

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



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

Overview

- RMM observations show a westward retreat of the MJO signal over the Western Pacific earlier this month, but has since resumed its eastward propagation and is nearing 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, where all models show the signal falling 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 forecasts suggest the latter, which depict more coherent MJO moving forward.
- Continued eastward propagation of the MJO across the Western Hemisphere and returning to the Indian Ocean would favor increased chances for tropical cyclogenesis in the South Pacific and southwestern Indian Ocean through early March.
- While destructive interference with the ongoing El Niño is likely to weaken intraseasonal activity, Western Hemisphere MJO events during late winter typically favor the development of anomalous mid-level troughing and colder than normal temperatures across many parts of central and eastern CONUS.

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

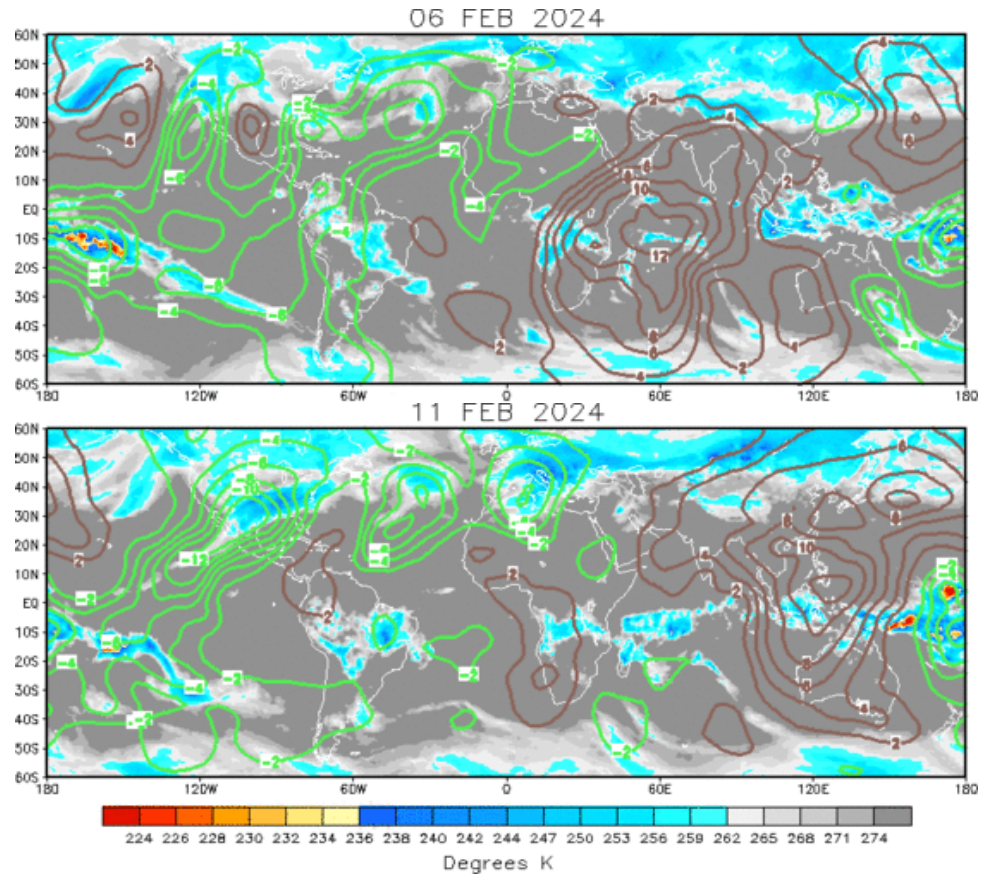
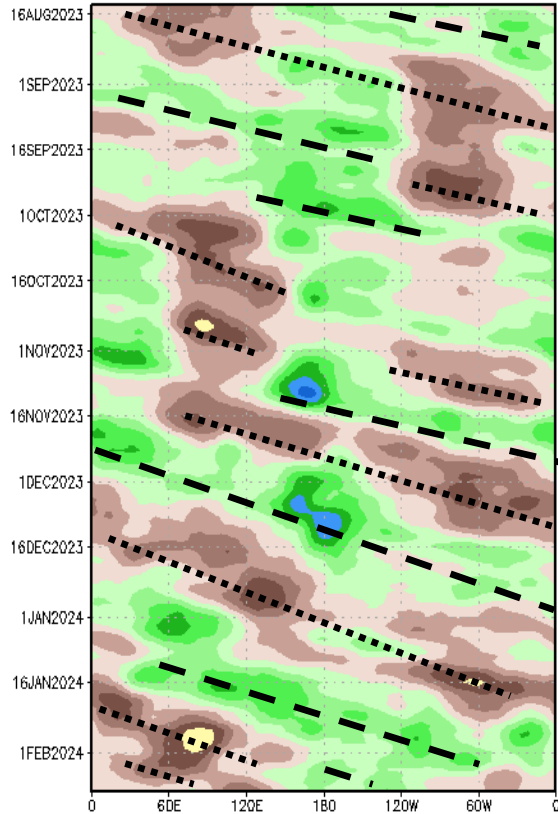
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

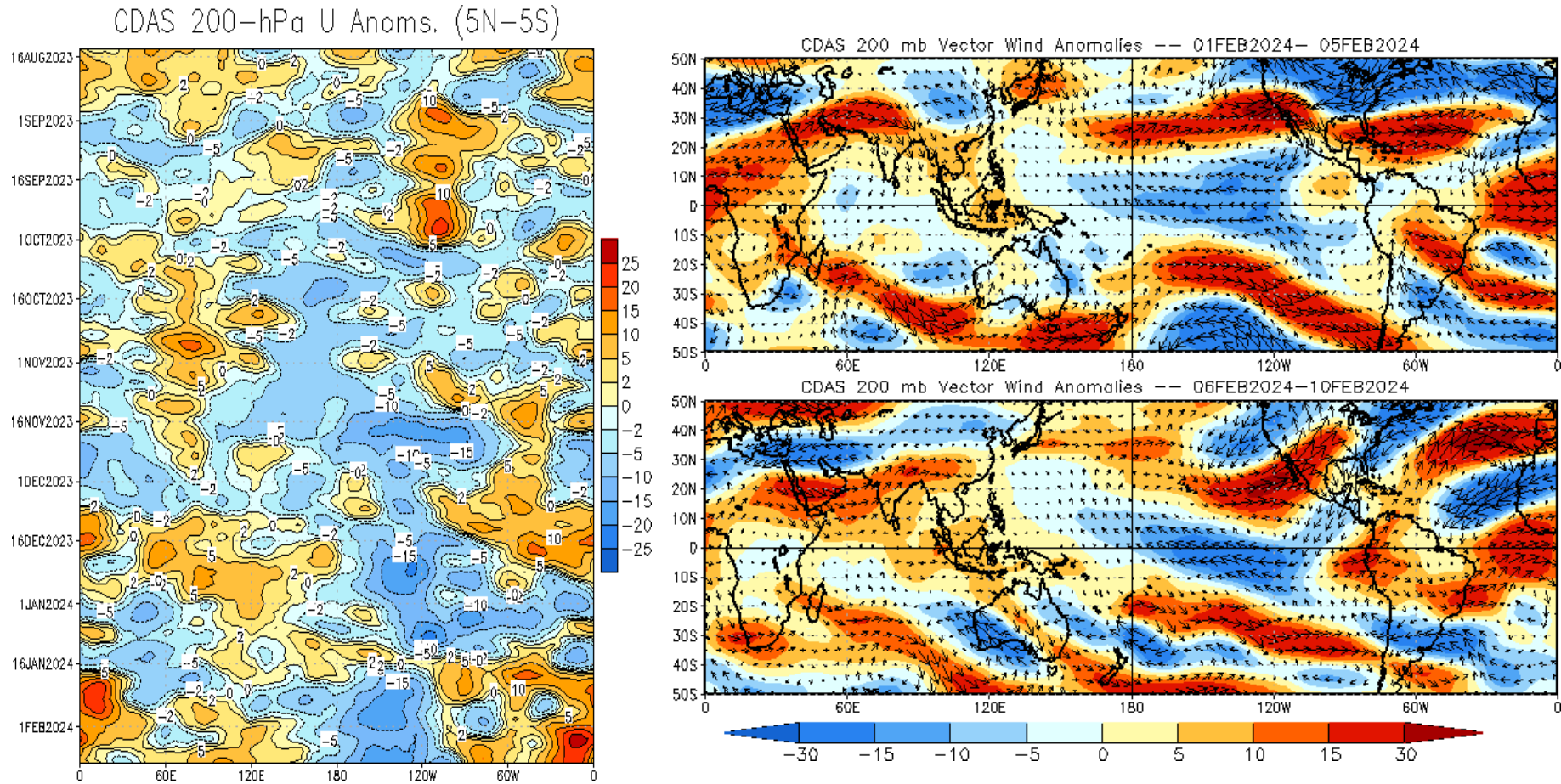
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- The upper-level velocity potential anomaly fields have become less coherent during the past week, with other modes of tropical variability contributing to the breakdown of the wave-1 pattern observed earlier in February.
- A westward shift of the enhanced and suppressed divergence envelopes suggest Rossby wave interference, but intraseasonal activity appears to have since resumed its eastward propagation more recently.

200-hPa Wind Anomalies

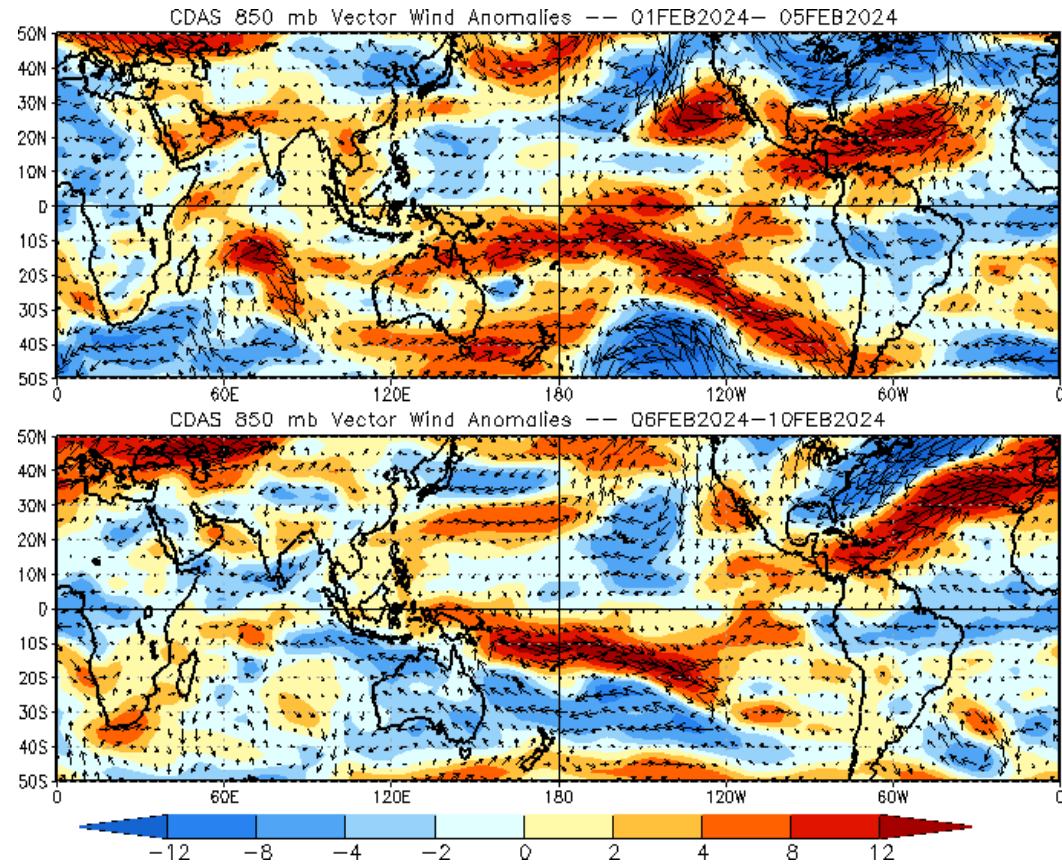
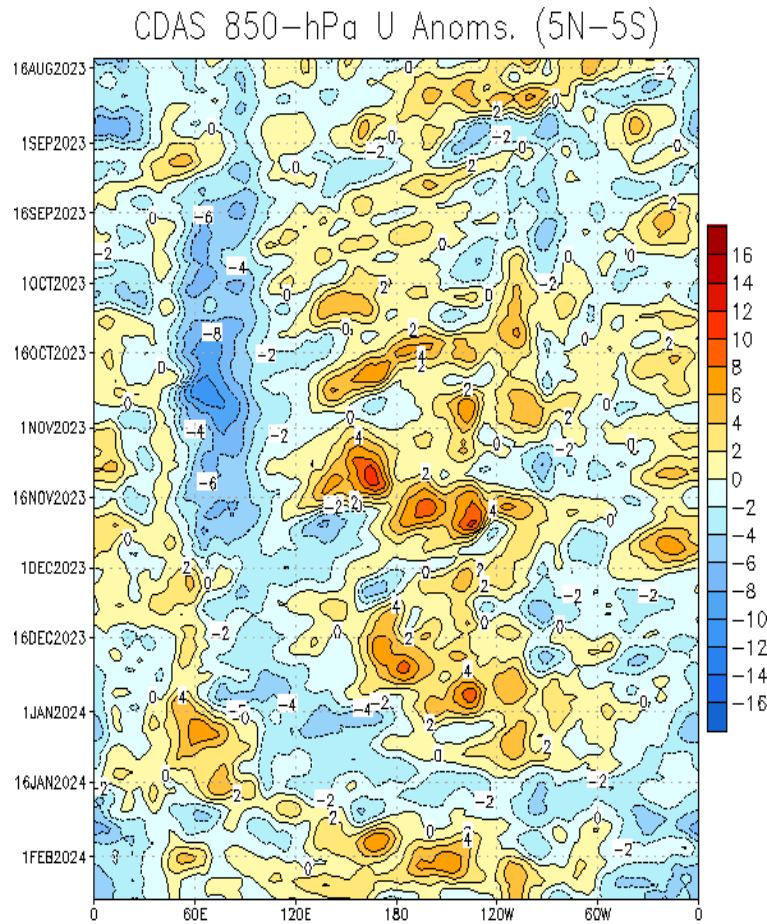
Shading denotes the zonal wind anomaly. **Blue shades: Anomalous easterlies.** **Red shades: Anomalous westerlies.**



- 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.

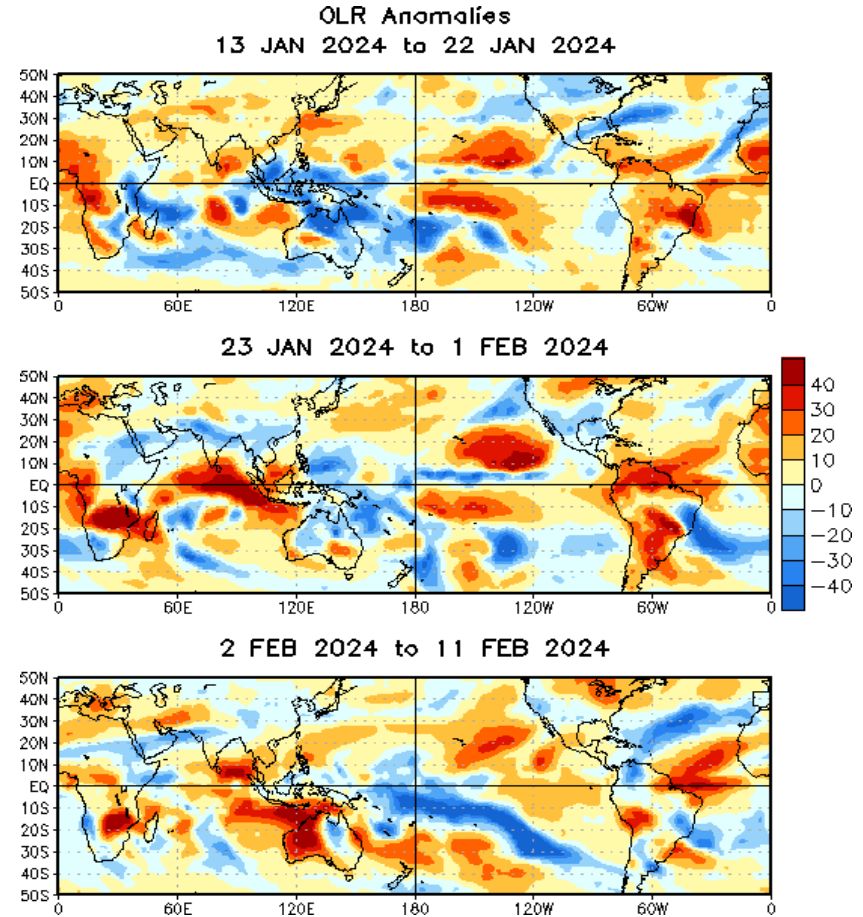
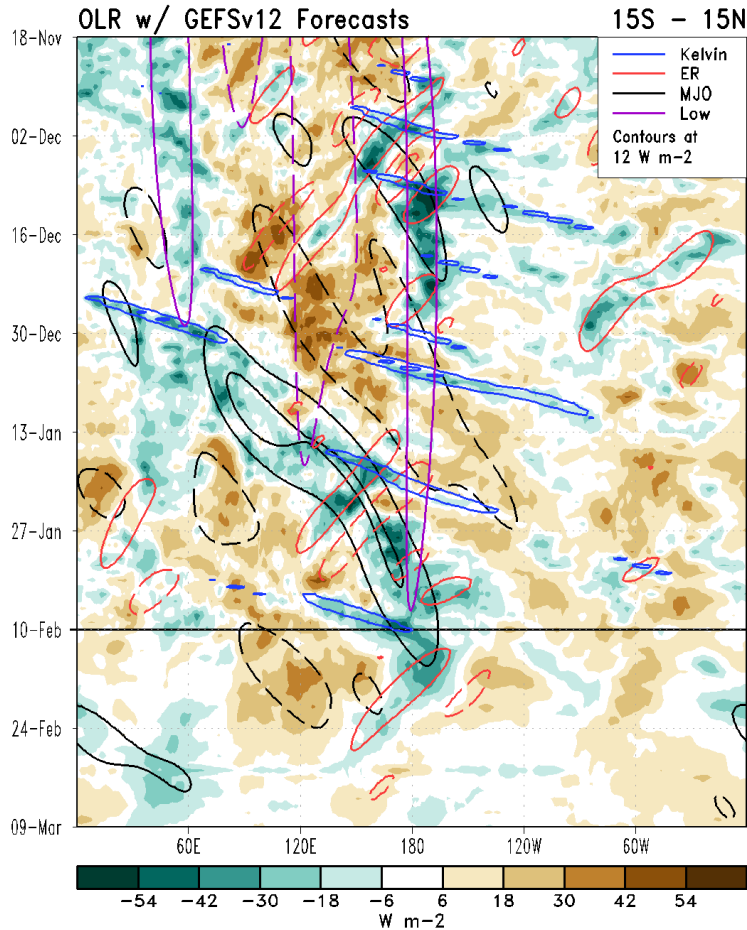


- Anomalous low-level westerlies propagated across the Pacific at relatively fast phase speed. A resurgence of westerlies is observed near the Date to the south of the equator, which has likely contributed to a pair of tropical cyclones forming in the South Pacific during the past week.
- Zonal wind anomalies appear mixed over the equatorial Indian Ocean, though trades did strengthen in the eastern portion of the basin 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

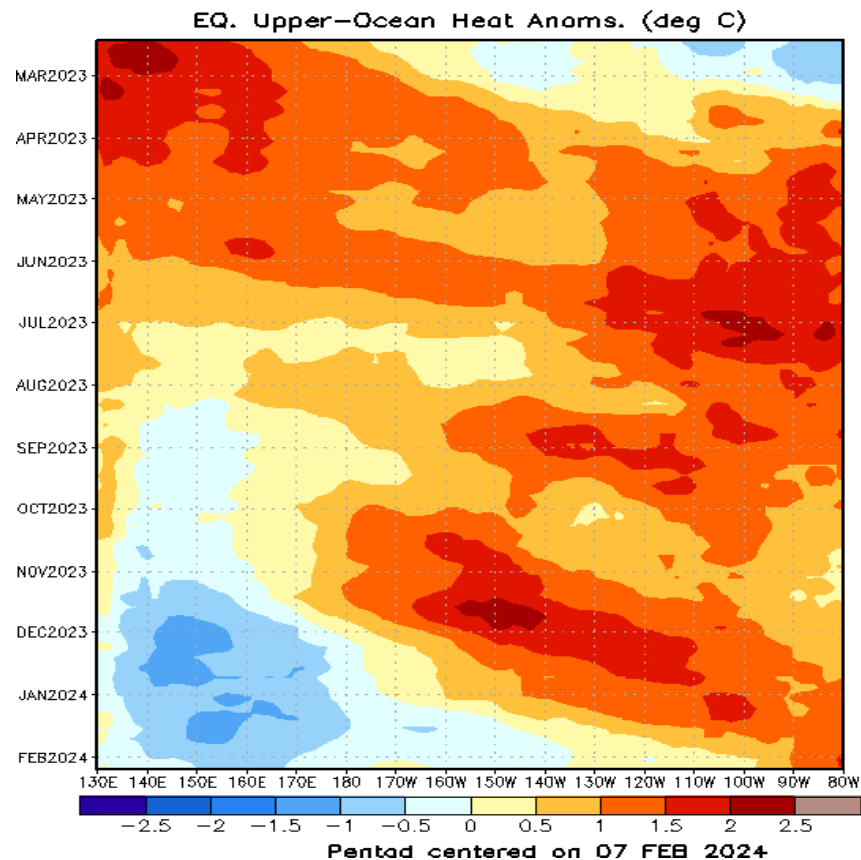
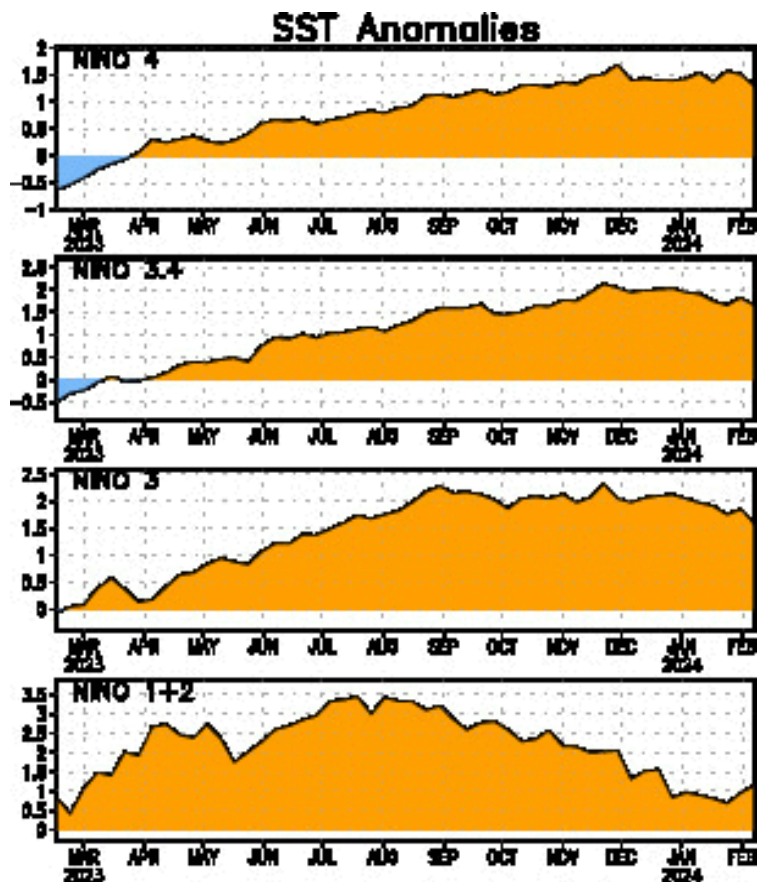
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- A robust MJO signal is apparent through the OLR filtering since last year, and is 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. The convective outlook appears to be at odds with the RMM forecasts.

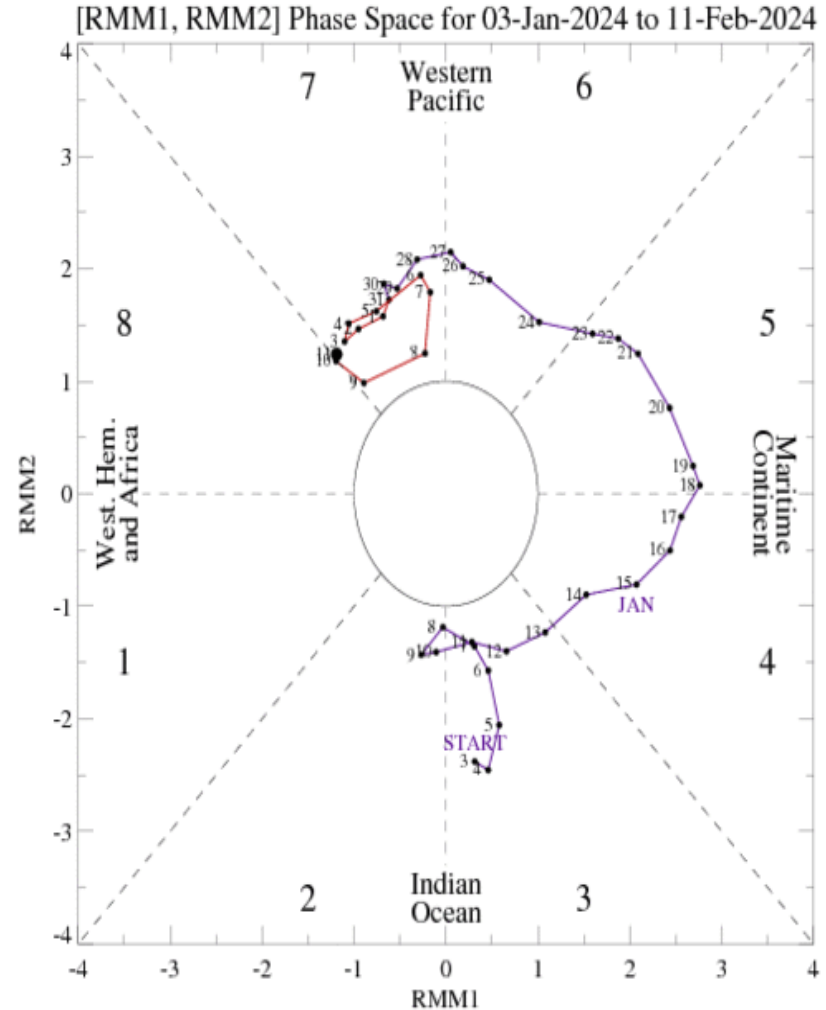
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- SSTs remain generally steady in the Niño regions, with a larger downward trend observed in the Niño 1+2 region over the past few months.
- Negative upper-ocean heat content anomalies have expanded eastward to 140°W since late January.
- Both the warm and cold subsurface anomalies appear weaker overall compared to earlier this winter.

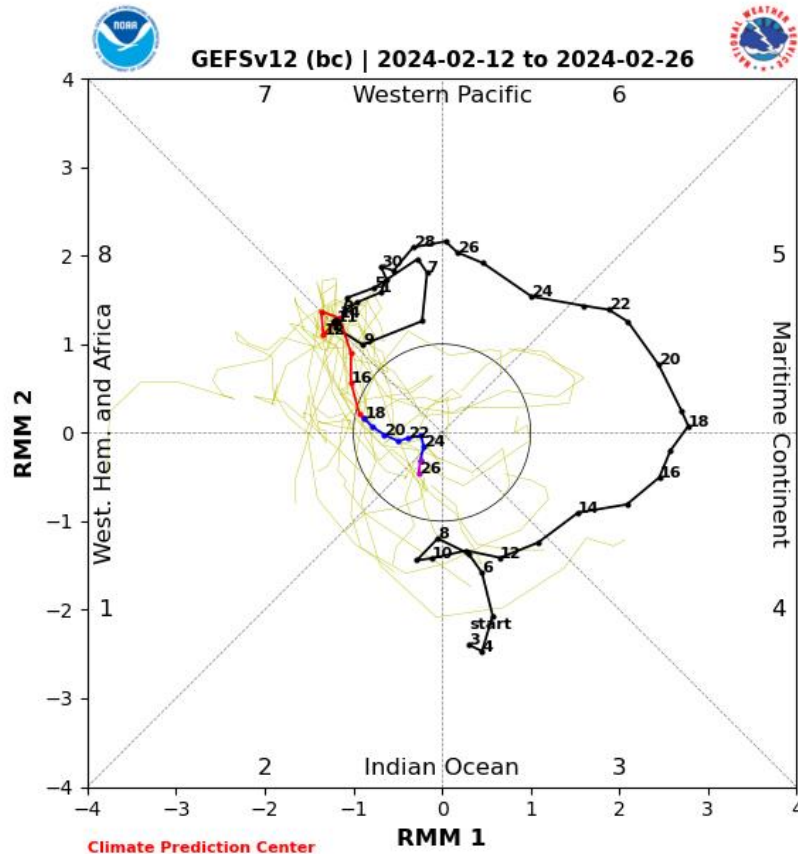
MJO Index: Recent Evolution

- The RMM-based MJO index shows a westward retreating signal earlier this month, followed by a fast eastward propagating signal during the past few days. The signal is currently along the interface between phases 7 and 8.

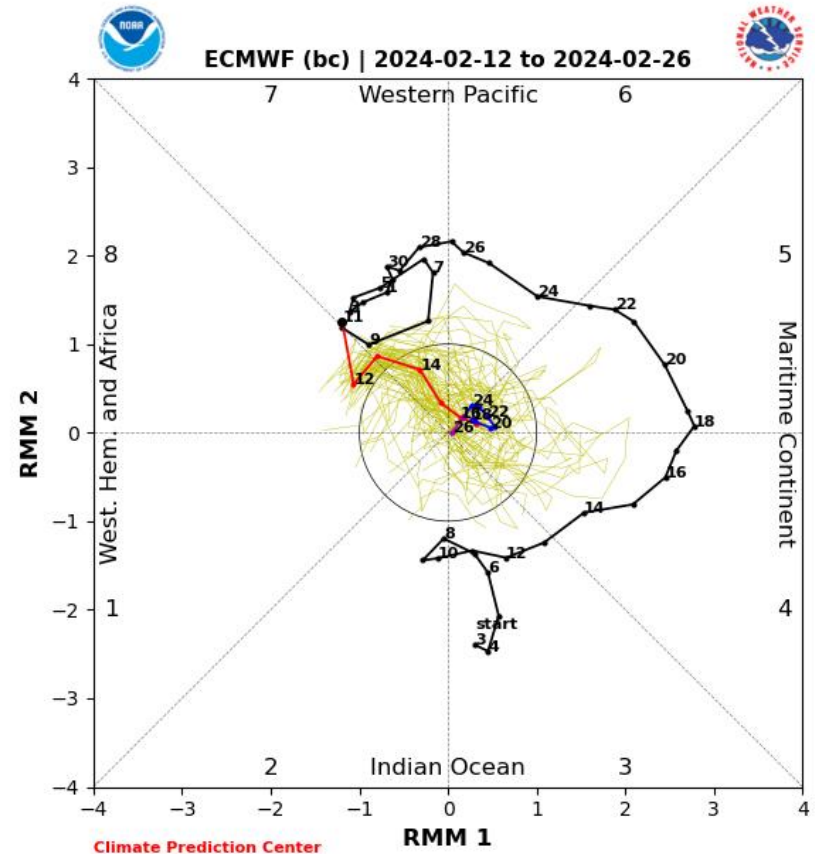


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



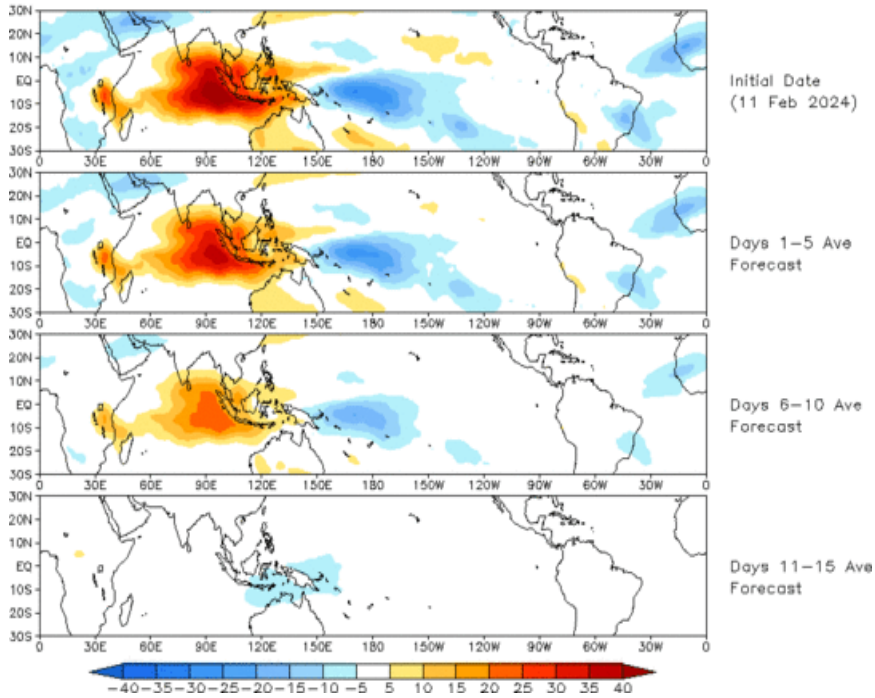
ECMWF Forecast

- While the GEFS meanders the MJO signal between phases 7 and 8 during next week, both models favor an incoherent MJO, with the signal falling within the unit circle during the next two weeks.
- However, a retention of the 120-day running mean in RMM computation shows indices are heavily skewed to the right due 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.

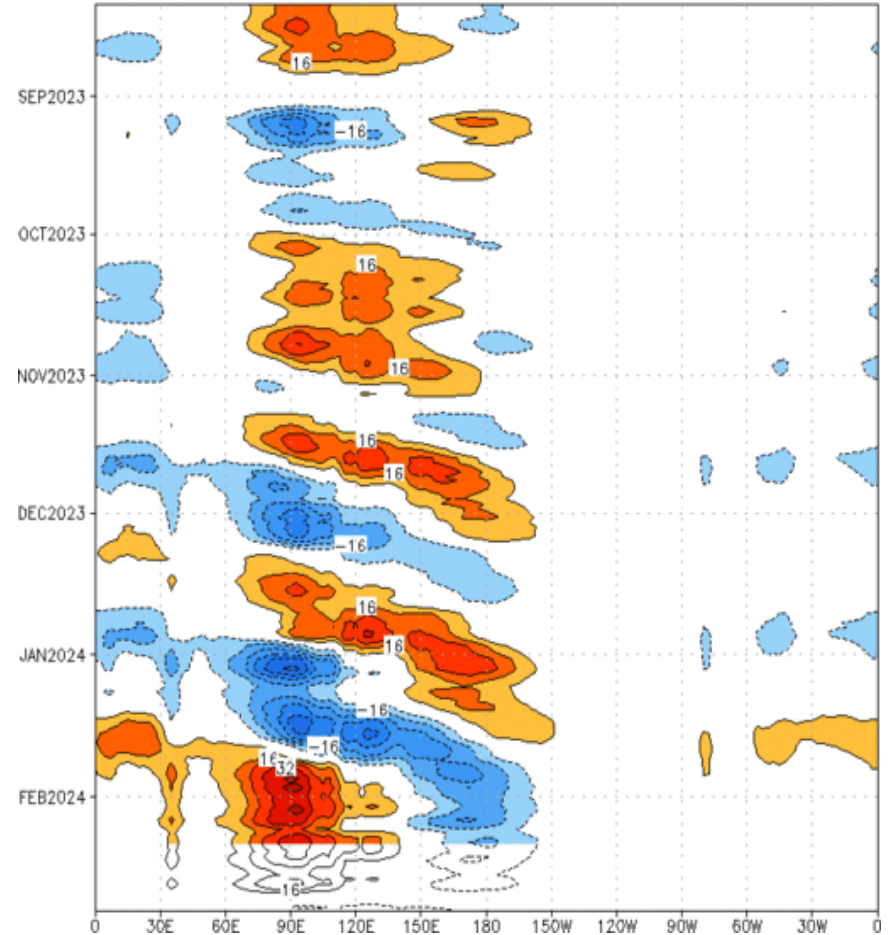
MJO: GEFS Forecast Evolution

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: 11 Feb 2024
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:12-Aug-2023 to 11-Feb-2024
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

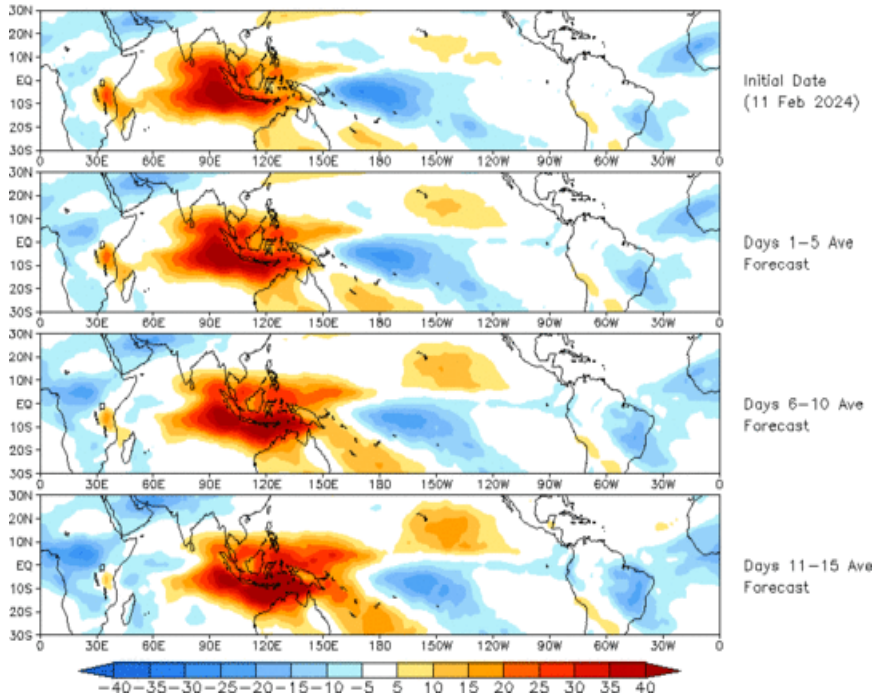


- The GEFS RMM-based OLR forecast depicts a stationary convective pattern that rapidly disappears towards the end of week-2.

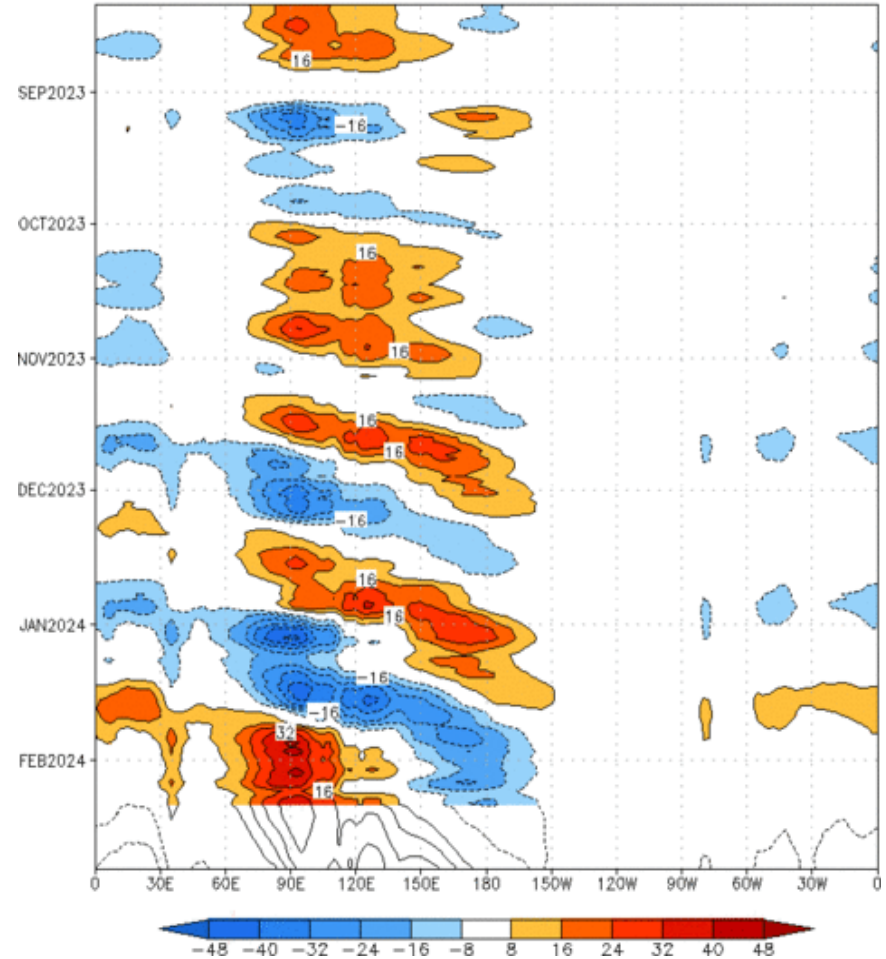
MJO: Constructed Analog Forecast Evolution

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 (11 Feb 2024)



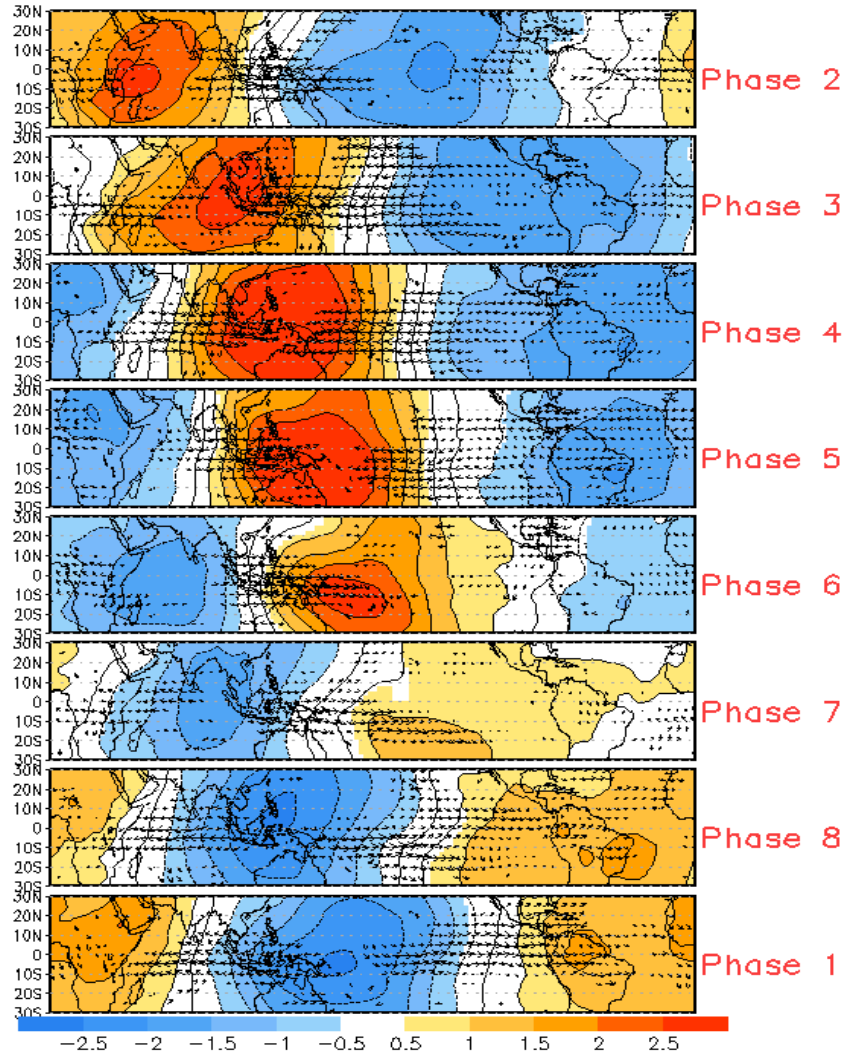
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:12–Aug–2023 to 11–Feb–2024
The unfilled contours are CA forecast reconstructed anomaly for 15 days



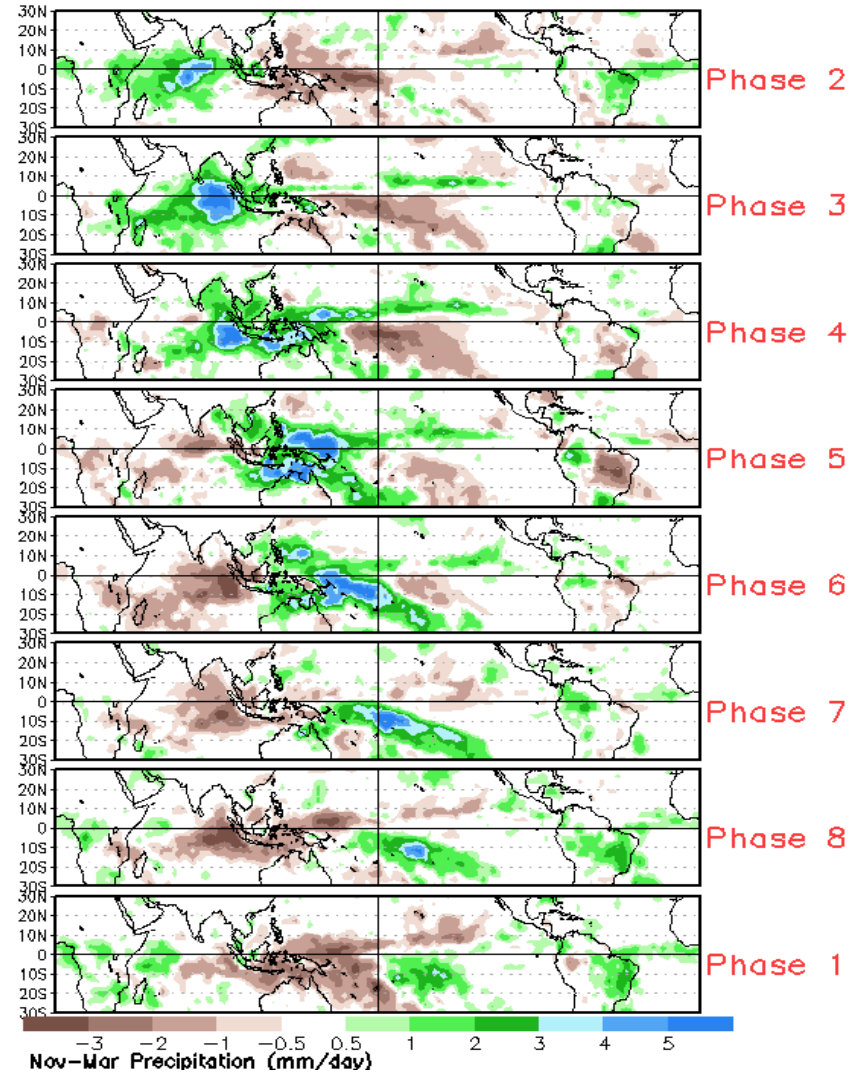
- The constructed analog (CA) RMM-based forecast suggests a more canonical Western Hemisphere MJO event, with enhanced convection eventually returning to the Indian Ocean.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



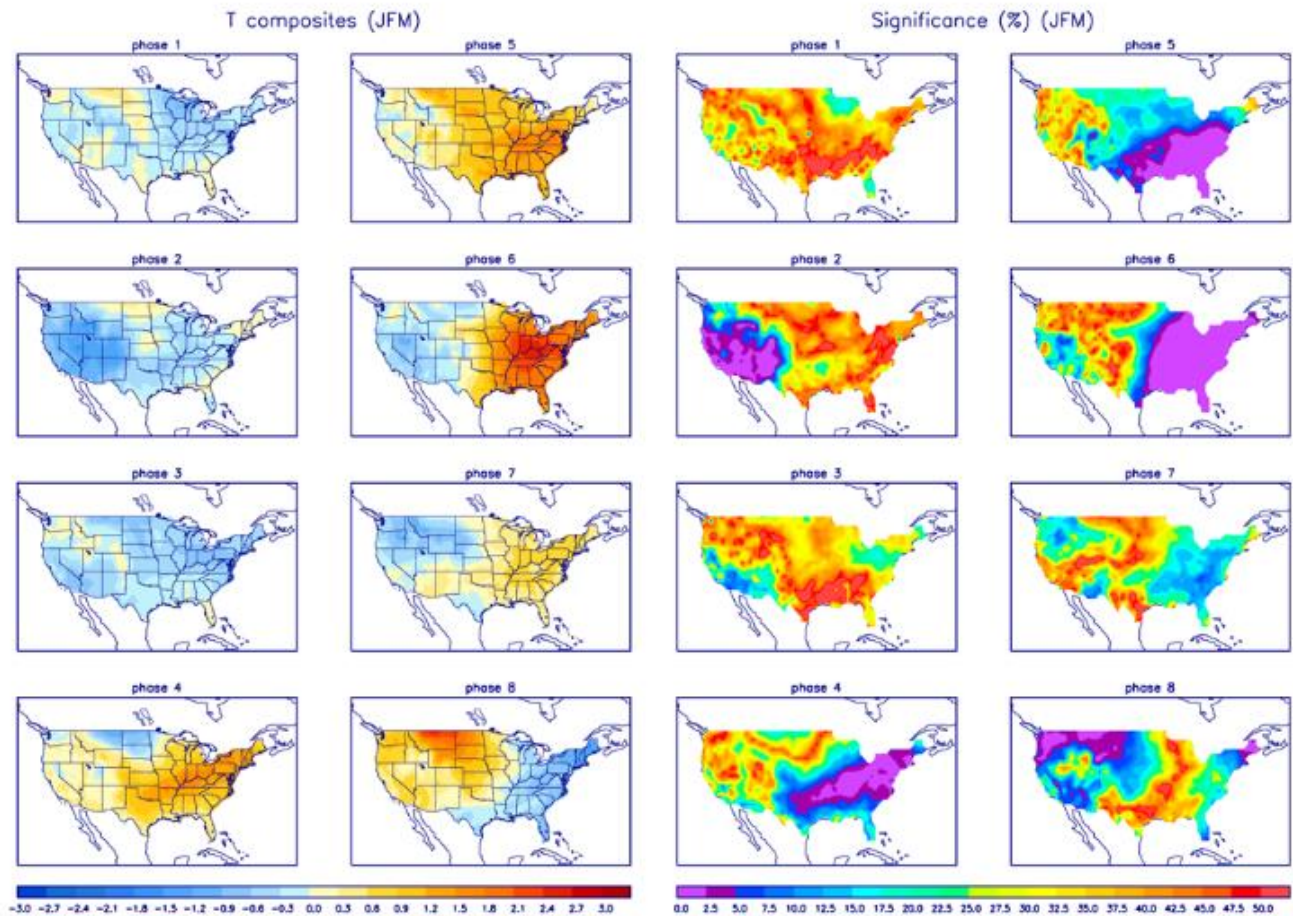
Precipitation Anomalies



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.

