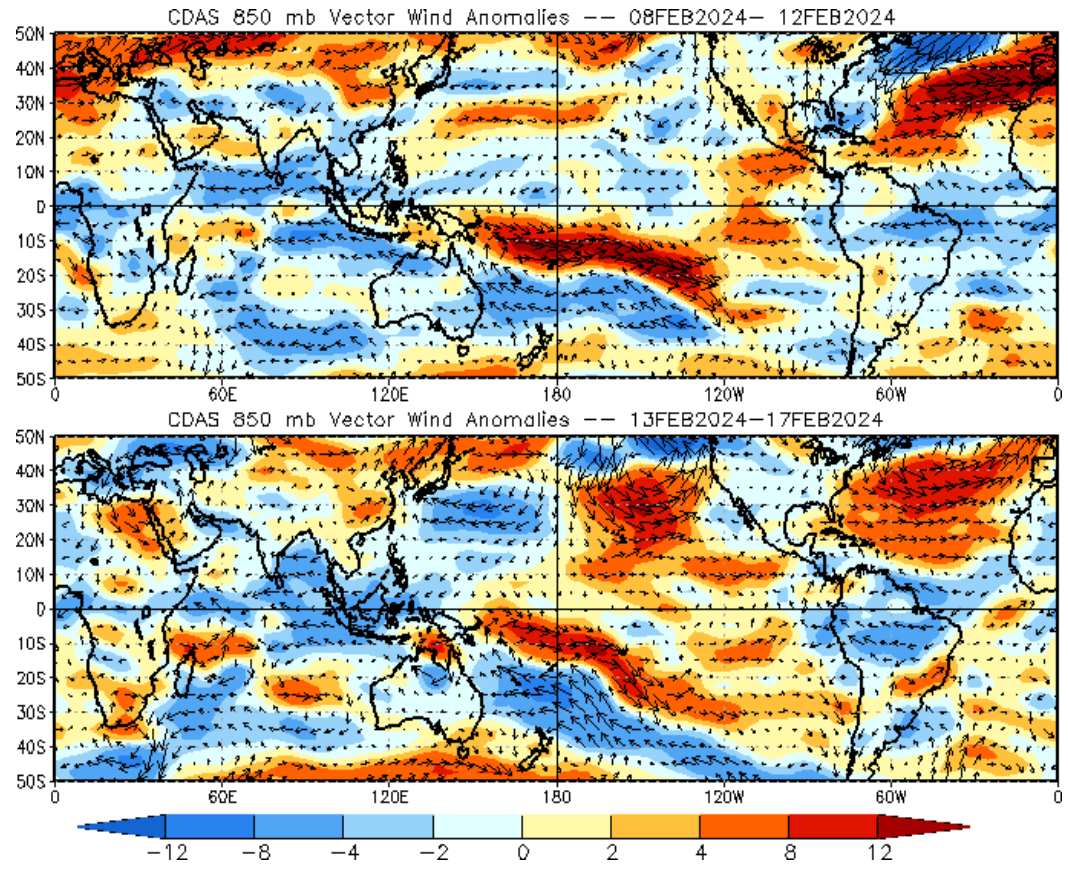
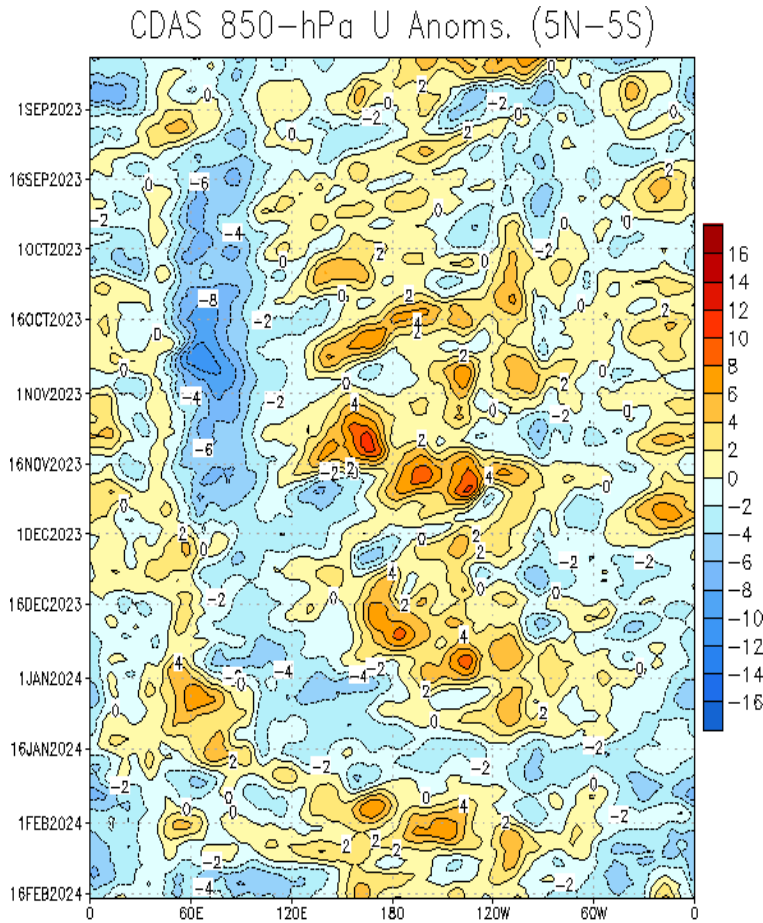
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- The easterly phase of the MJO has stalled over the central and eastern Pacific, constructively interfering with the low frequency footprint over the basin.
- Similarly, little eastward propagation of the westerly MJO phase is seen over the equatorial Indian Ocean; however, anomalous westerlies have become more robust over the eastern part of the basin.
- An enhanced jet is observed across the subtropical Pacific and extending into the southwestern CONUS coinciding with atmospheric river activity.

850-hPa Wind Anomalies

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

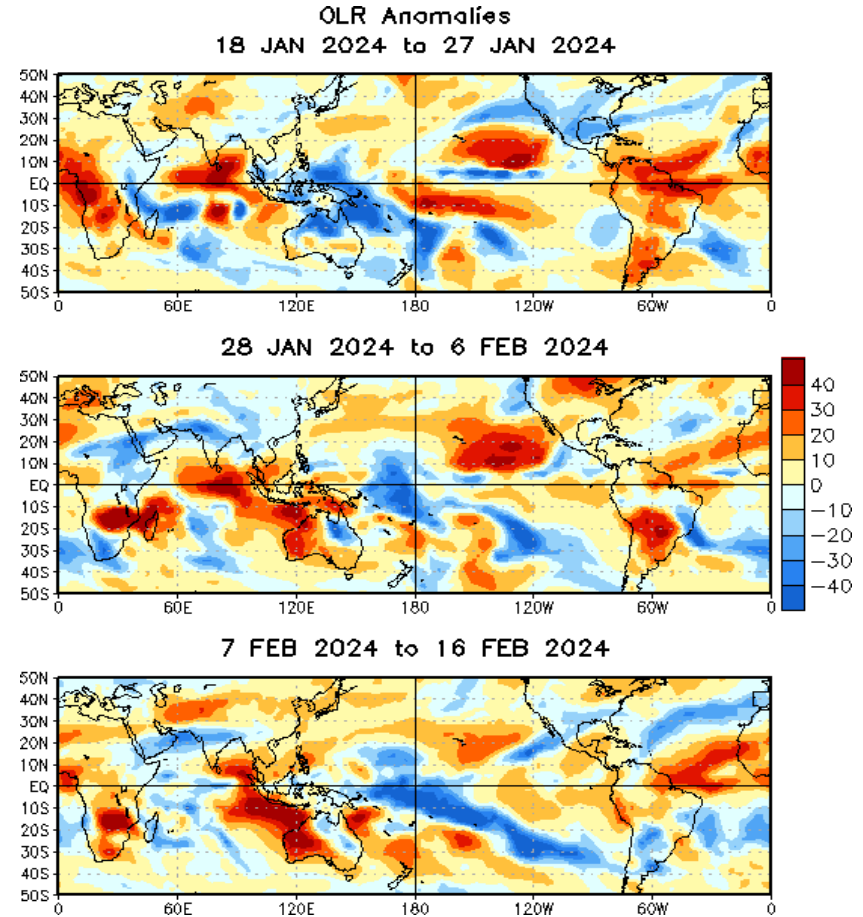
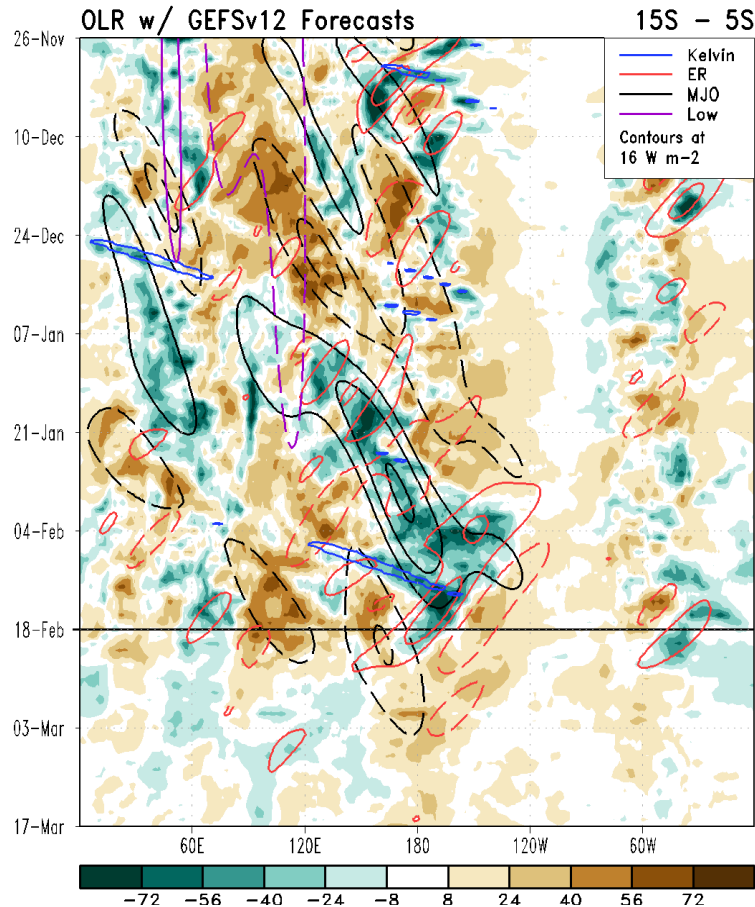


- Anomalous low-level westerlies spread across the Pacific over the last week, with enhanced anomalous westerlies over the South Pacific.
- Zonal wind anomalies appear mixed over the equatorial Indian Ocean, though trades remain stronger than usual over much of the Indian Ocean, consistent with Western Hemisphere MJO activity.
- Anomalous westerlies near 60E mainly south of the equator have become a low frequency feature.

Outgoing Longwave Radiation (OLR) Anomalies

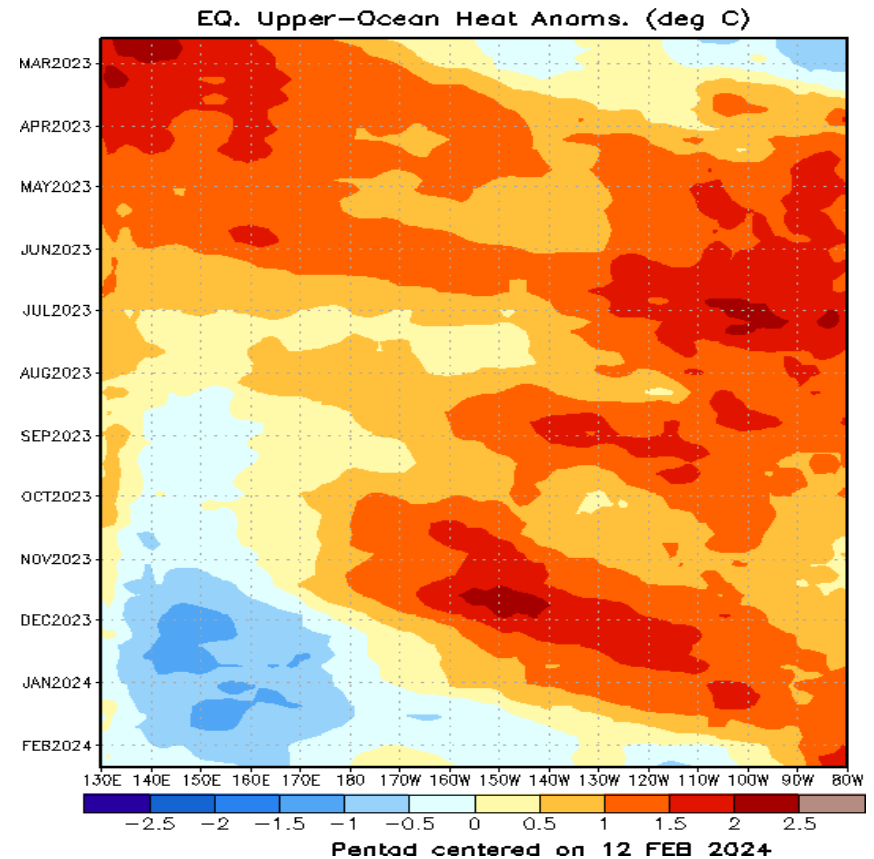
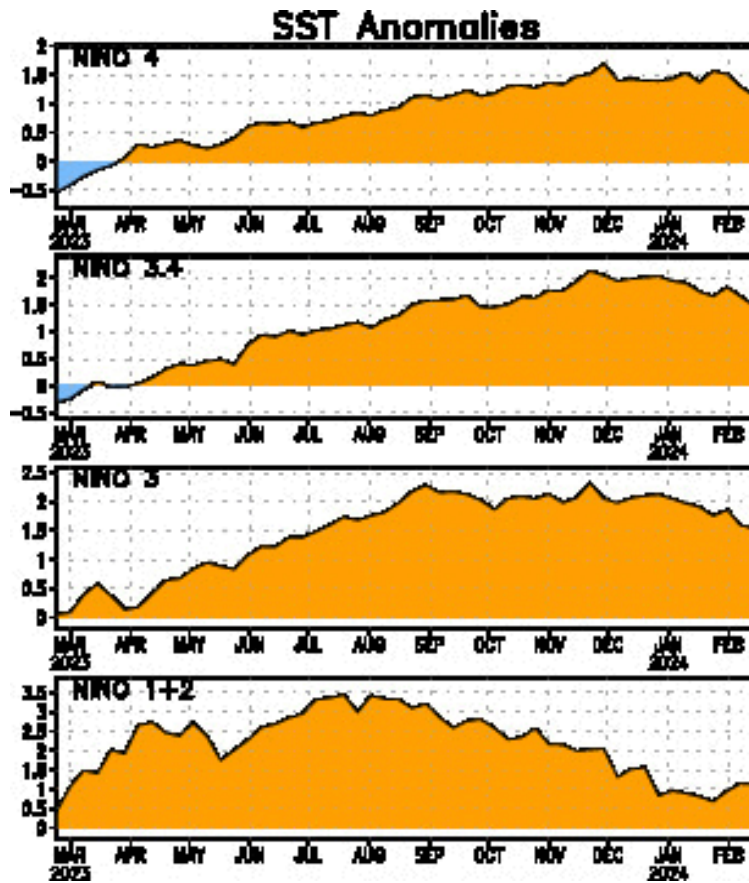
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- A robust MJO signal is apparent through the OLR filtering since last year, and has been constructively interfering with the ongoing El Niño to produce widespread enhanced (suppressed) convection on both sides of the Date Line (over the eastern Indian Ocean and Maritime Continent).
- OLR forecasts also show MJO activity coming through the filtering, with the enhanced phase crossing the Prime Meridian and entering the Indian Ocean later in February and early March. There is a lot of noise in the forecast, possibly contributing to low signal in the RMM forecasts.

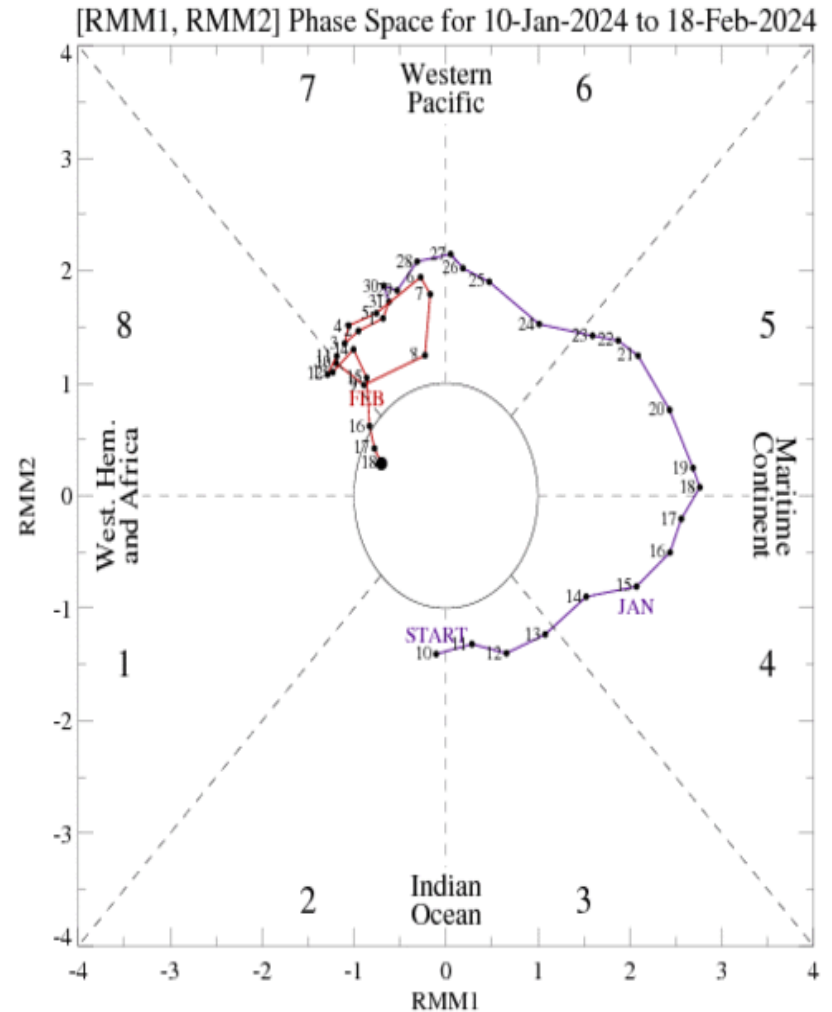
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- SST anomalies are beginning to decline in the western Niño regions, with a slowing downward trend observed in the Niño 1+2 region over the past month.
- Negative upper-ocean heat content anomalies continue to expand eastward, extending past 110°W in the latest observations.
- Both the warm and cold subsurface anomalies appear weaker overall compared to earlier this winter.

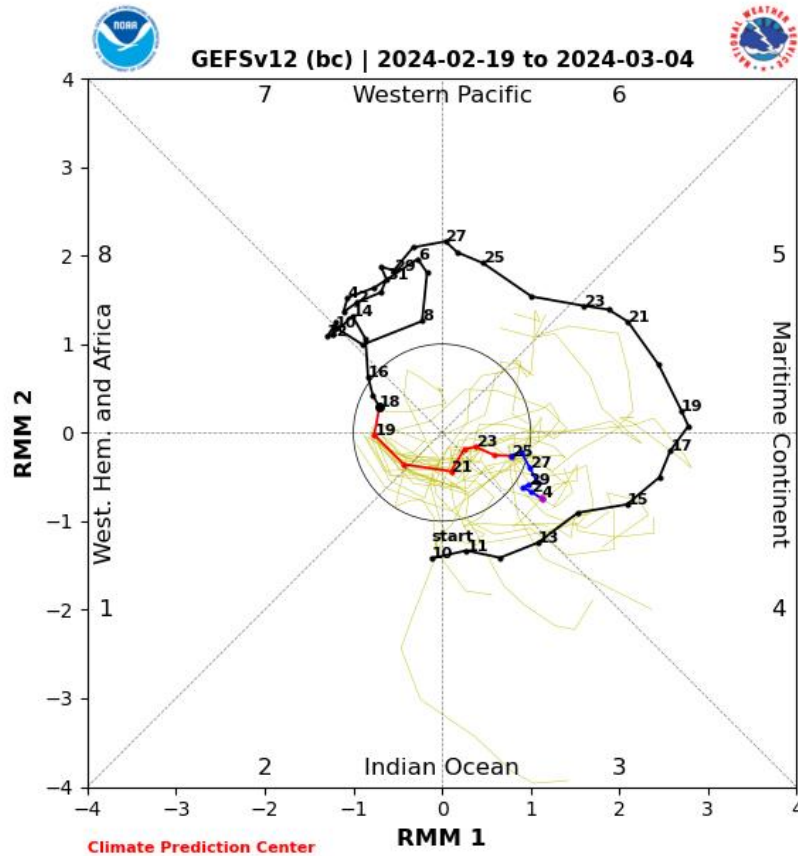
MJO Index: Recent Evolution

- The RMM-based MJO index has meandered mostly within phase 7 for much of February, although over the last week it has moved into phase 8 with a weakening amplitude.

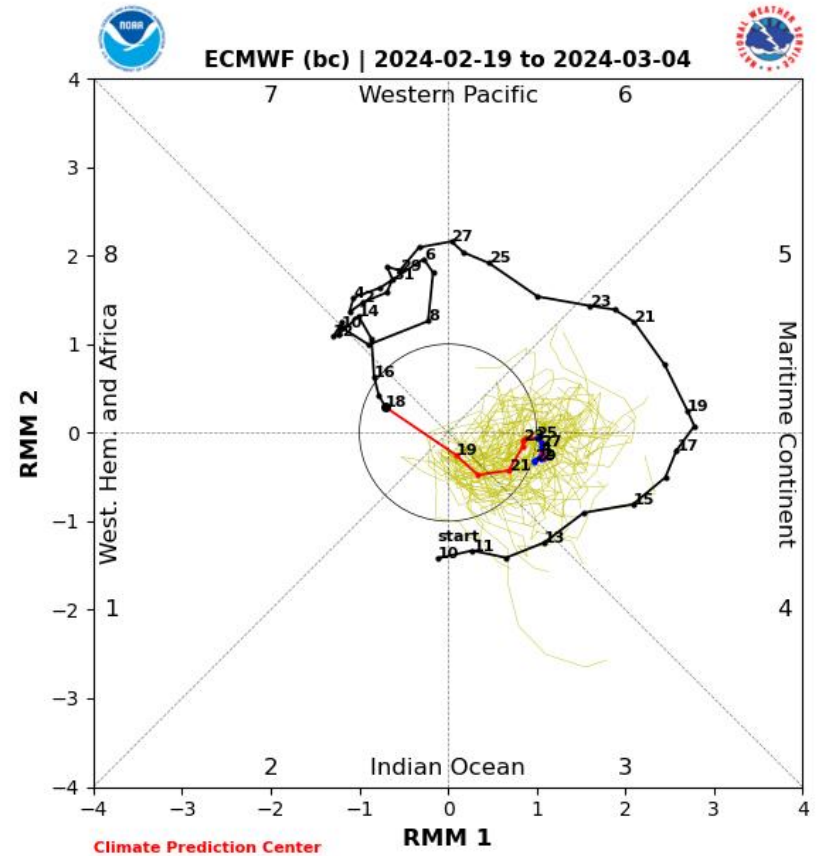


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



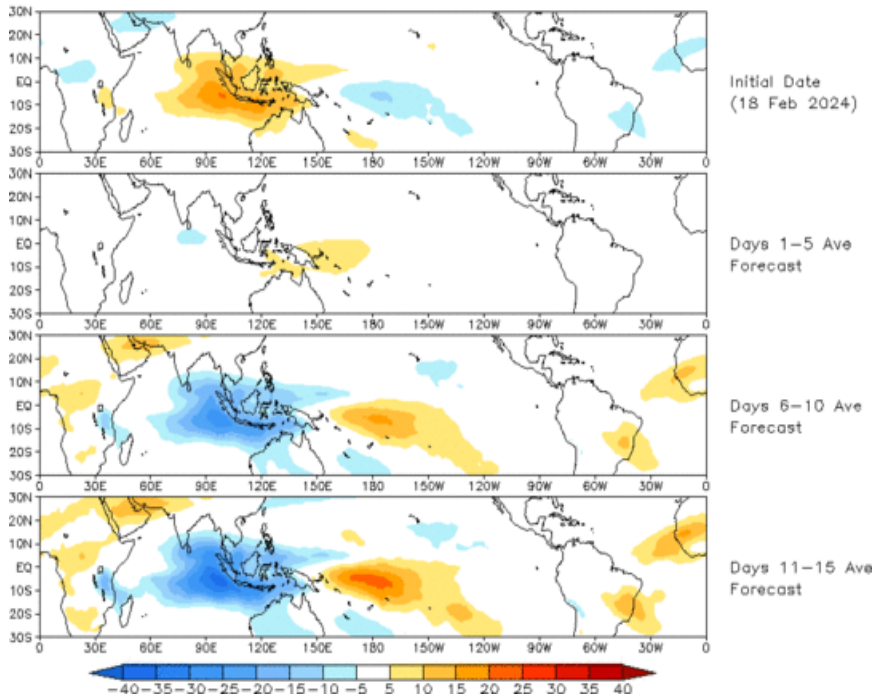
ECMWF Forecast

- Both the GEFS and ECMWF RMM forecasts indicate a more orderly eastward propagation of the MJO over the coming weeks albeit at a low amplitude, remaining mostly confined to the unit circle.
- However, a retention of the 120-day running mean in RMM computation shows indices are heavily skewed to the right to correct for a strong +IOD event this past fall. Because this low frequency response is no longer evident in the tropical circulation, this suggests the RMM forecasts need to be taken with caution.

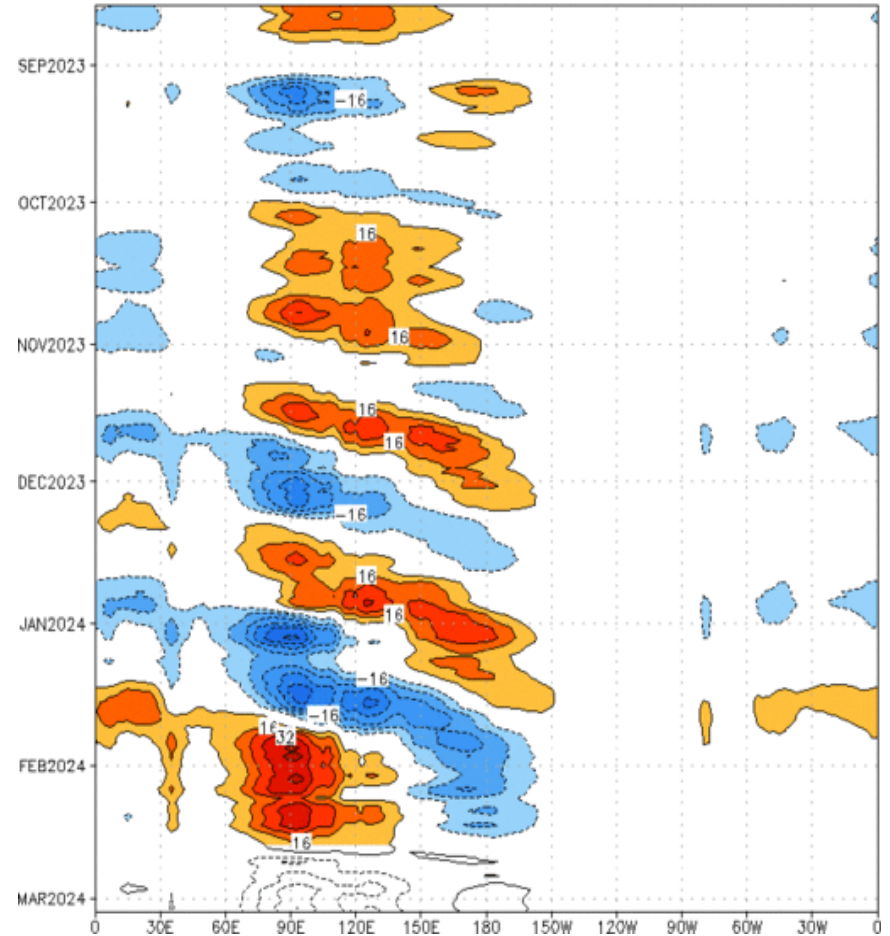
MJO: GEFS Forecast Evolution

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: 18 Feb 2024
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:19-Aug-2023 to 18-Feb-2024
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

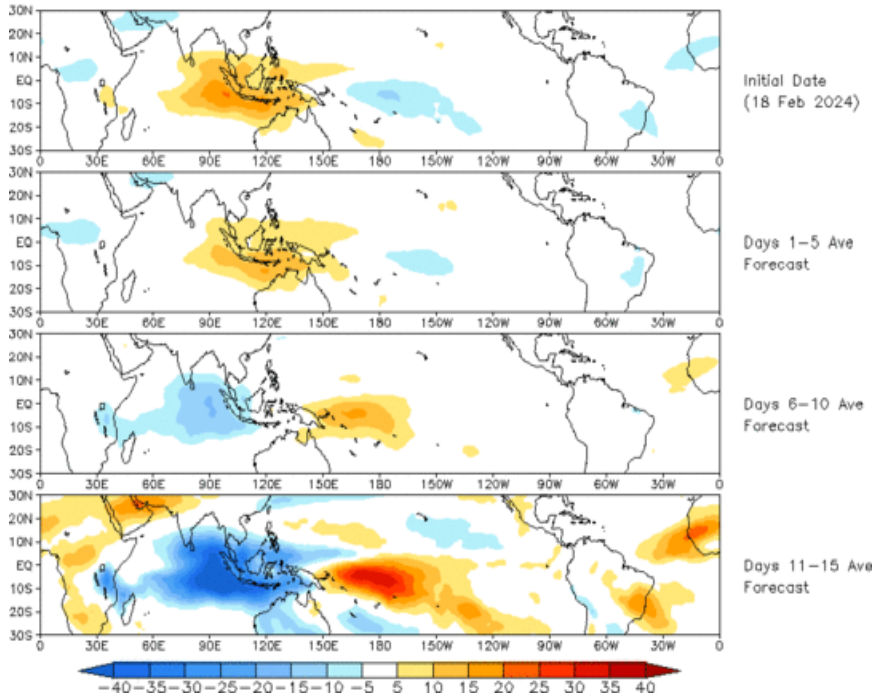


- The GEFS RMM-based OLR forecasts the emergence of a robust enhanced convective envelope emerging over the Indian Ocean during week-2.

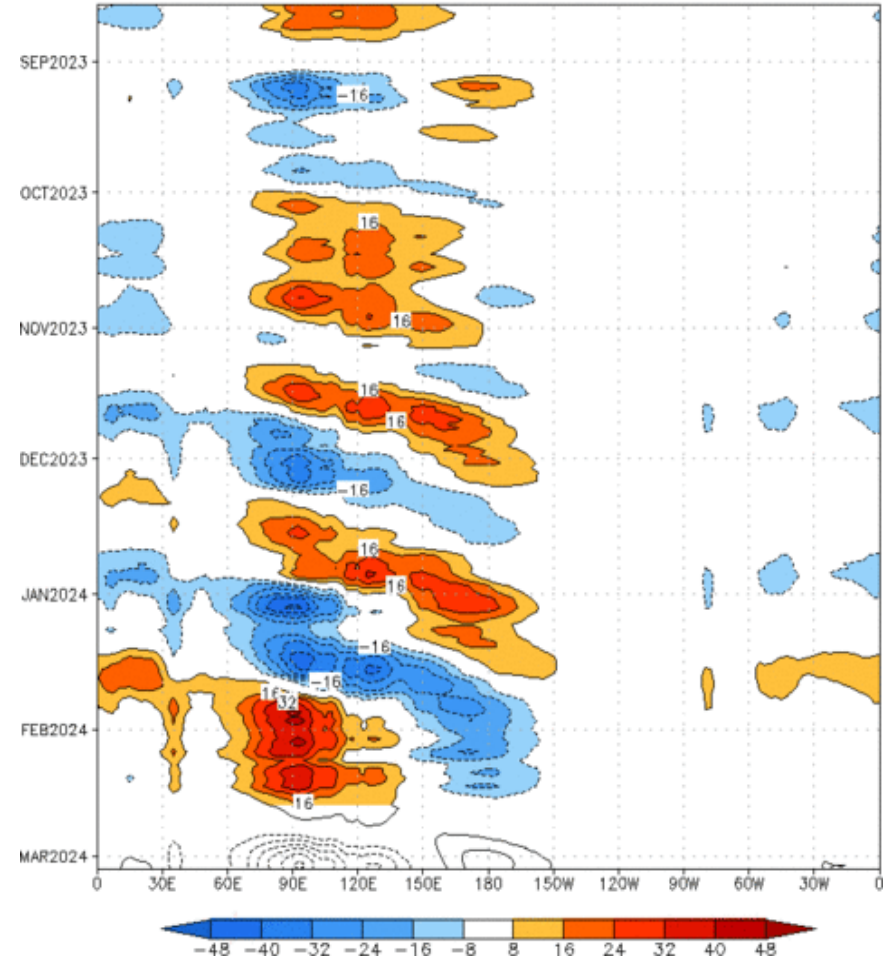
MJO: Constructed Analog Forecast Evolution

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 (18 Feb 2024)



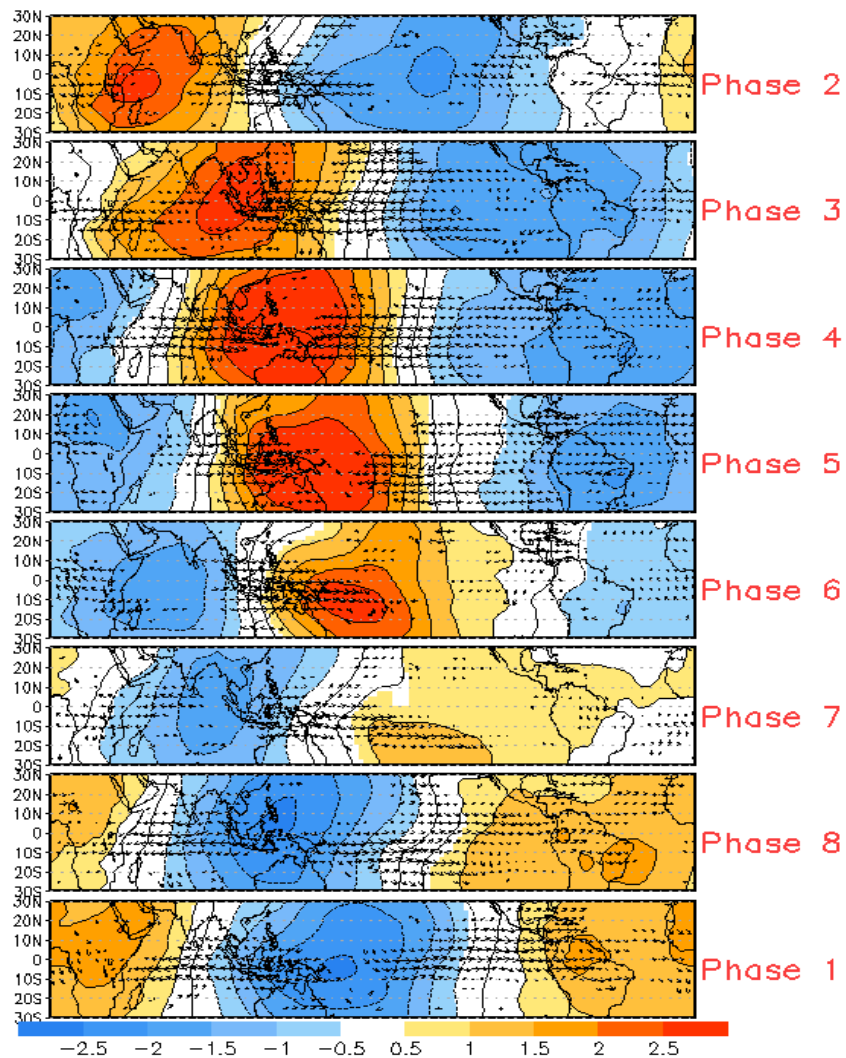
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:19–Aug–2023 to 18–Feb–2024
The unfilled contours are CA forecast reconstructed anomaly for 15 days



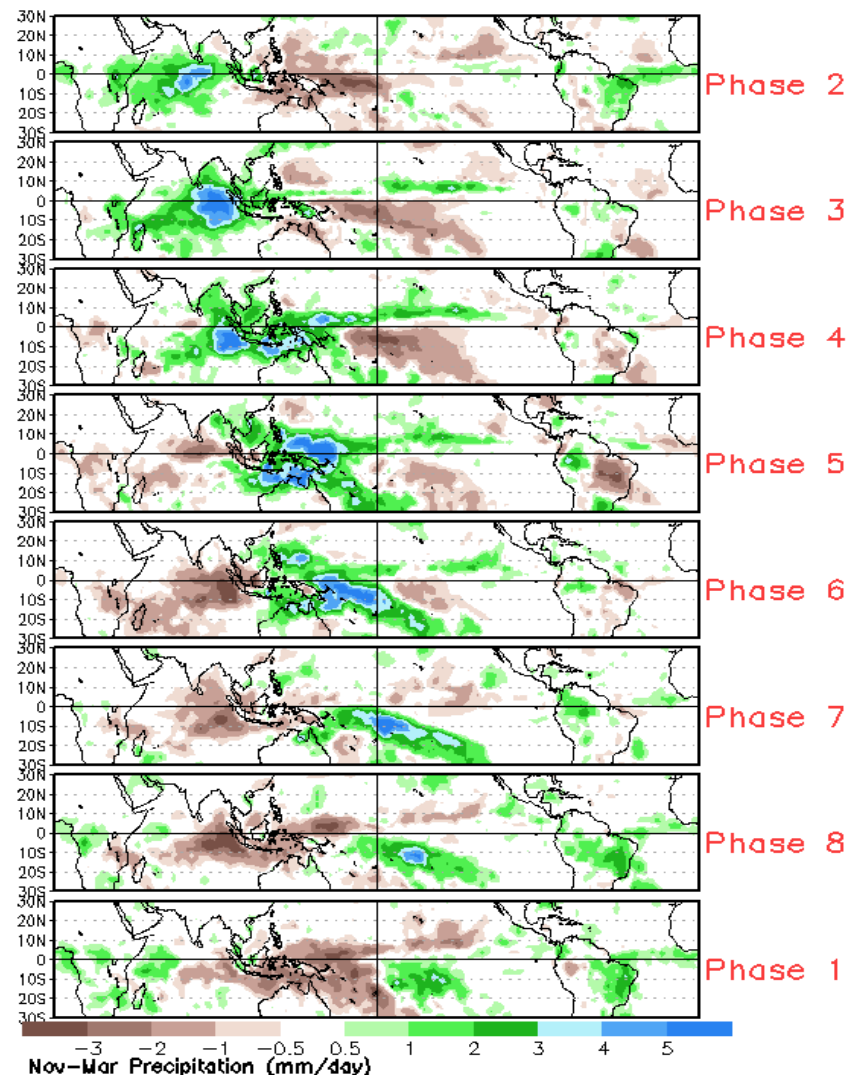
- The constructed analog (CA) RMM-based forecast also favors the emergence of enhanced convection over the Indian Ocean during week-2, with more evident eastward propagation of anomalous centers throughout the forecast period.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



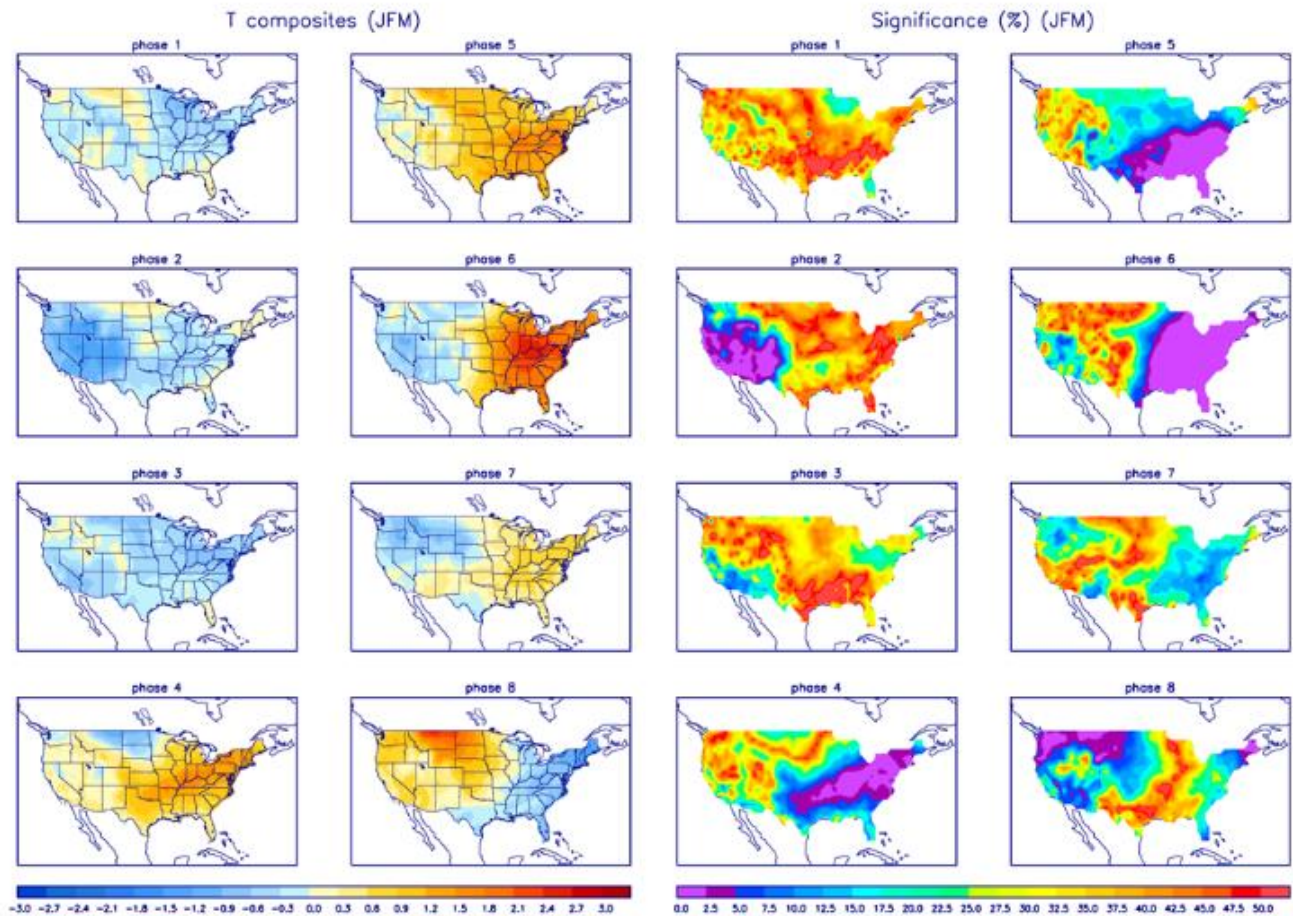
Precipitation Anomalies



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.

