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

Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
23 December 2024

Overview

- The MJO continues to play a substantive role in the evolution of the global tropical wind fields and convective pattern. The enhanced convective phase is currently crossing the Pacific.

- Destructive interference from both the low frequency base state trending towards La Niña and Rossby wave activity over the Maritime Continent have slowed the eastward propagation of the enhanced convective signal.

- Suppressed convection remains entrenched along the Equator near the Date Line, though enhanced convection recently overspread the Coral Sea and SPCZ region.

- Dynamical models depict a rapid progression and re-amplification of the MJO signal over the east-central Pacific, potentially due to constructive interference between the MJO and East Pacific Rossby wave activity.

- Beyond Week-2, dynamical models show continued eastward progation, but uncertainty increases whether the MJO signal will remain coherent as other modes (IOD, ENSO base state) become increasingly prominent.

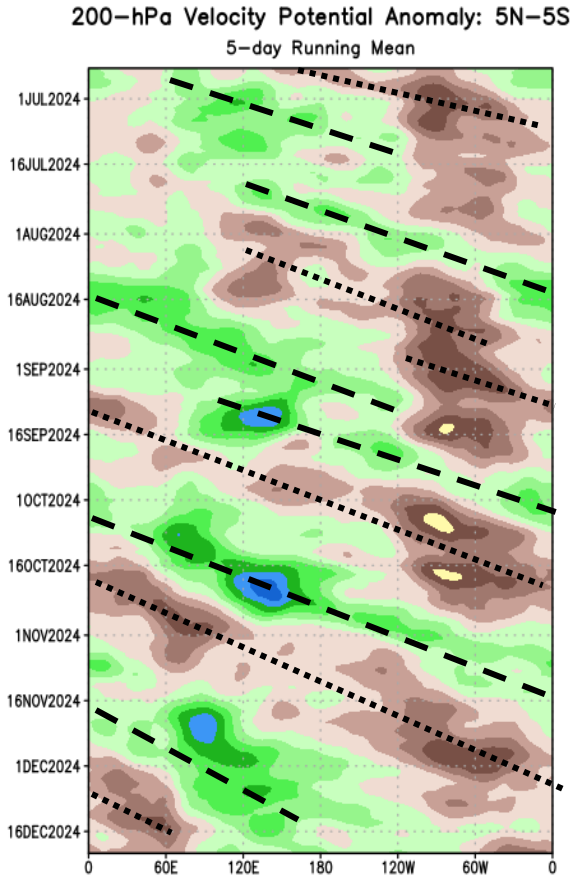
- An MJO signal crossing the Pacific tends to be associated with a pattern change favoring increased troughing over the eastern US. This pattern shift has recently become quite prominent in dynamical model forecasts for early January.

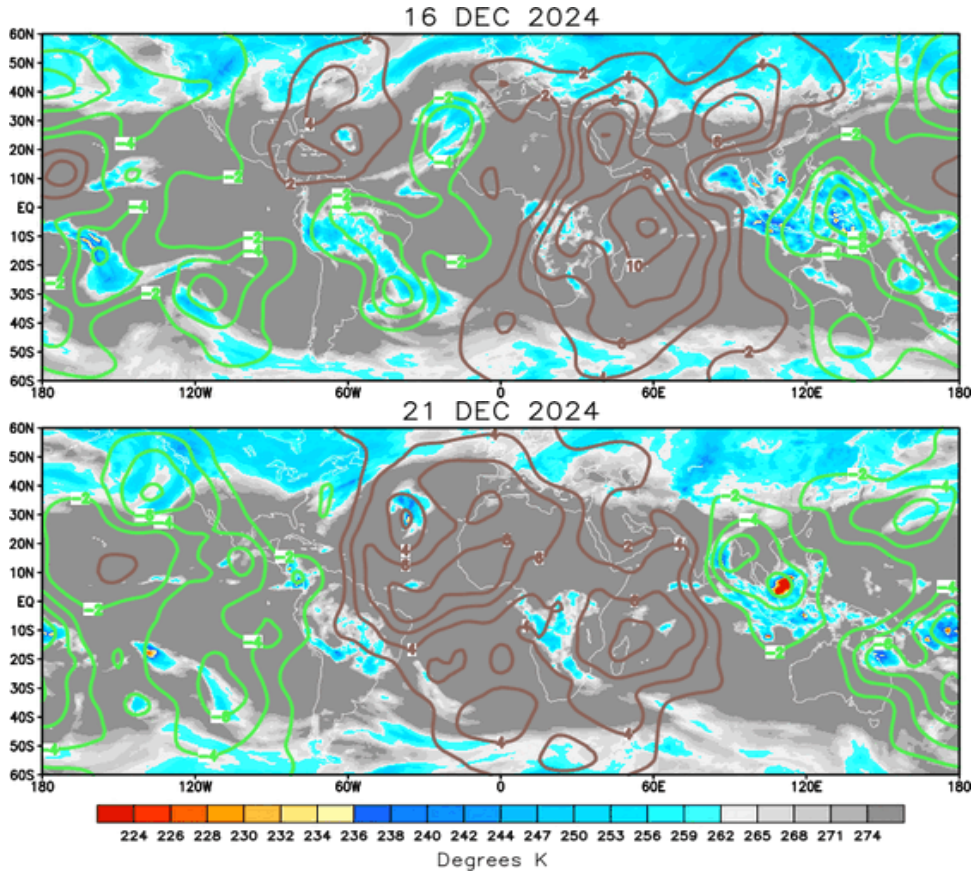
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

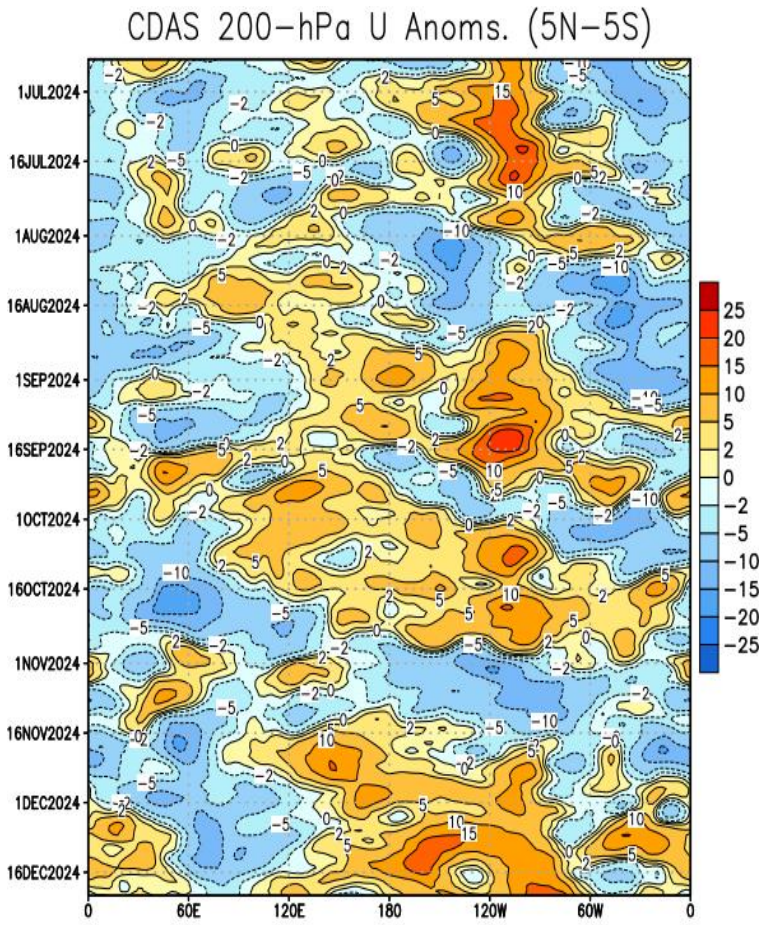


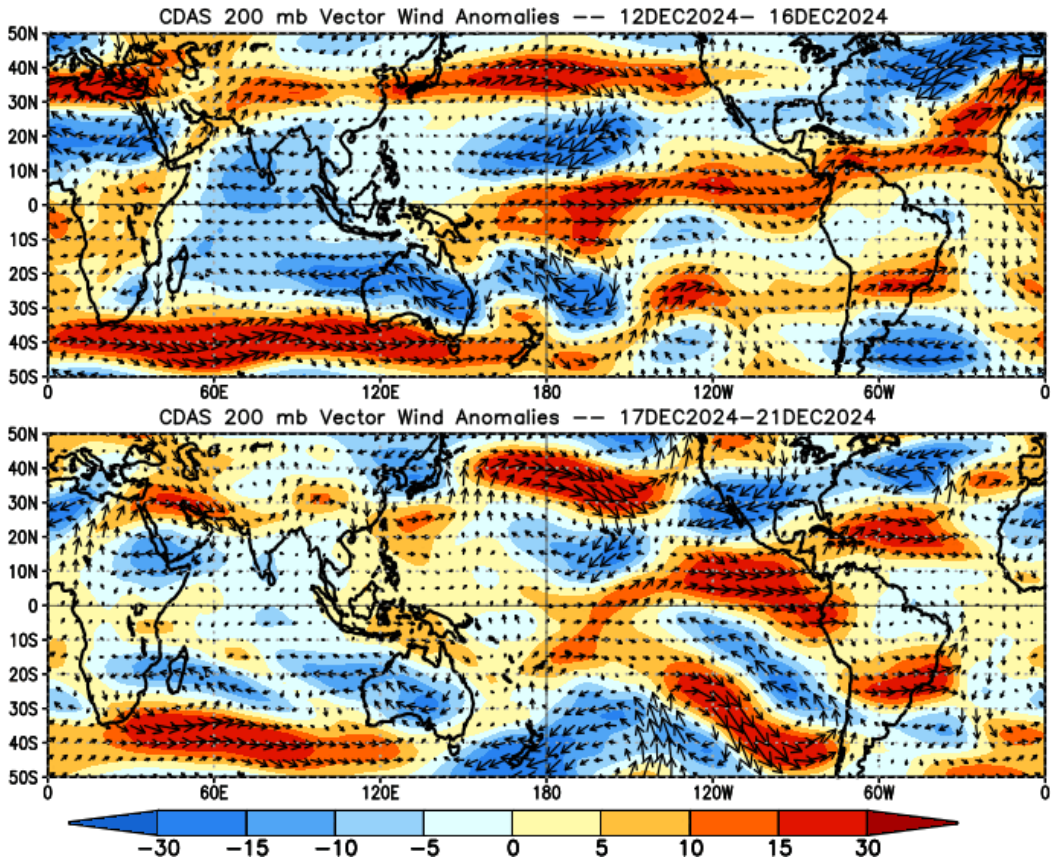


- The upper-level VP anomaly pattern continues to exhibit a Wave-1 pattern and eastward propagation, consistent with an active MJO evolution.
- The enhanced divergent signal is currently crossing the Pacific, disrupting the low frequency enhanced convergence centered near 60W.
- Other modes, including Rossby wave activity over the Maritime Continent and far eastern Pacific are also influencing the pattern.

200-hPa Wind Anomalies

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

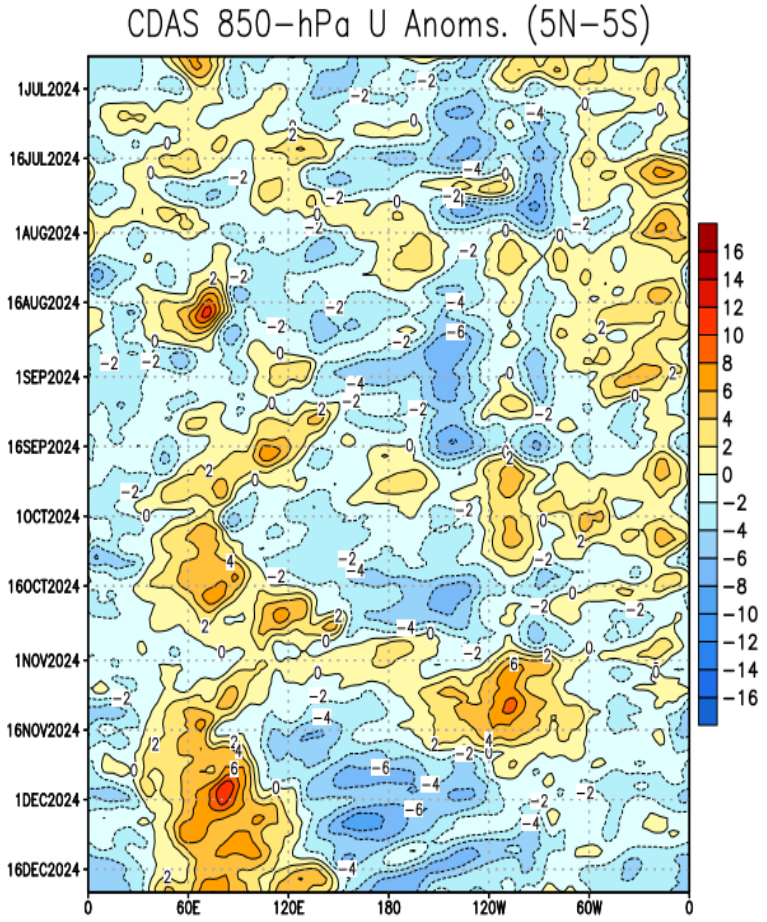


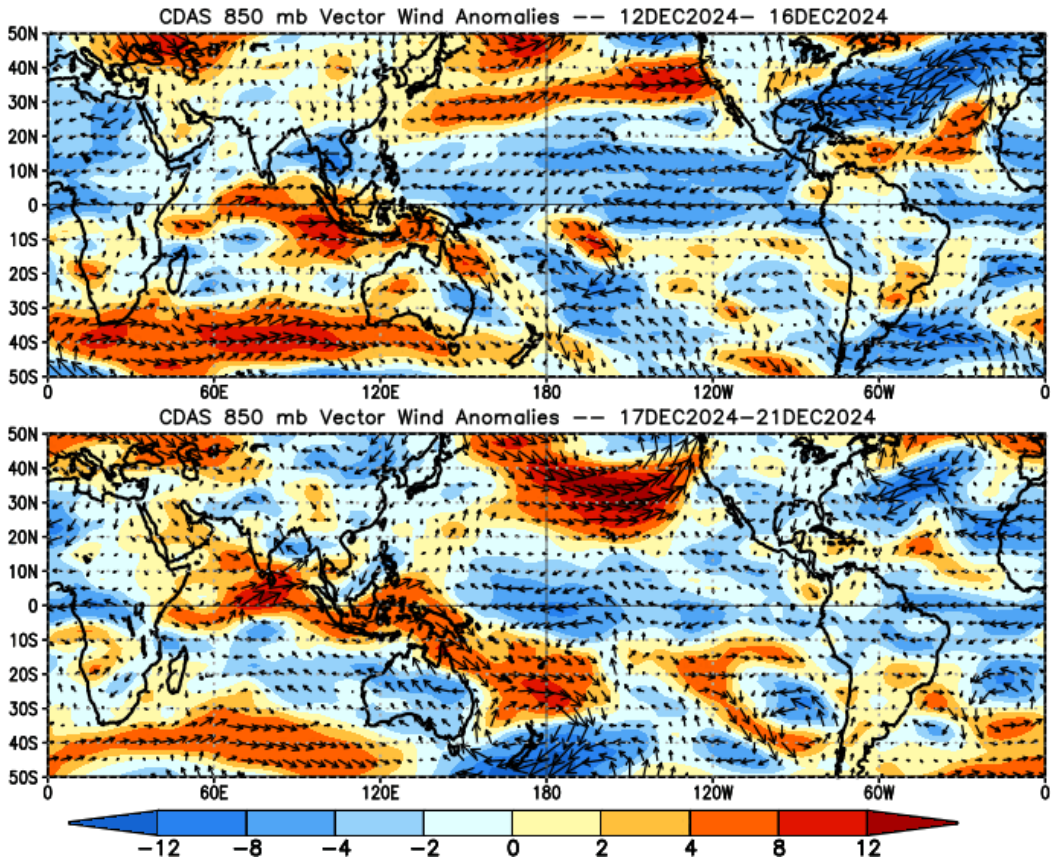


- Eastward propagation of coherent envelopes of easterly and westerly zonal wind anomalies was evident during November and early December.
- Persistent westerlies aloft over the Pacific appear to be due to an atmospheric response to developing La Niña conditions; however, the MJO crossing the Pacific is also playing a role.
- Easterly anomalies weakened over the Indian Ocean basin.

850-hPa Wind Anomalies

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

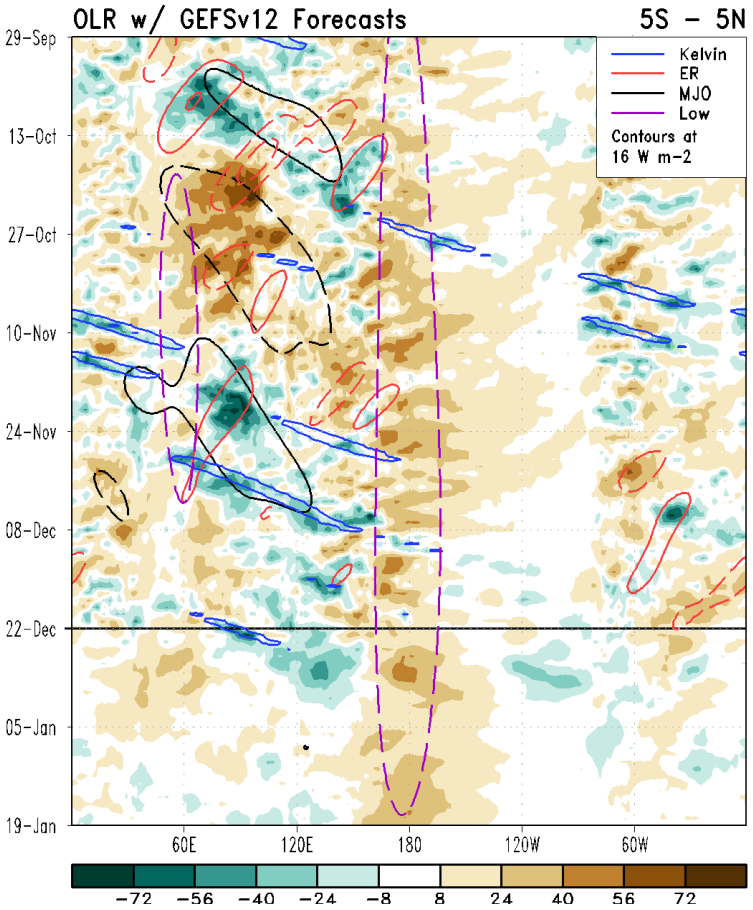


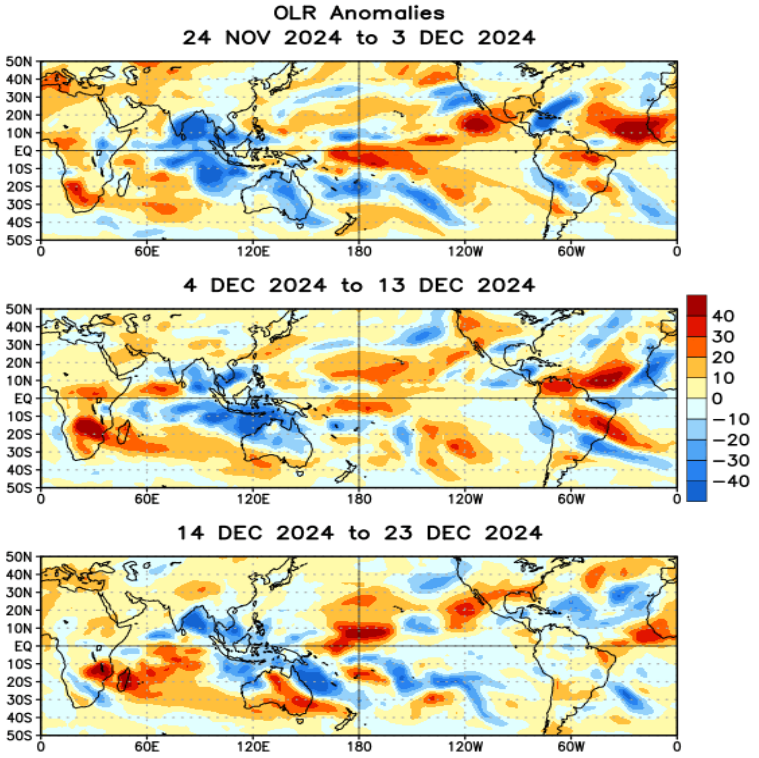


- Low-level westerlies have persisted across much of the Indian Ocean, partly due to IOD activity.
- Enhanced trades persist across the central and eastern Pacific, though there is some evidence of eastward propagating westerly anomalies across the far western and southwestern Pacific.
- Equatorial Rossby wave activity is apparent over the Maritime Continent.

Outgoing Longwave Radiation (OLR) Anomalies

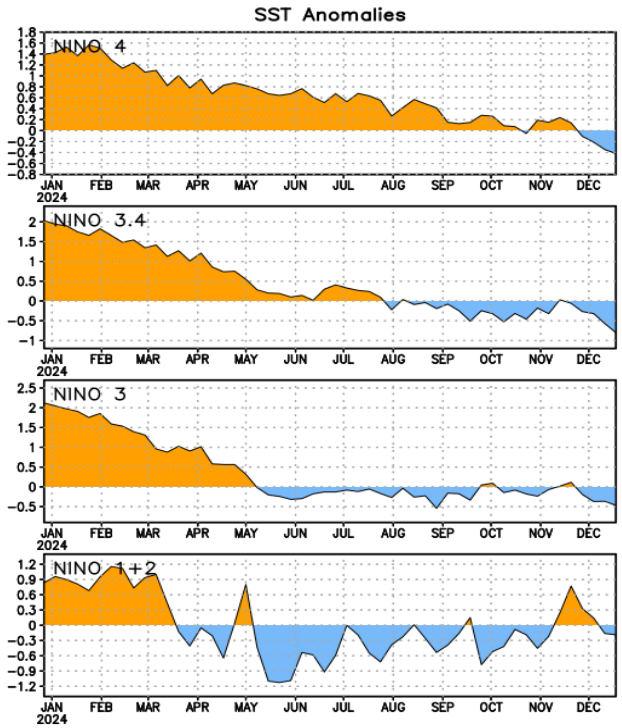
Green shades: Anomalous convection (wetness)
Brown shades: Anomalous subsidence (dryness)

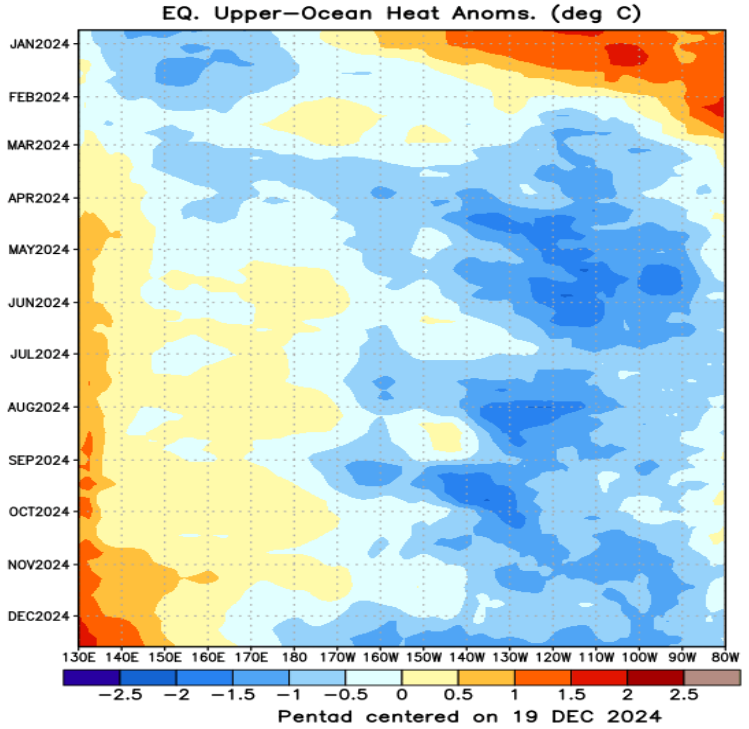




- While the MJO has been apparent in the VP and wind fields, the low frequency state has had a stronger influence near the equator in terms of convective response.
- Eastward propagation of enhanced convection across the Pacific has been primarily achieved through Kelvin waves.
- West Pacific convection has increased, primarily across the Coral Sea and SPCZ regions.

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

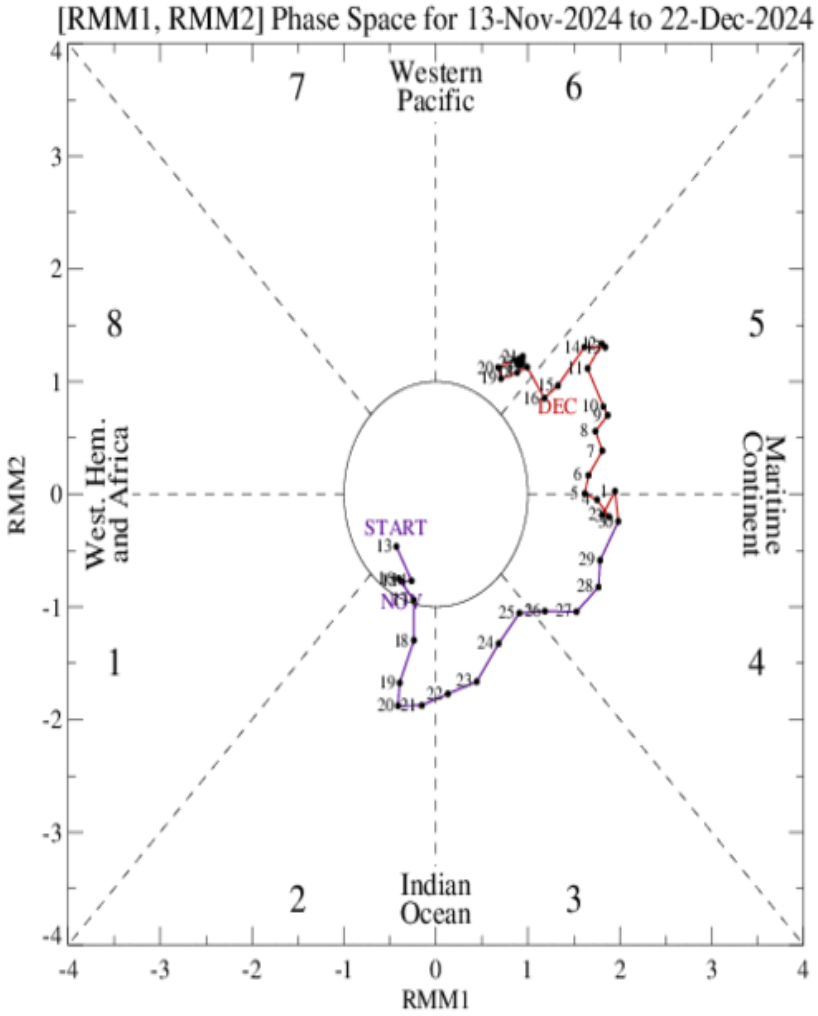




- Recent trade wind surges has resulted in upwelling across much of the central and eastern Pacific, resulting in decreasing SSTs in all of the Niño basins and increased cooler waters in the upper ocean column.
- The Niño 3.4 SST has dropped below -0.5 and is approaching -1.0C below average, indicating a potentially developing La Niña event.

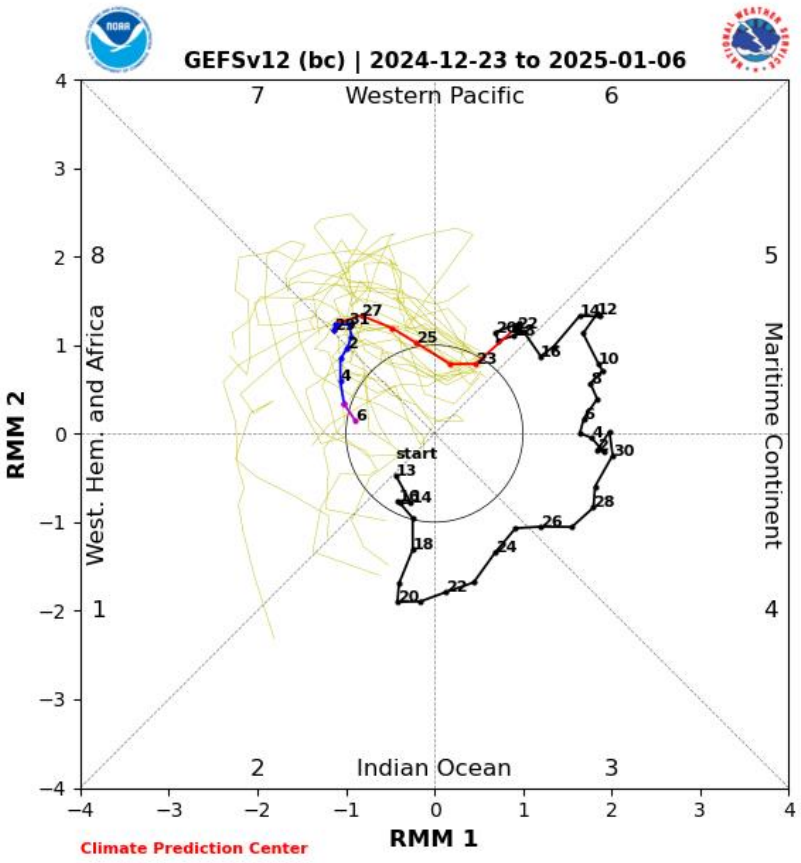
MJO Index: Recent Evolution

- Following steady eastward propagation of an amplified MJO signal during much of November and early December, the MJO has stalled over the West Pacific.
- Influence from the base state and equatorial Rossby wave activity are playing a role in the more stationary presentation of the MJO index.

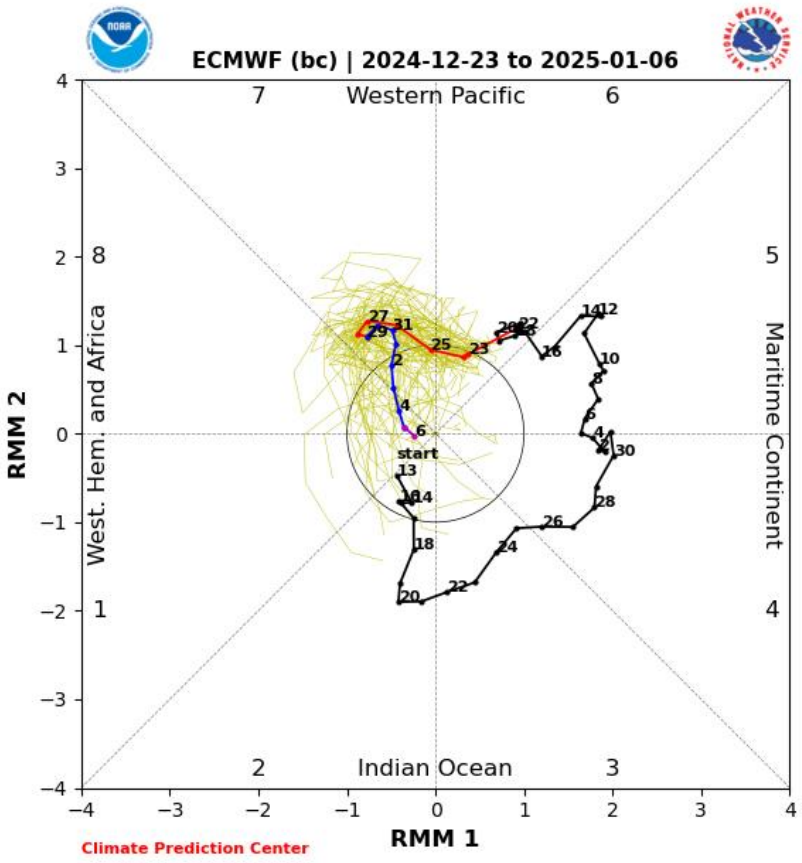


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast

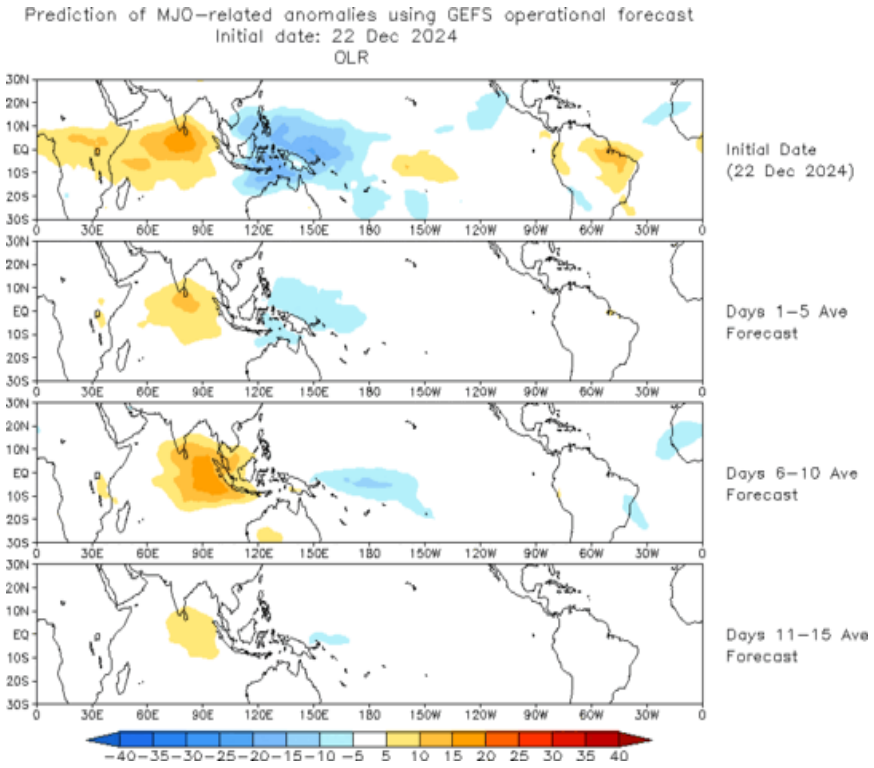


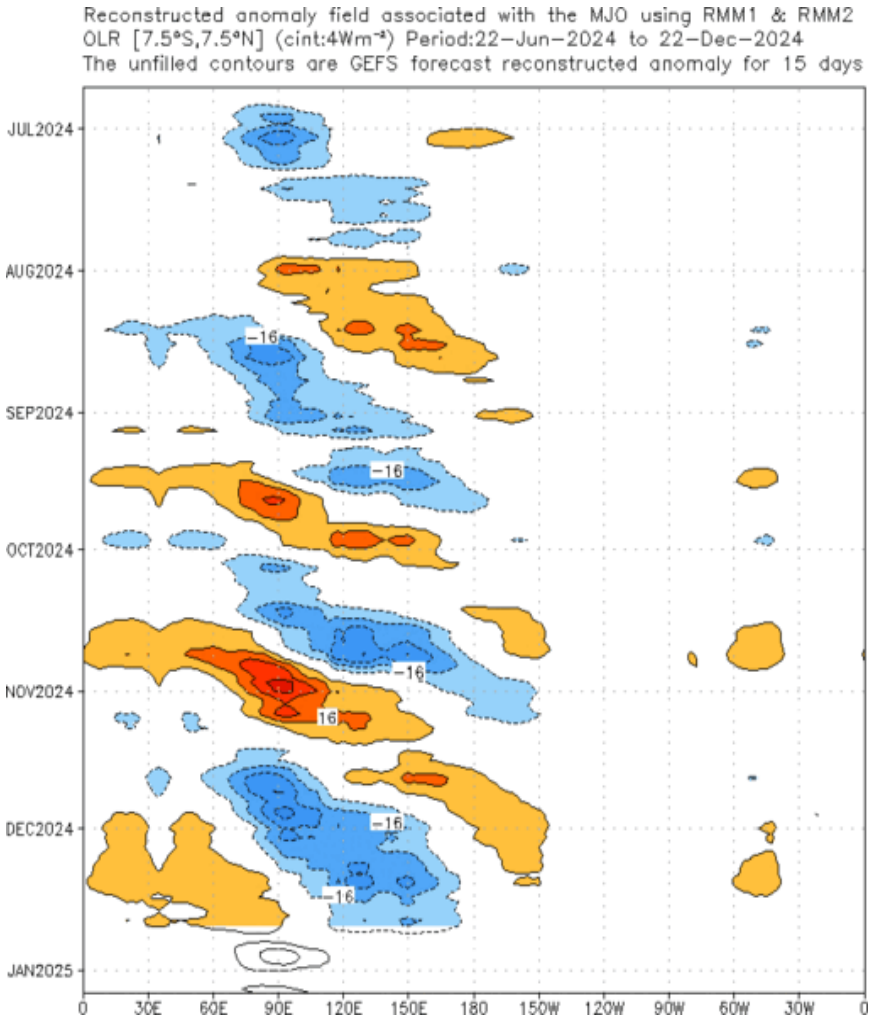
ECMWF Forecast

- Both the GEFS and ECMWF depict a fairly rapid transition towards the central Pacific during Week-1, as Rossby wave activity shifts from the Maritime Continent to the Indian Ocean, reducing constructive interference.
- Beyond Week-2, dynamical models show continued MJO propagation, but with increased uncertainty whether the signal will remain coherent.

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.)

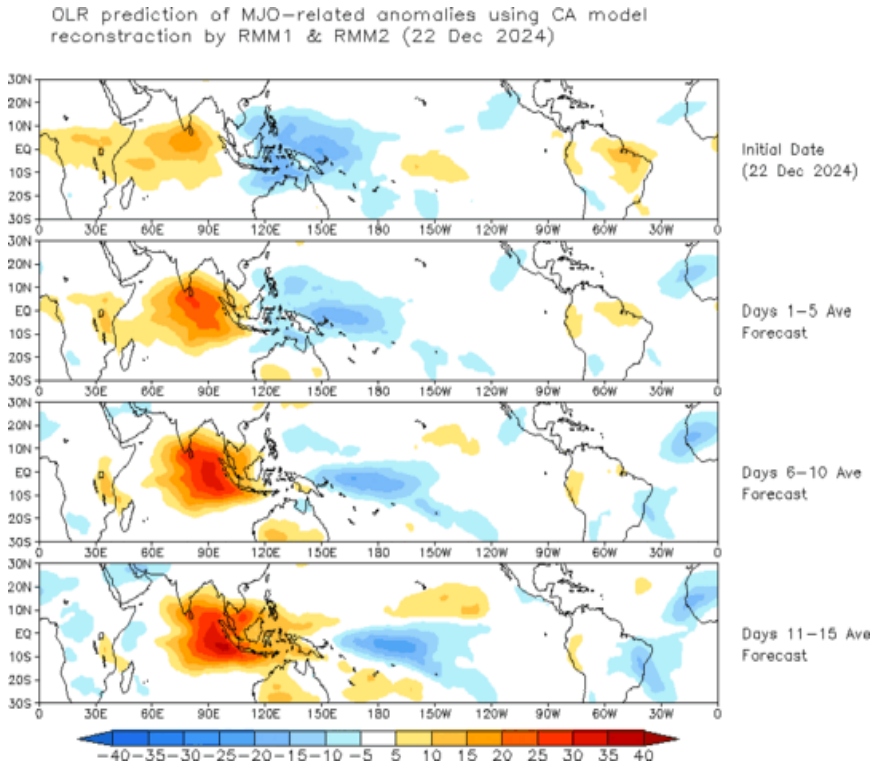


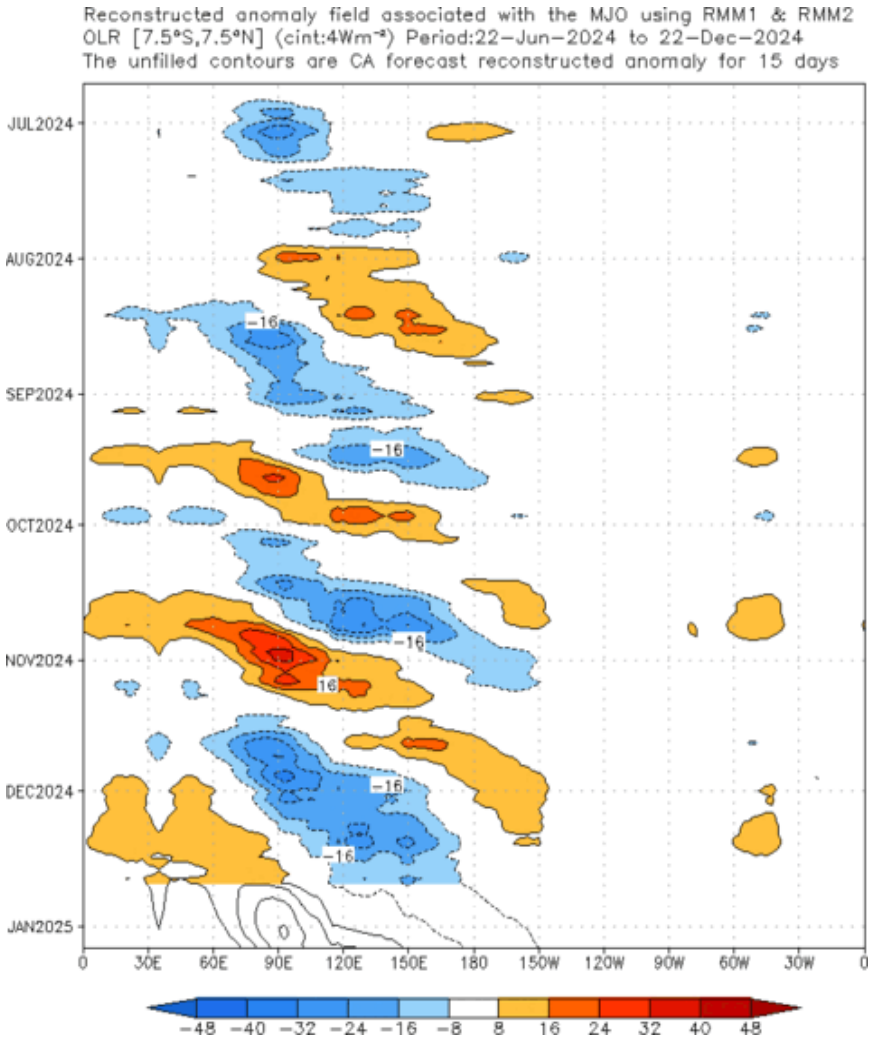


- The GEFS OLR anomaly forecast based on the RMM index shows eastward propagation with a rapidly decreasing amplitude.

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.)

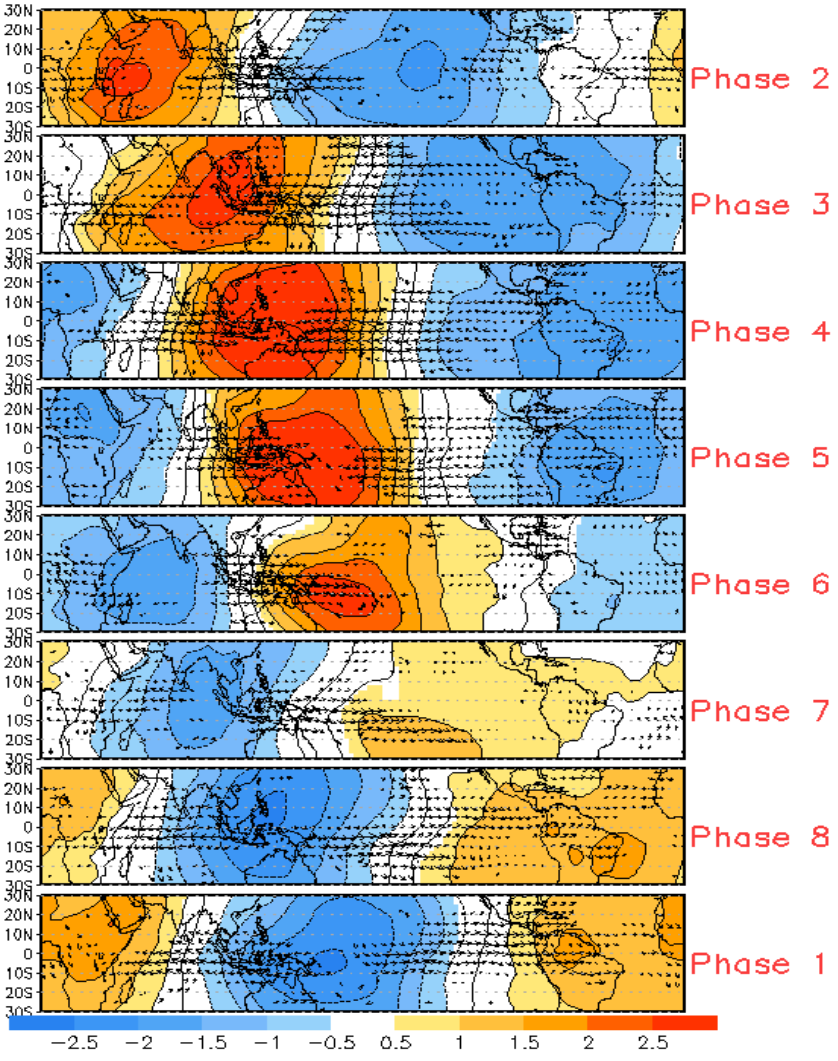




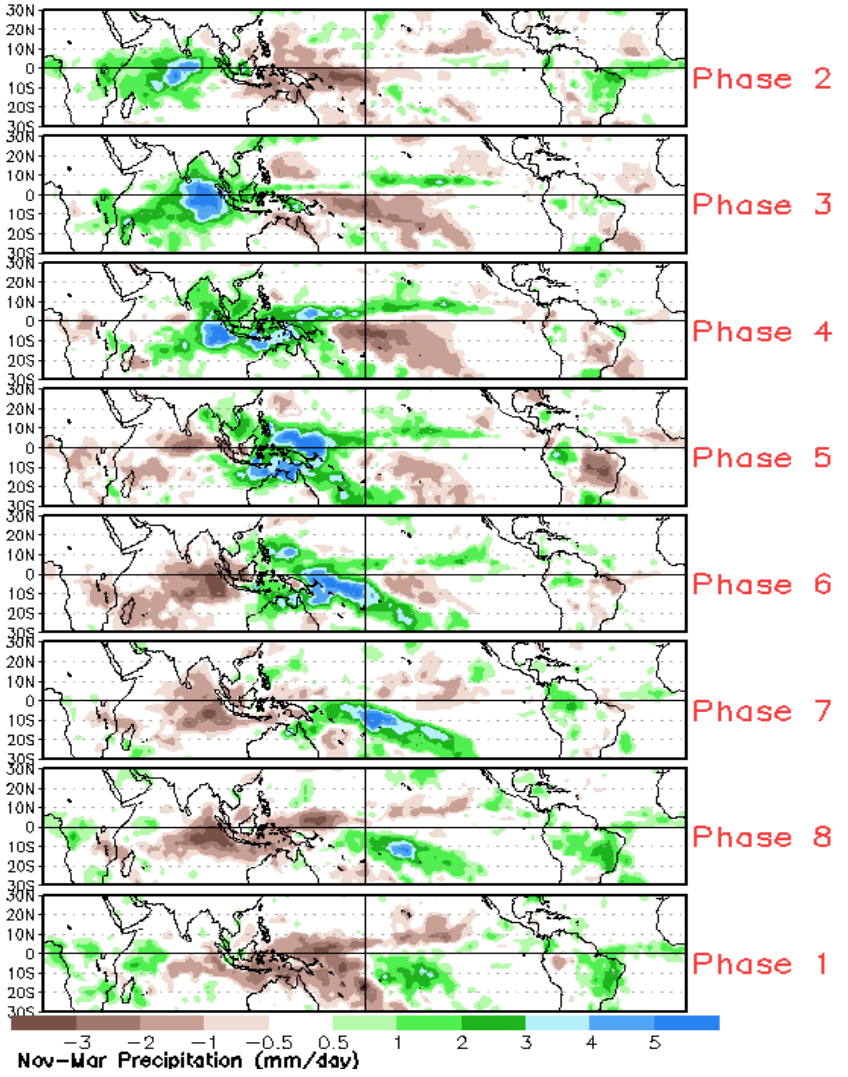
- The constructed analog forecast depicts canonical MJO propagation across the Pacific towards the Western Hemisphere, a much more amplified signal than depicted in the dynamical models.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



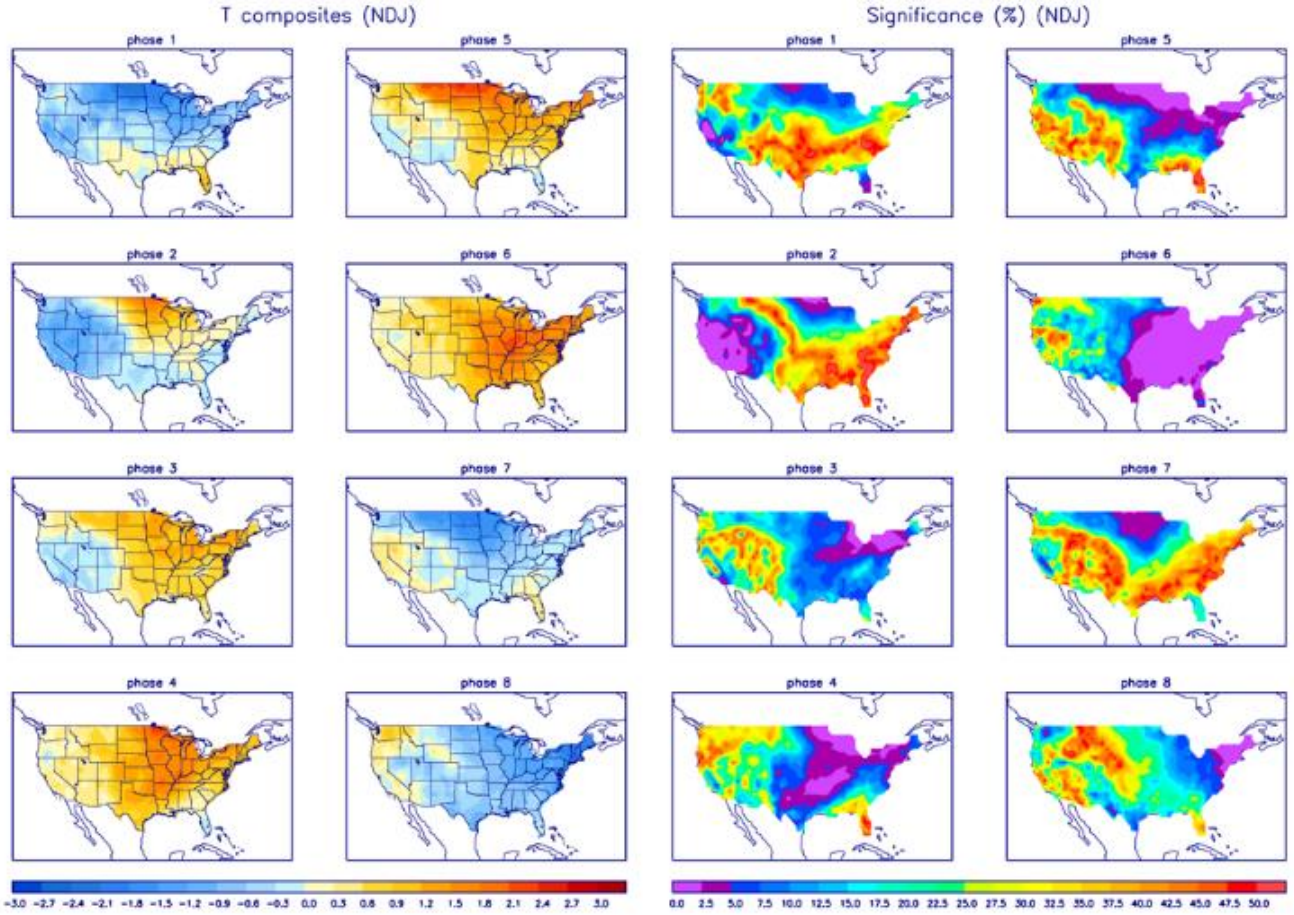
Precipitation Anomalies



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.

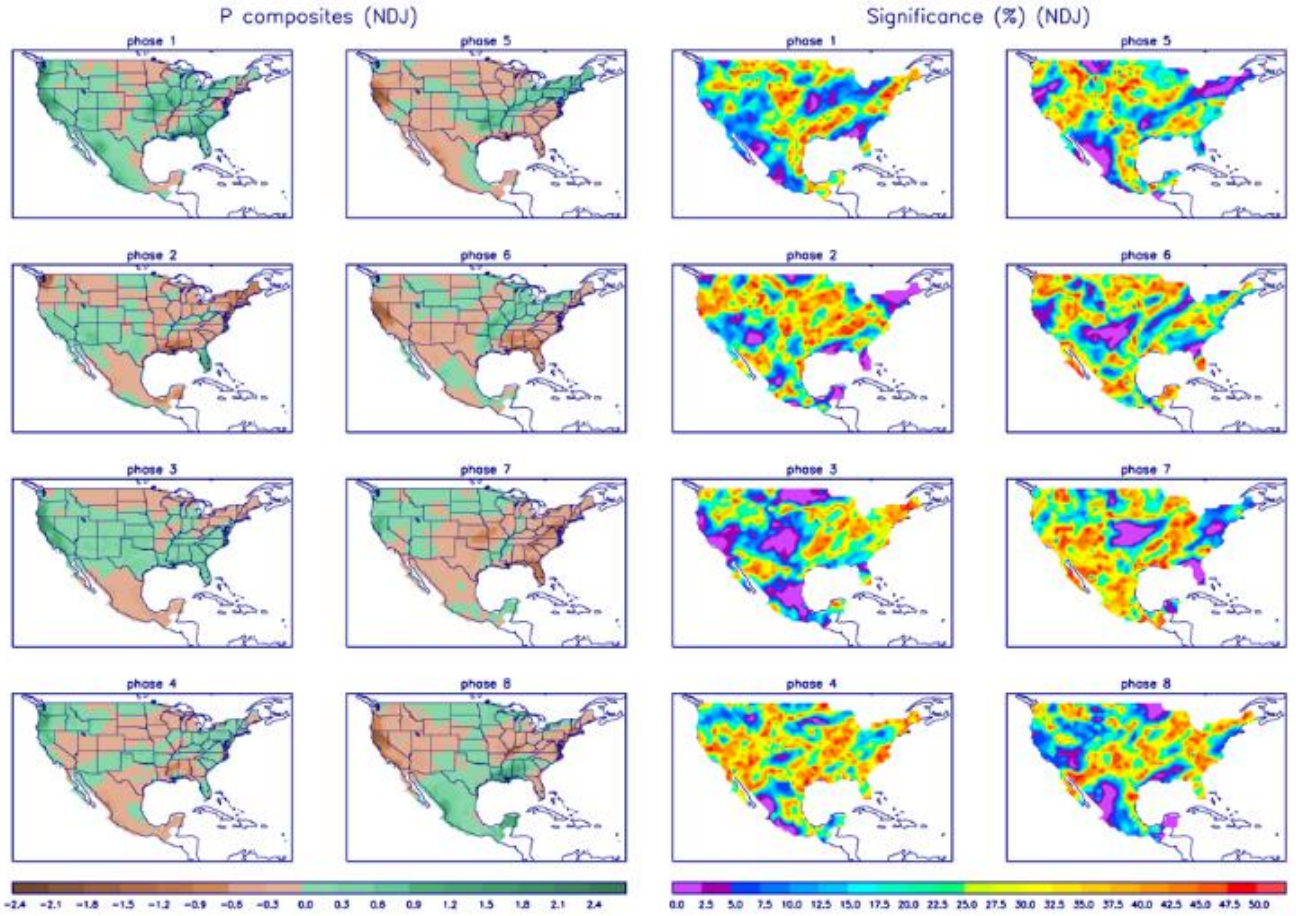


More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

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.



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