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

Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
3 March 2025

Overview

- The global tropical circulation has been a little chaotic lately as multiple modes of variability have interfered with each other. However, a wave-2 structure has begun to emerge in recent days.

- Dynamical model RMM forecasts favor the return of eastward propagation of the MJO signal into Phase 2 during Week-1 and approaching the Maritime Continent later in March.

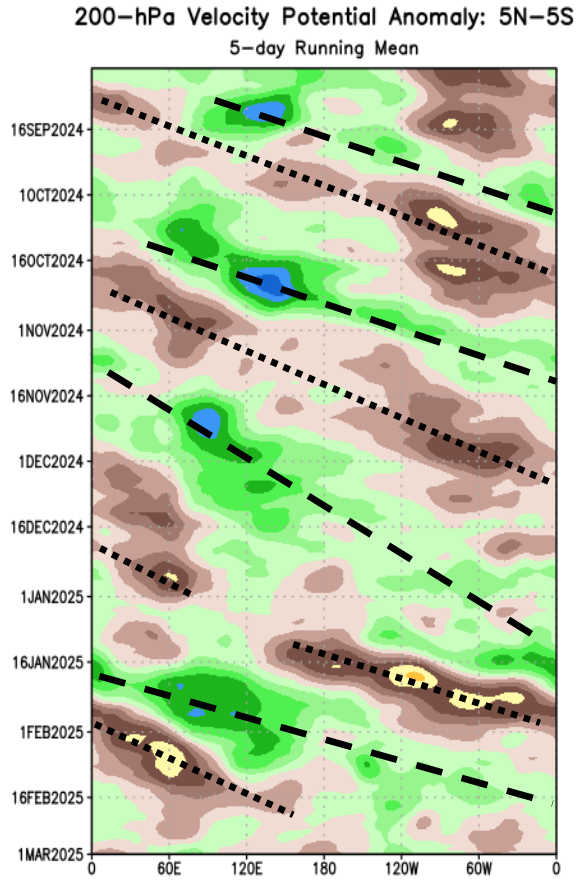
- Given the MJO evolution, tropical cyclone (TC) development is favored in the western Indian Ocean (IO) during week-2 and shifting to the eastern IO in week-3. Model guidance also indicates an enhanced potential for TC formation north of Australia and westward into the South Indian during week-3.

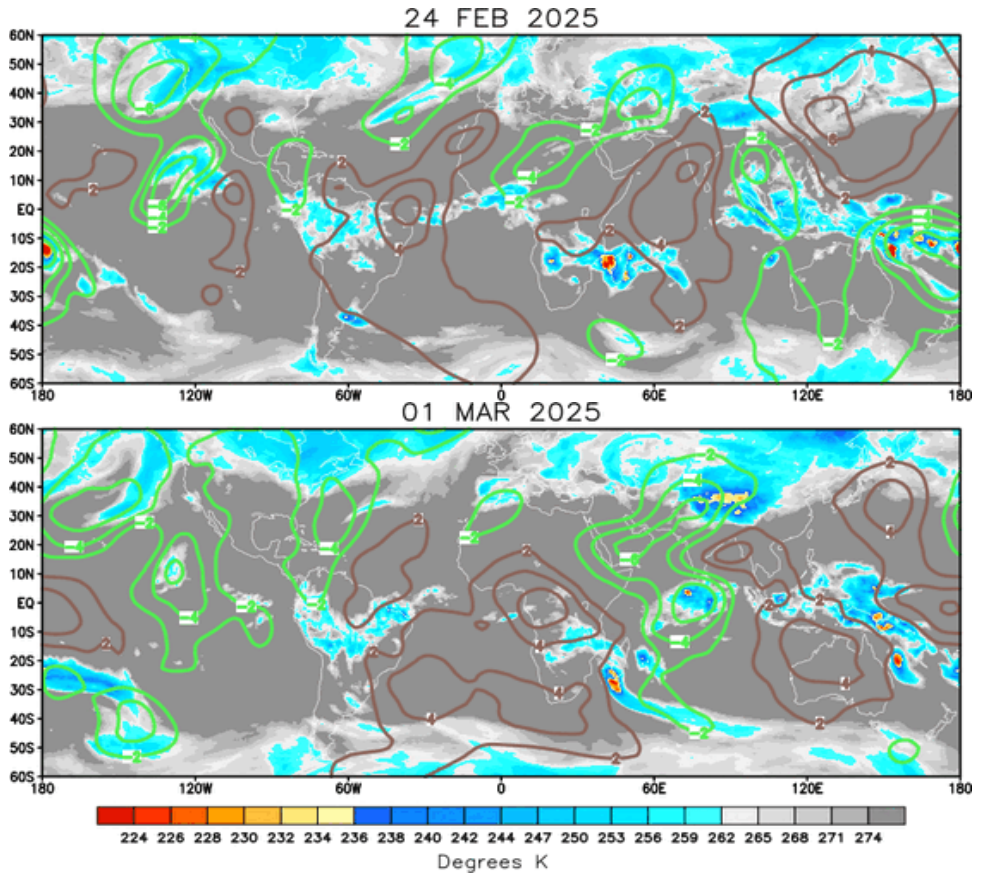
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

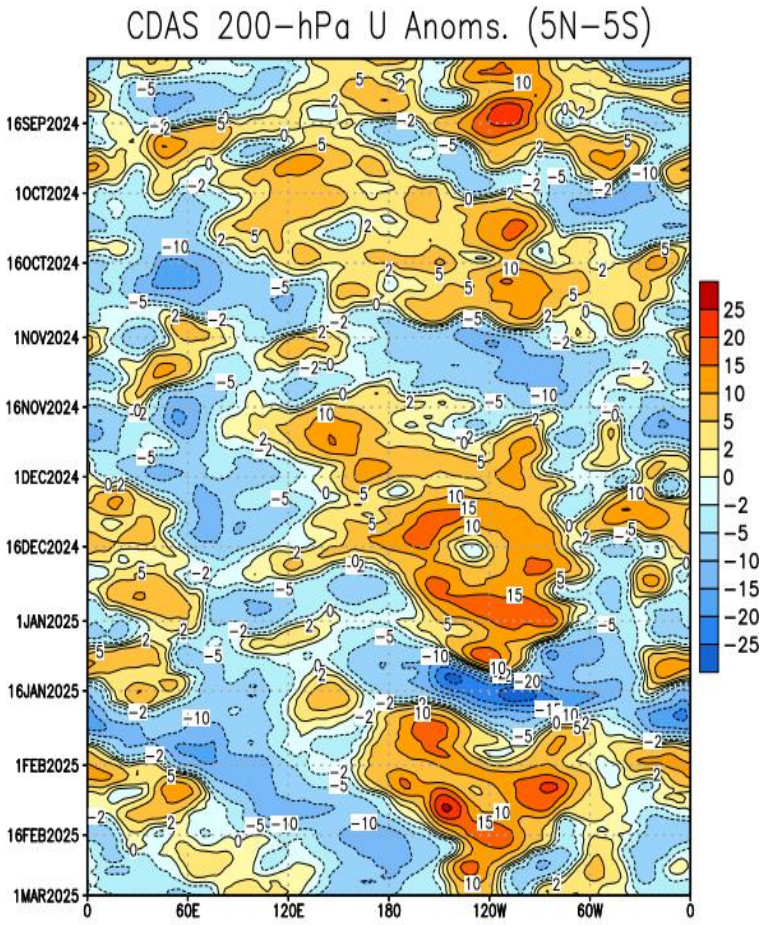


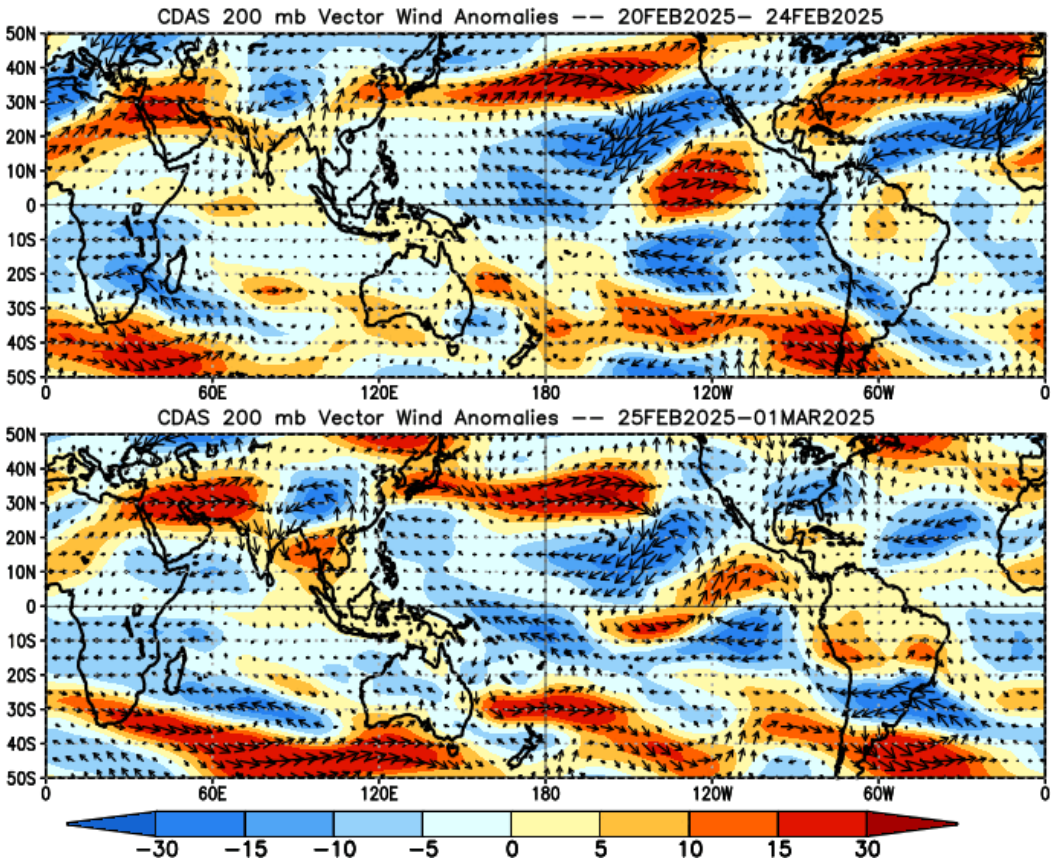


- After a very robust MJO signal beginning in early January, the associated wave-1 asymmetry broke down in mid-February, yielding to a rather chaotic pattern as depicted in 200-hPa velocity potential anomaly and Hovmoller plots.
- Most recently, a wave-2 pattern has begun to emerge, with anomalous divergence (convergence) over the Indian Ocean and Eastern Pacific (Africa and Western Pacific)

200-hPa Wind Anomalies

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

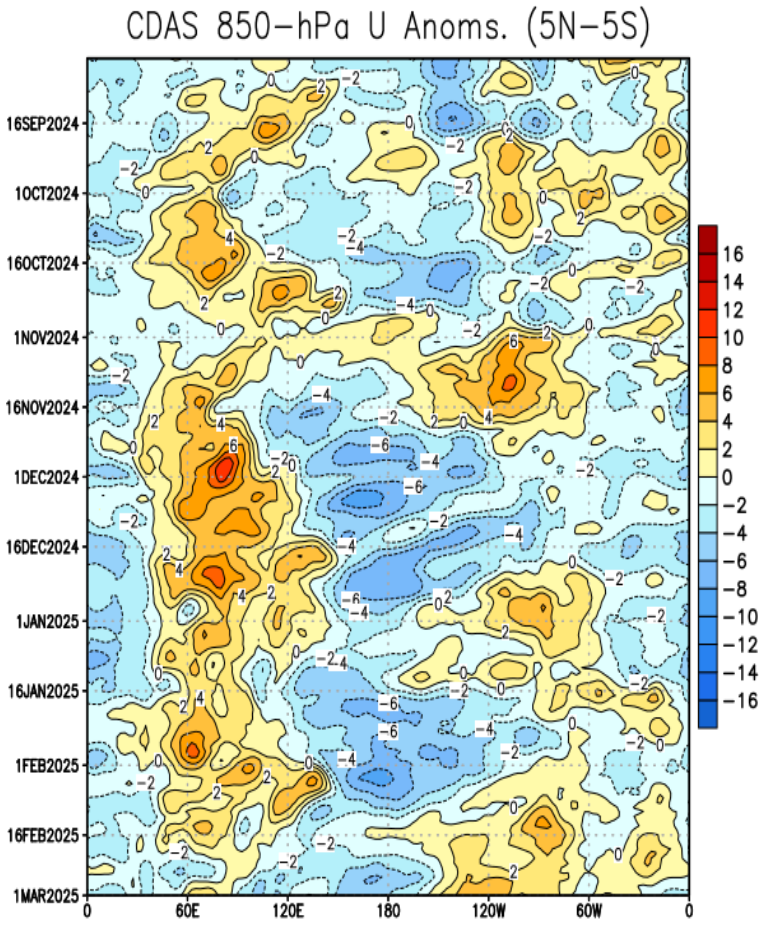


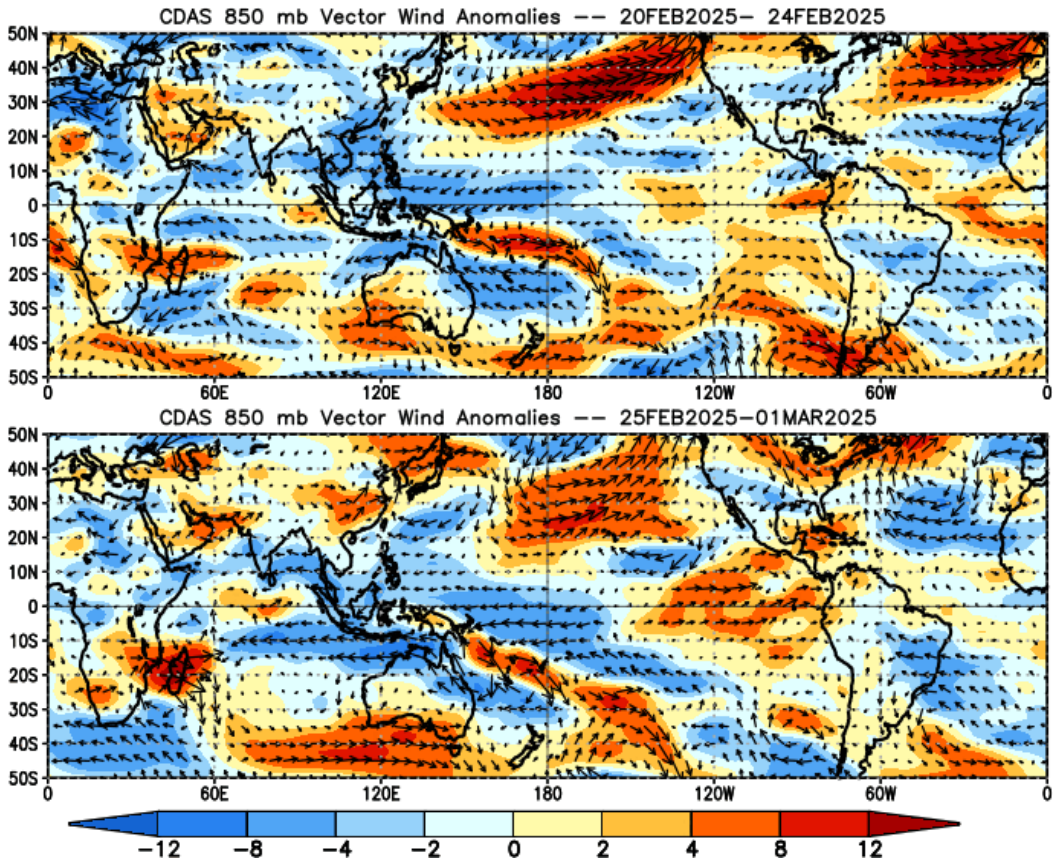


- The most recent wave of upper-level easterly anomalies associated with the MJO did not hold up against the La Nina footprint nearly as well as previous waves, likely related to the recent breakdown of the wave-1 asymmetry.
- The strong Northern Hemisphere jet feature over the Pacific has recently been subject to blocking along the West Coast.

850-hPa Wind Anomalies

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

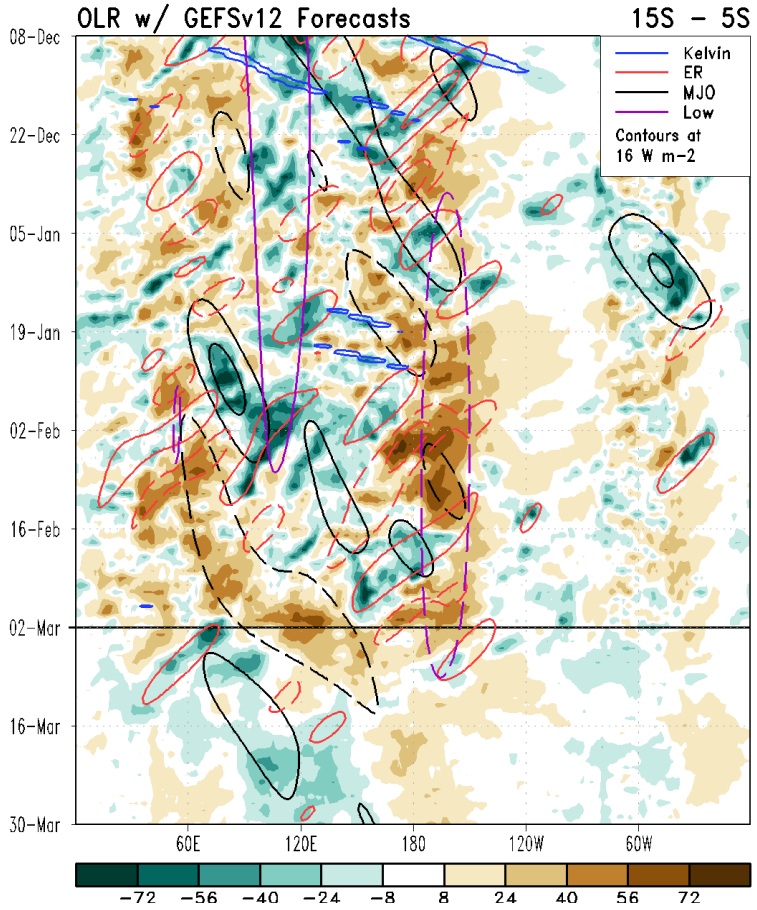


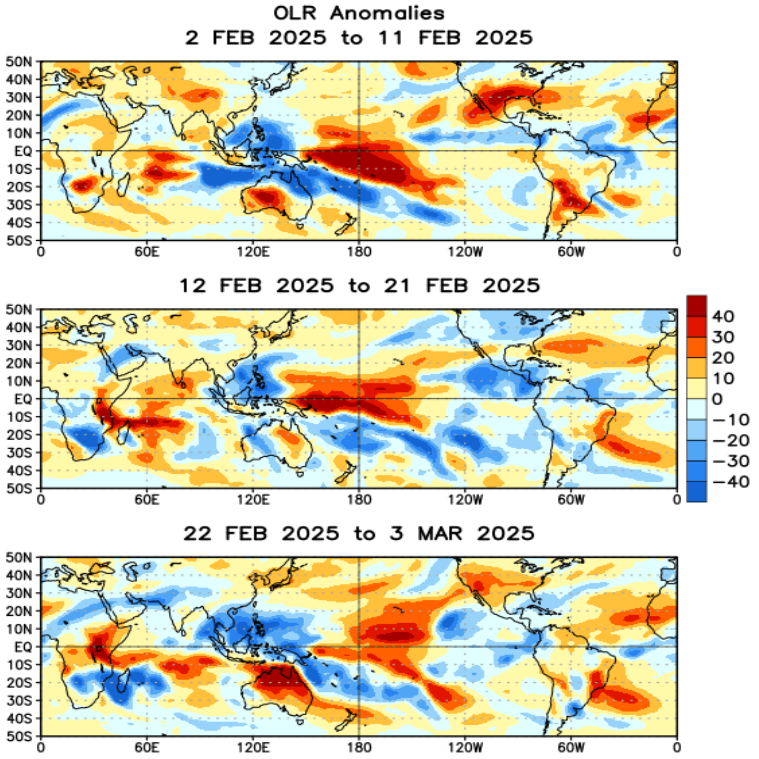


- Enhanced trades remain near and west of the Date Line, but anomalous westerlies over the Eastern Pacific have continued and intensified recently.
- Anomalous easterlies have persisted over the southeastern Indian Ocean, and persistent anomalous westerlies near 60°E have weakened substantially.
- Broad cyclonic circulation is noted over the North Pacific.

Outgoing Longwave Radiation (OLR) Anomalies

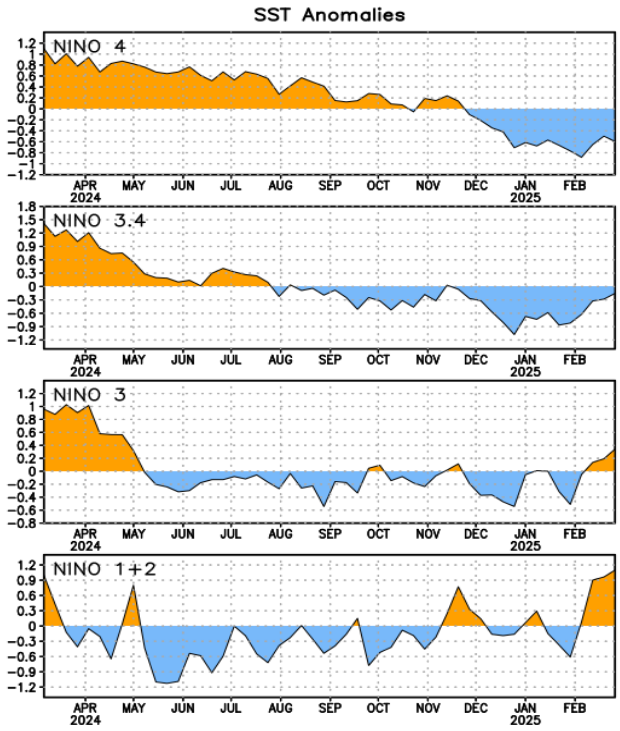
Green shades: Anomalous convection (wetness)
Brown shades: Anomalous subsidence (dryness)

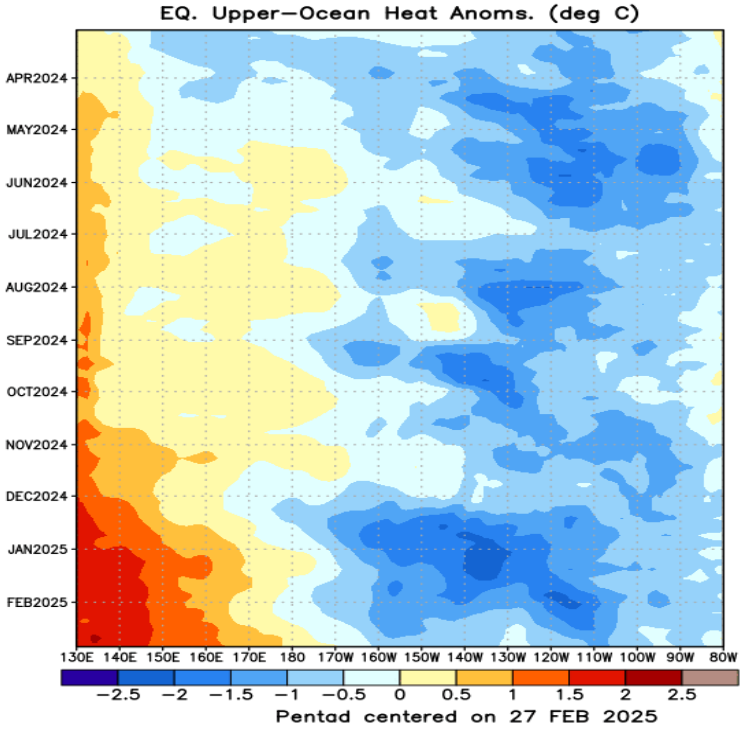




- The OLR Hovmoller reveals a complex picture recently, with substantial Rossby wave activity interacting with both the La Niña base state as well as the MJO. The GEFS forecast indicates a reemergence of the MJO with constructive interference from La Niña.
- The La Niña base state is very pronounced in OLR anomalies. Also noteworthy is enhanced convection over and around Central America.

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

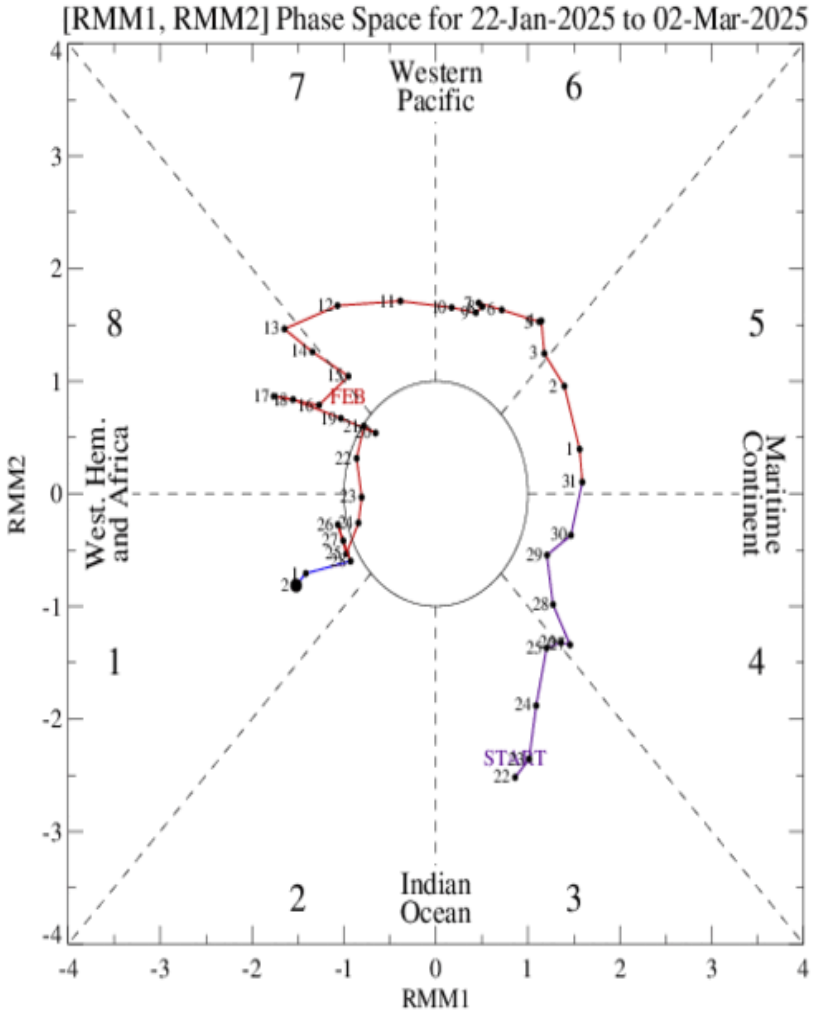




- The uptick in sea surface temperature (SST) anomalies across all four regions continued with NINO 3 becoming positive.
- Positive subsurface heat content anomalies have extended eastward back to the Dateline while maintaining a strong signal over the Western Pacific. The negative subsurface heat content anomalies have weakened in February.

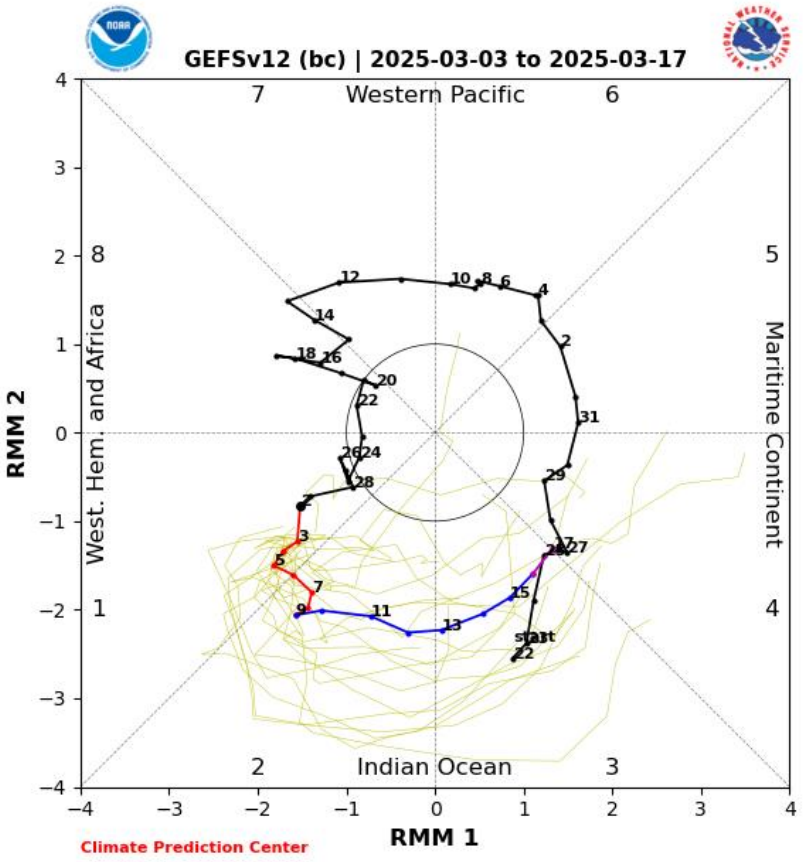
MJO Index: Recent Evolution

- Up until mid-February, the RMM index has depicted coherent MJO activity, with the signal consistently remaining outside the unit circle and nearly completing a full global circumnavigation since mid-January.
- However over the past two weeks, the signal has stalled in Phase 8 and retreated back into the unit circle likely due to destructive interference from strong Rossby wave activity.
- Over the past week or so, the signal resumed its eastward propagation, moved into Phase 1 and has increased in amplitude over the last few days.

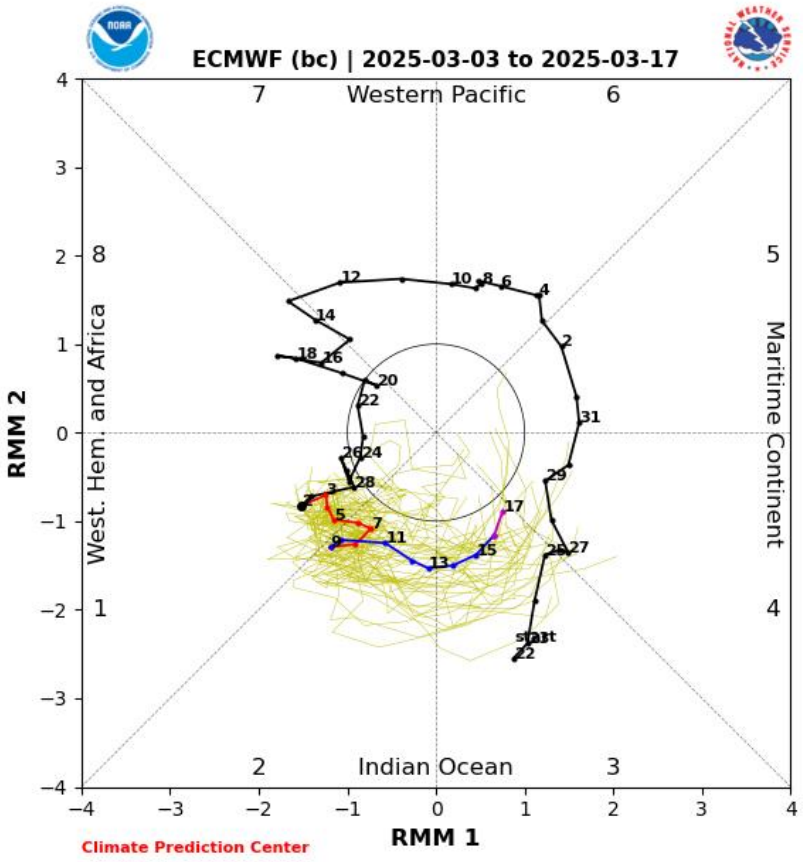


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



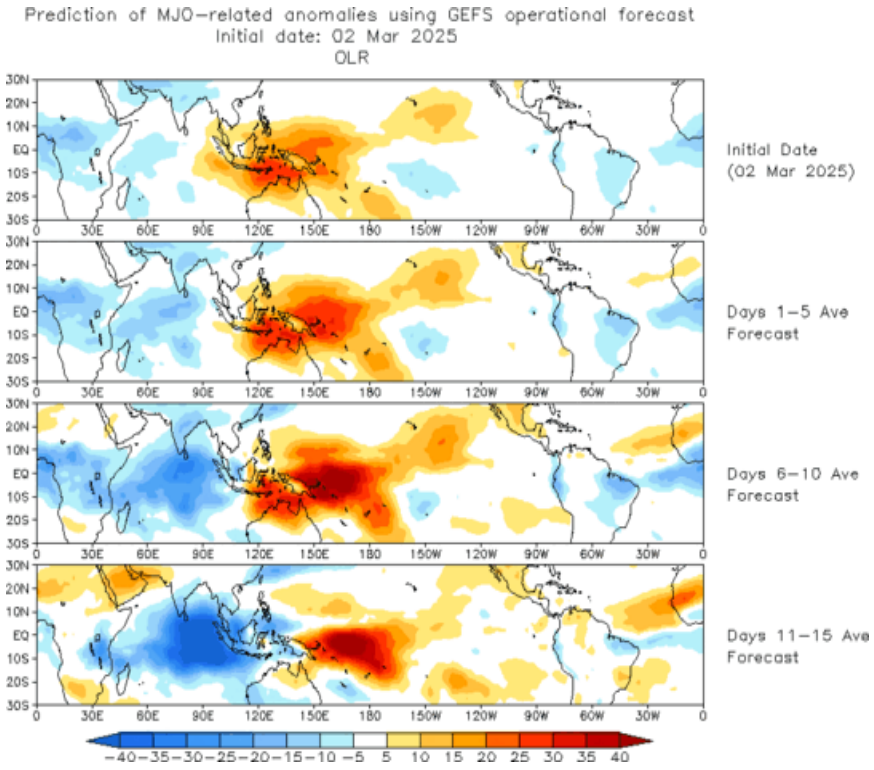
ECMWF Forecast

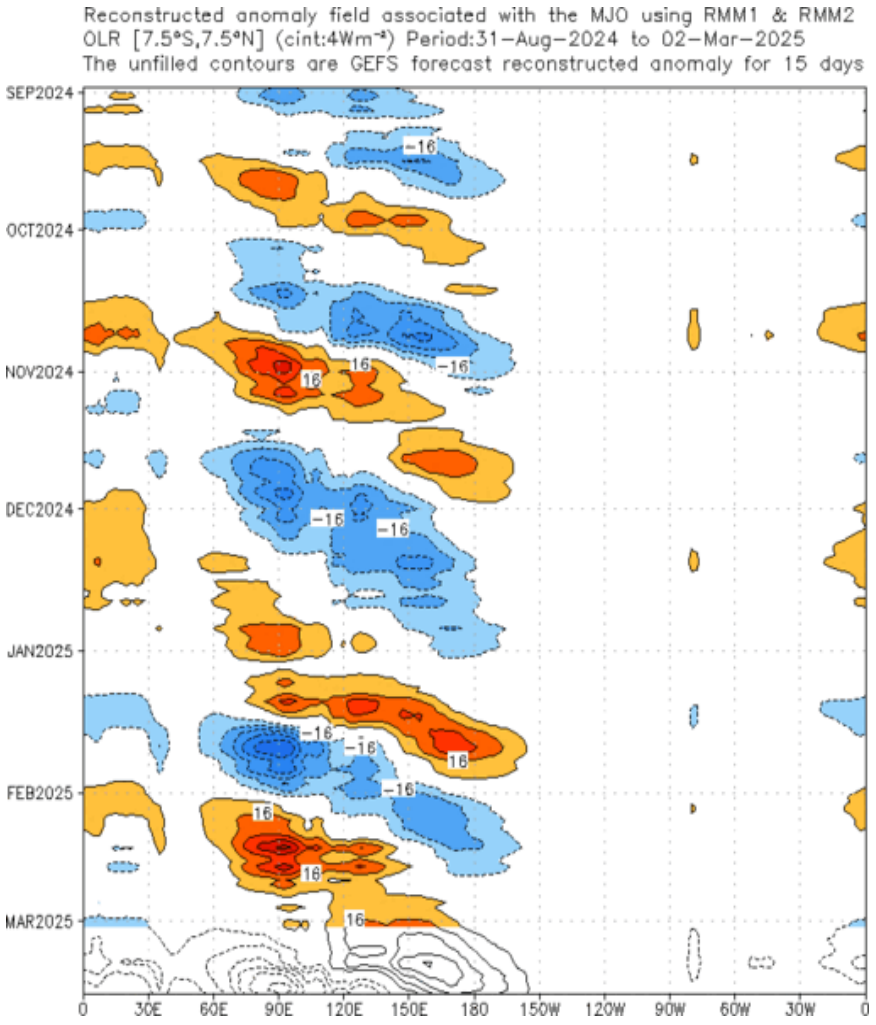
- Both the GEFS and ECMWF ensembles stall the MJO signal in phase 1 or 2 in week 1, but renew its eastward propagation into Phase 3 by the end of Week-2.

- Both models increase the signal strength during Week-1, with the GEFS favoring a strong MJO signal by week-2, as well as a faster propagation speed than the ECMWF.

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.)

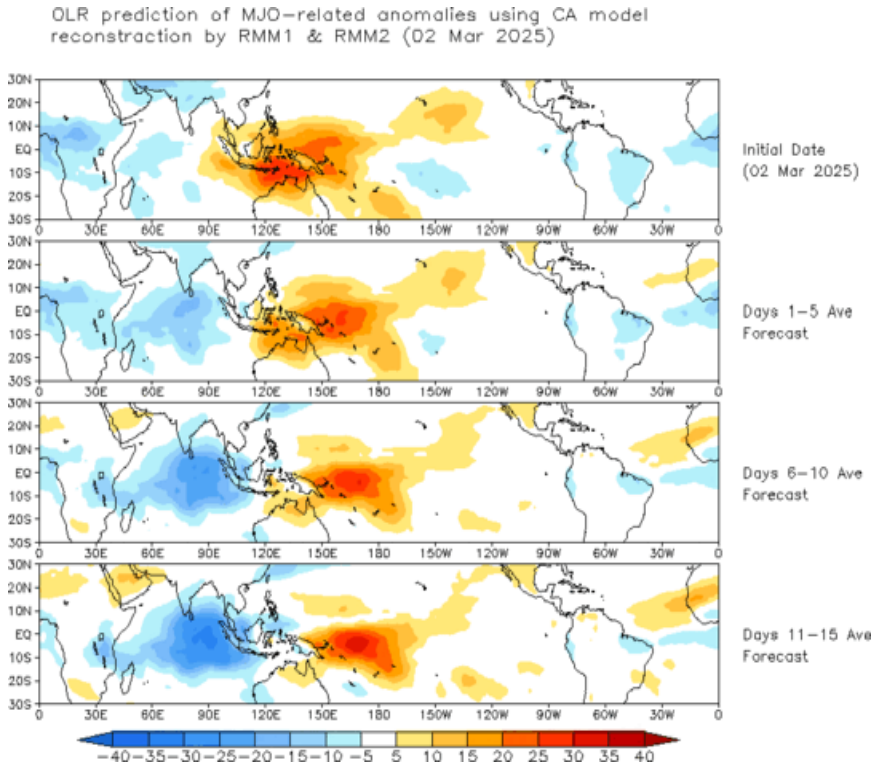


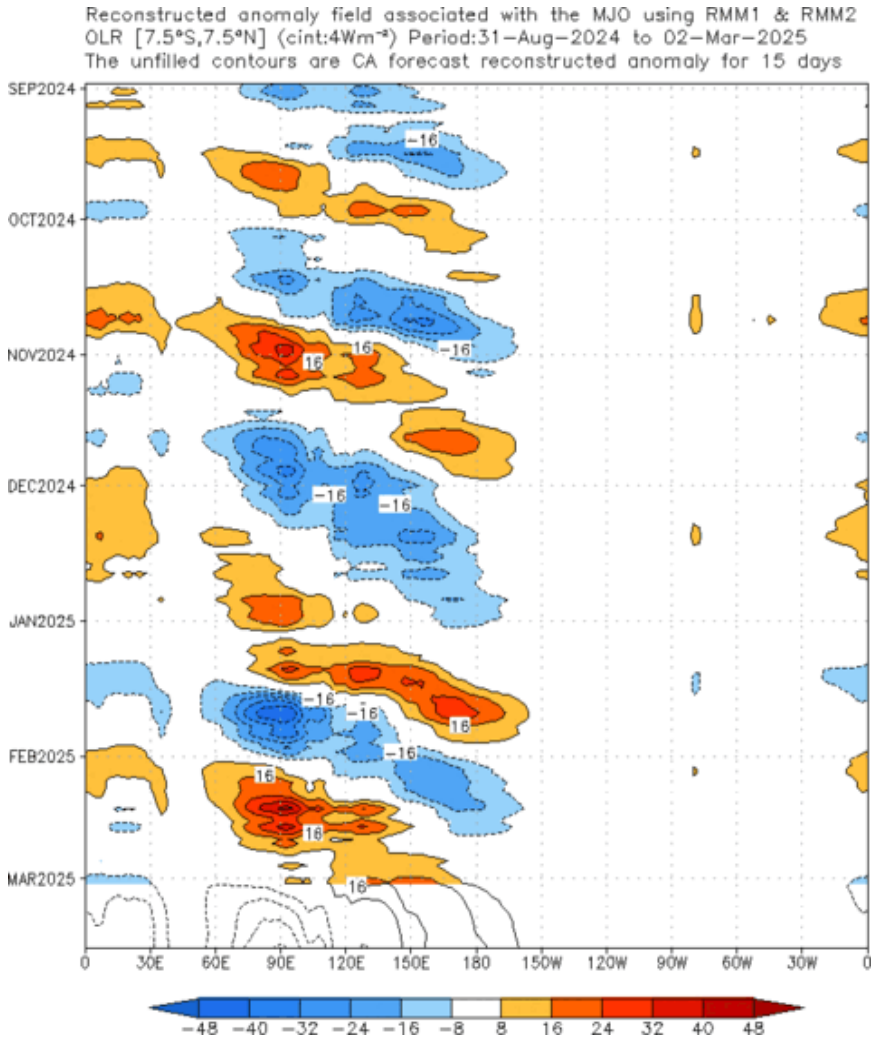


- The GEFS OLR forecast depicts positive OLR anomalies (suppressed convection) slowly propagating eastward from the Maritime Continent into the Western Pacific. Negative OLR anomalies (enhanced convection) develop over the western Indian Ocean and intensify as they approach the Maritime Continent, resulting in a strong MJO dipole.

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.)

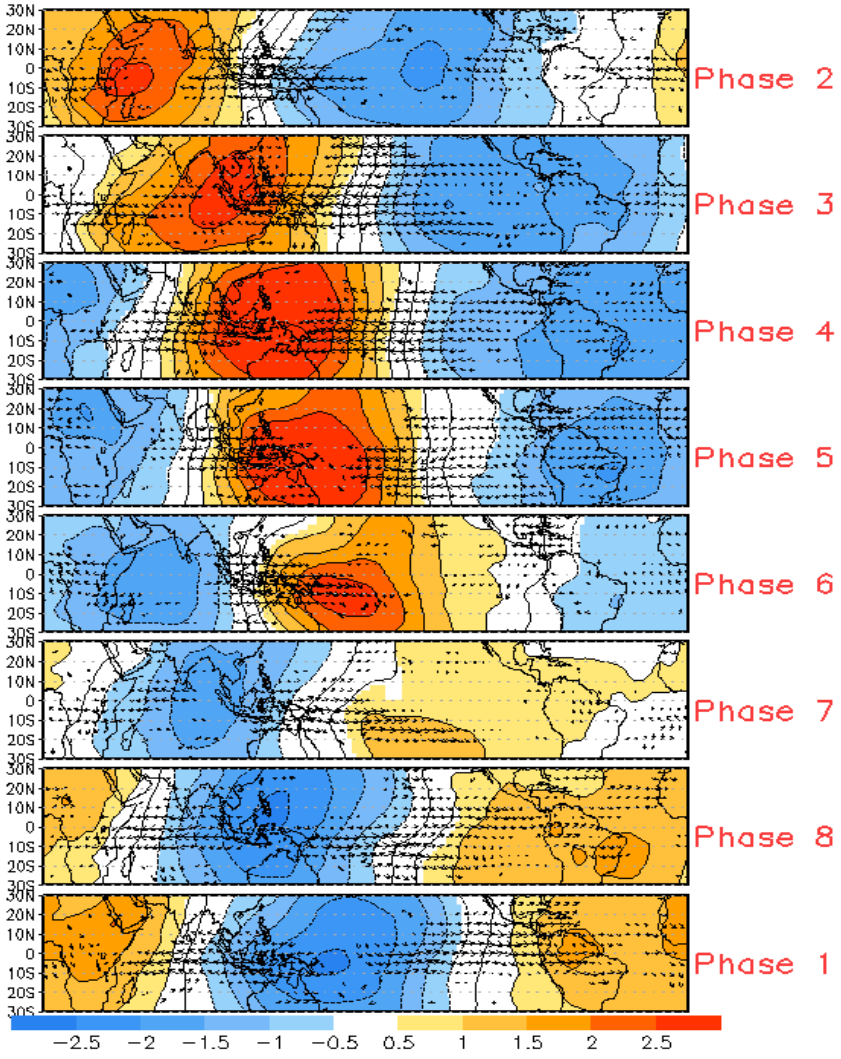




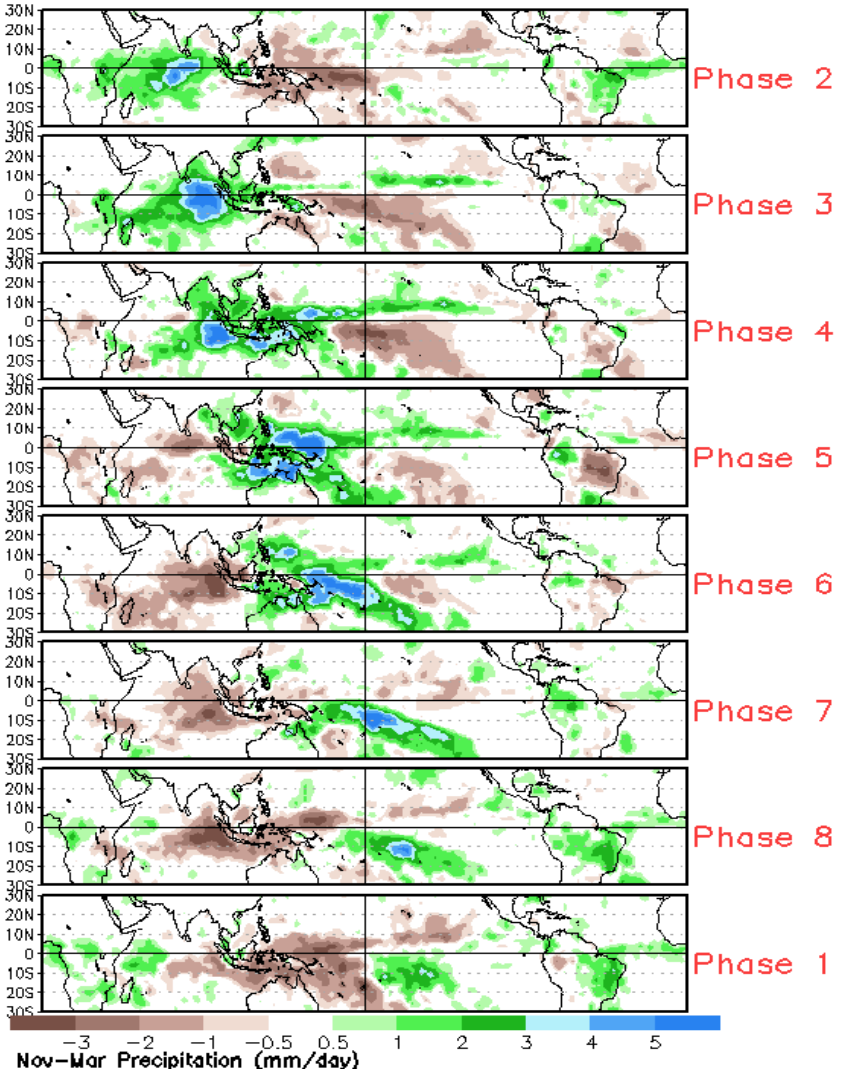
- The constructed analog forecast is very similar to the GEFS with slightly weaker anomalies.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



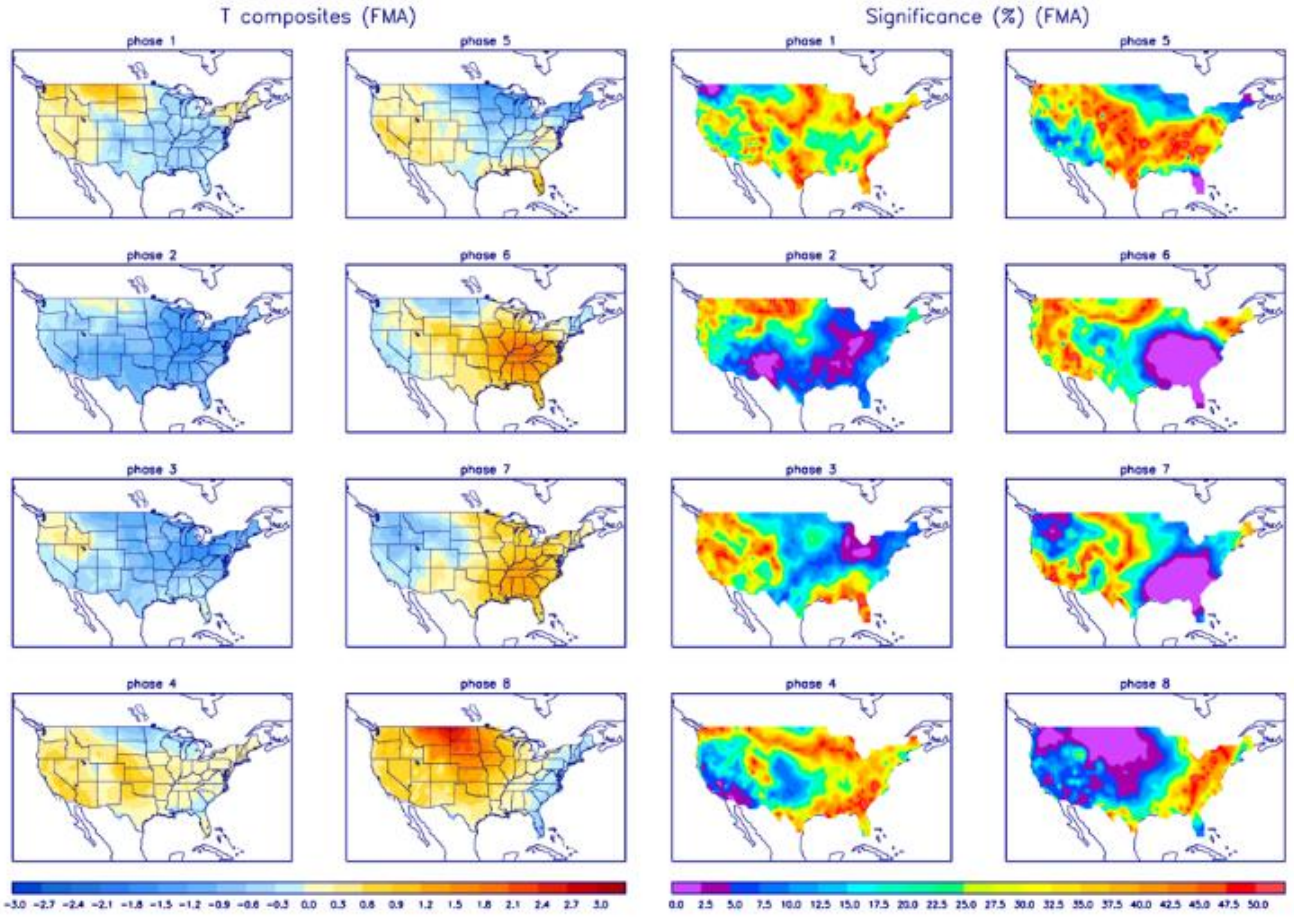
Precipitation Anomalies



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.

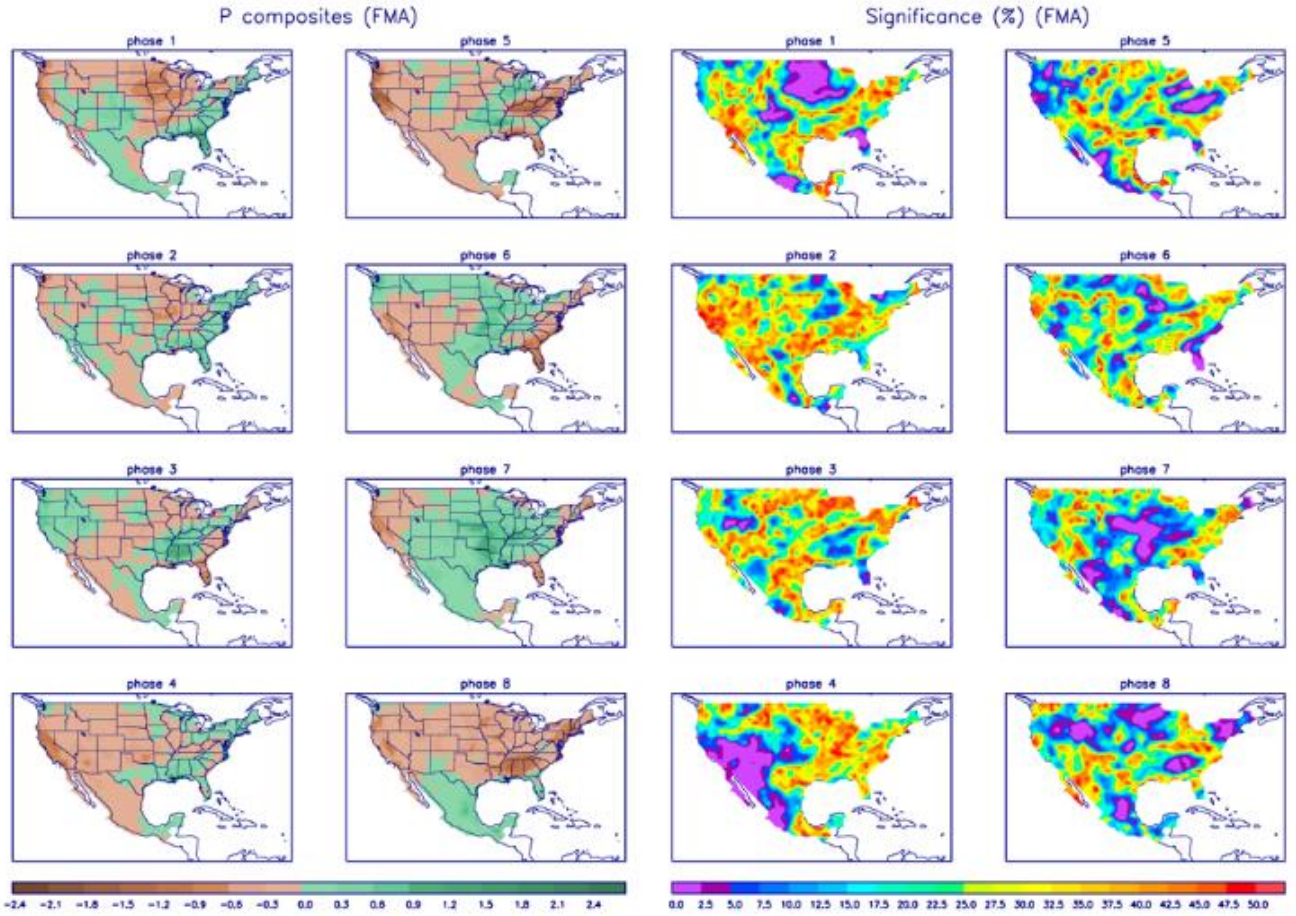


More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

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