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

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

Overview

- The MJO propagated eastward from the Indian Ocean to the Maritime Continent since late November, but its eastward propagation slowed by the beginning of December.

- Dynamical model forecasts depict continued eastward propagation of the MJO signal with a slow phase speed as the base state trending towards La Niña conditions also plays a role in anomalous tropical rainfall.

- Based on the predicted MJO evolution, there is an enhanced chance of tropical cyclone development over the West Pacific and near northern Australia through late December.

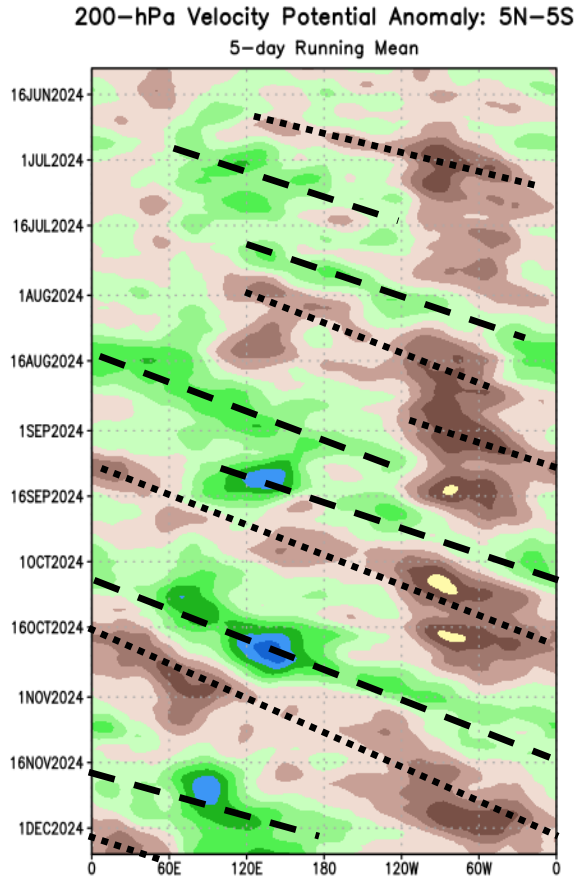
- A continued eastward MJO propagation over the Pacific would favor a period of below-normal temperatures across the eastern U.S. heading into the New Year.

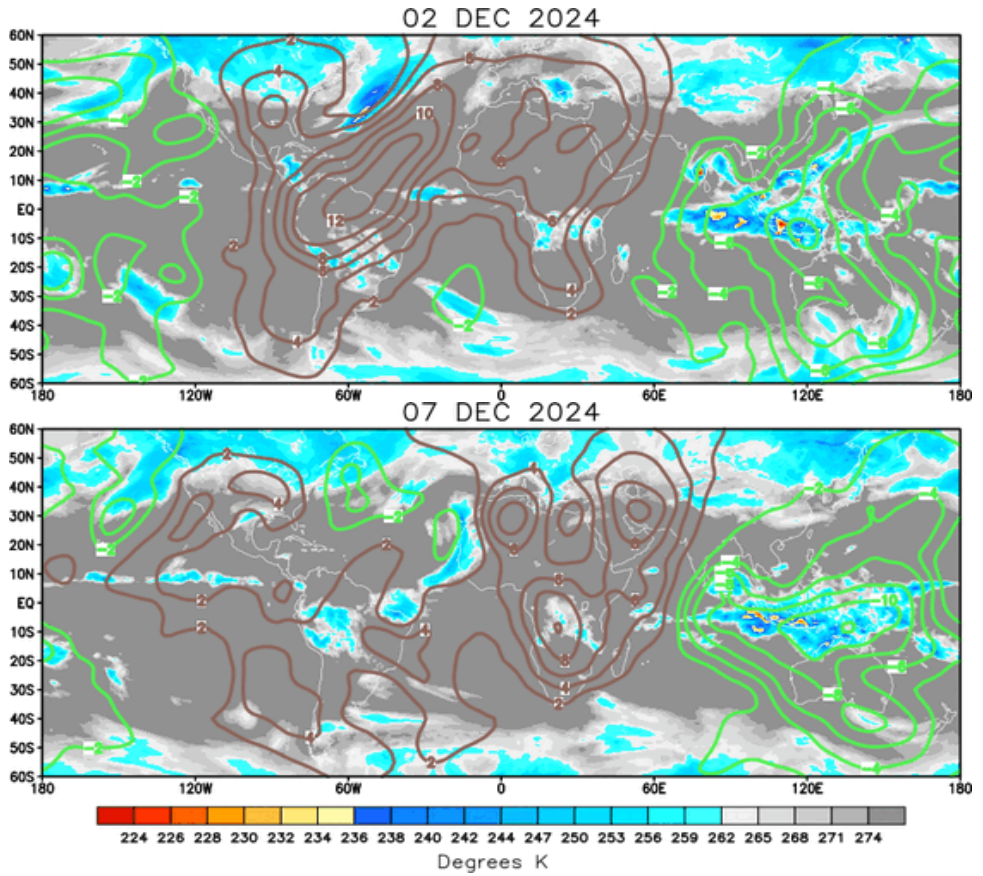
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

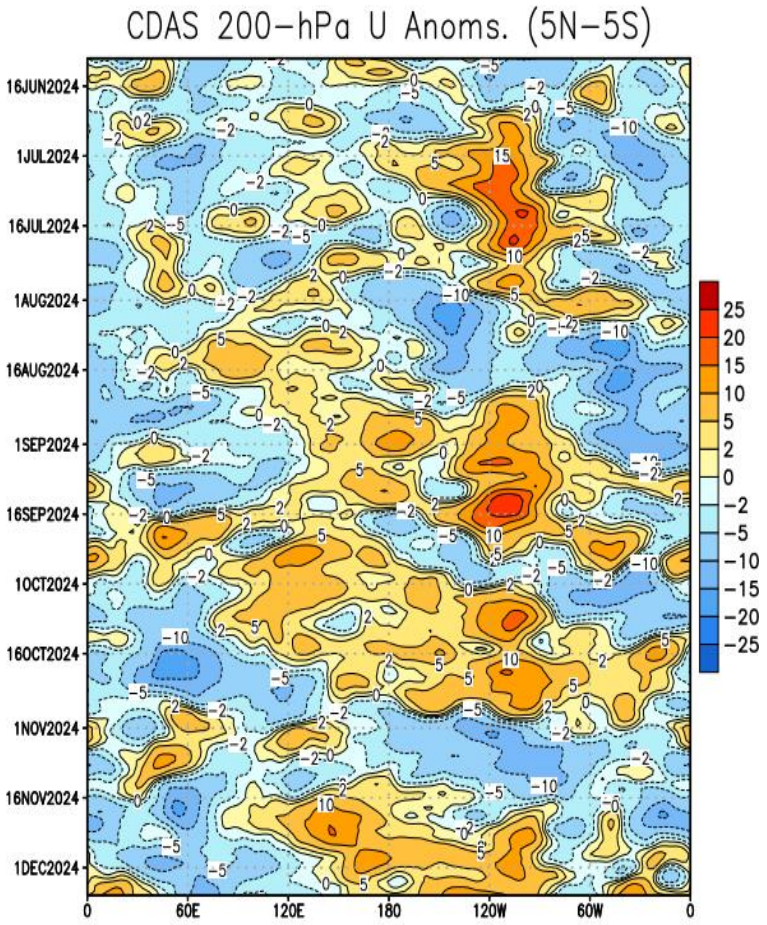


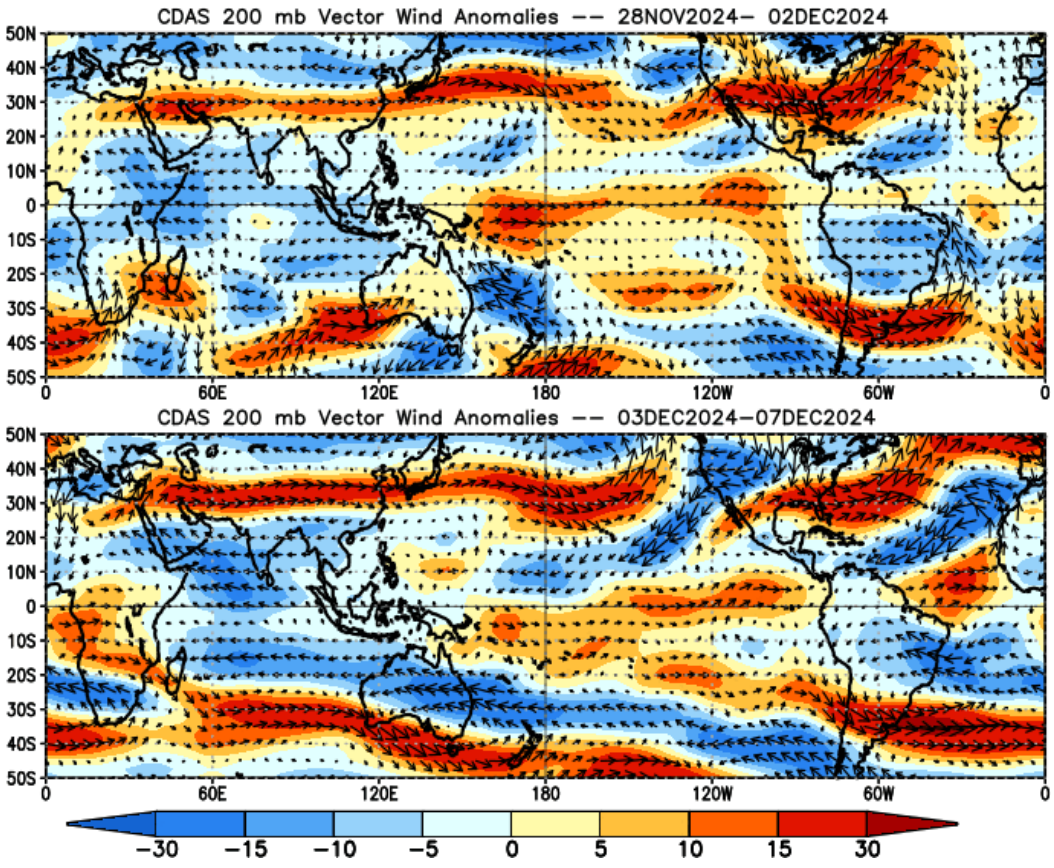


- A robust wave-1 pattern persisted into the beginning of December.
- Eastward propagation of this signal remains apparent, with the enhanced divergent envelope pushing just east of the Date Line.
- Constructive interference between the intraseasonal signal and the emerging low frequency base state is likely slowing the overall eastward propagation of the broad-scale convective envelope.

200-hPa Wind Anomalies

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

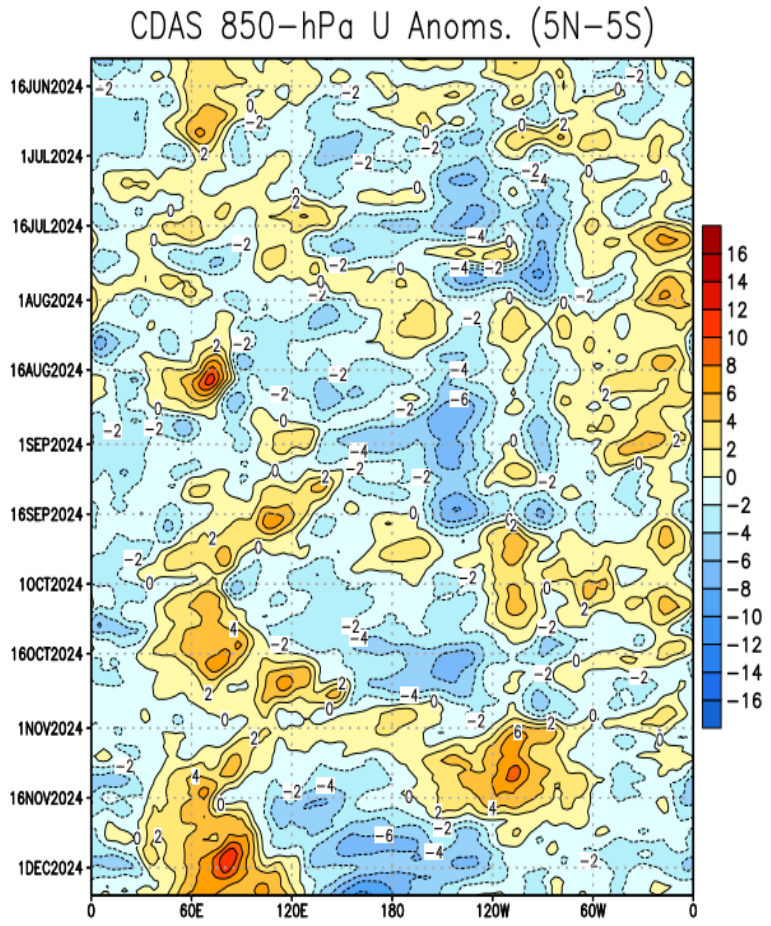


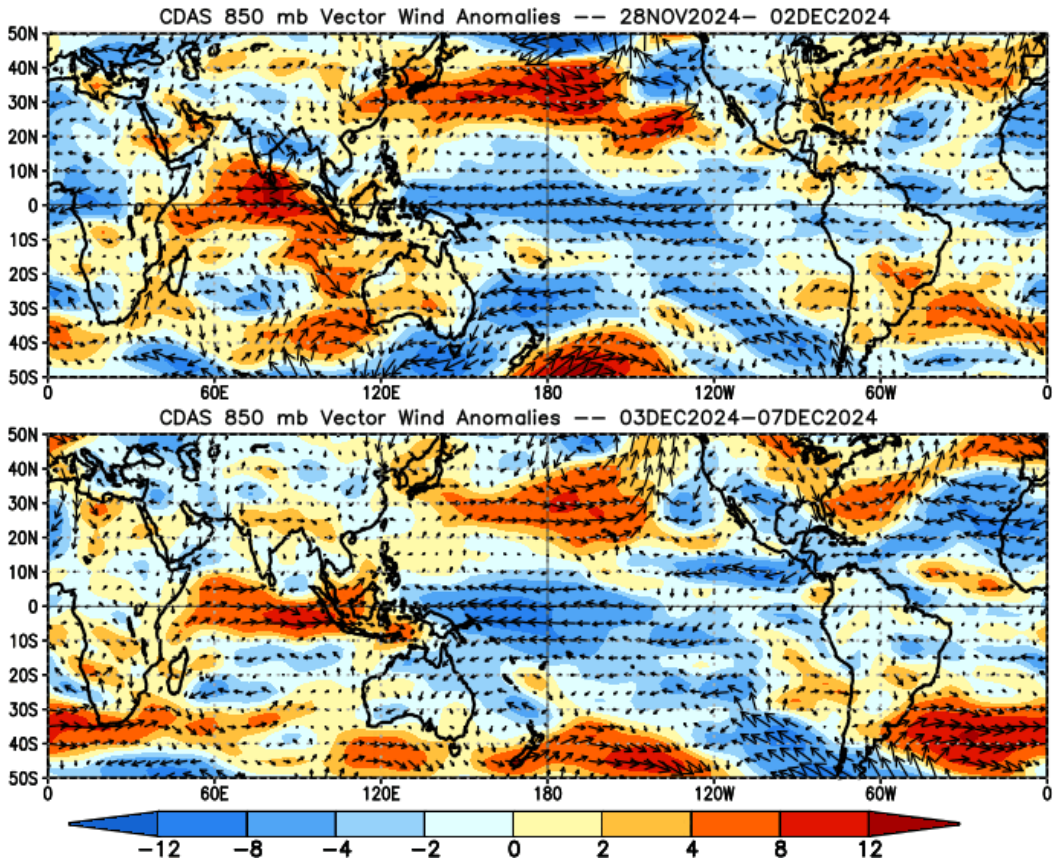


- Eastward propagation of enhanced westerlies aloft over the Pacific was observed from late November through early December, while easterly anomalies strengthened over the Indian Ocean basin.
- Strongly enhanced divergence is now centered over the Maritime Continent, consistent with the upper level velocity potential analysis.

850-hPa Wind Anomalies

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

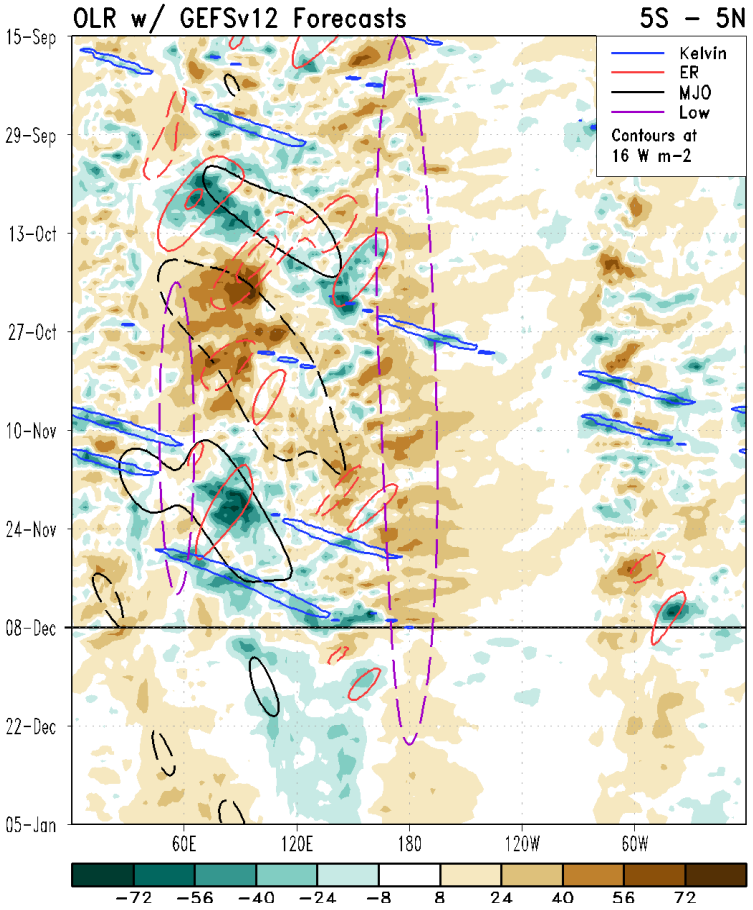


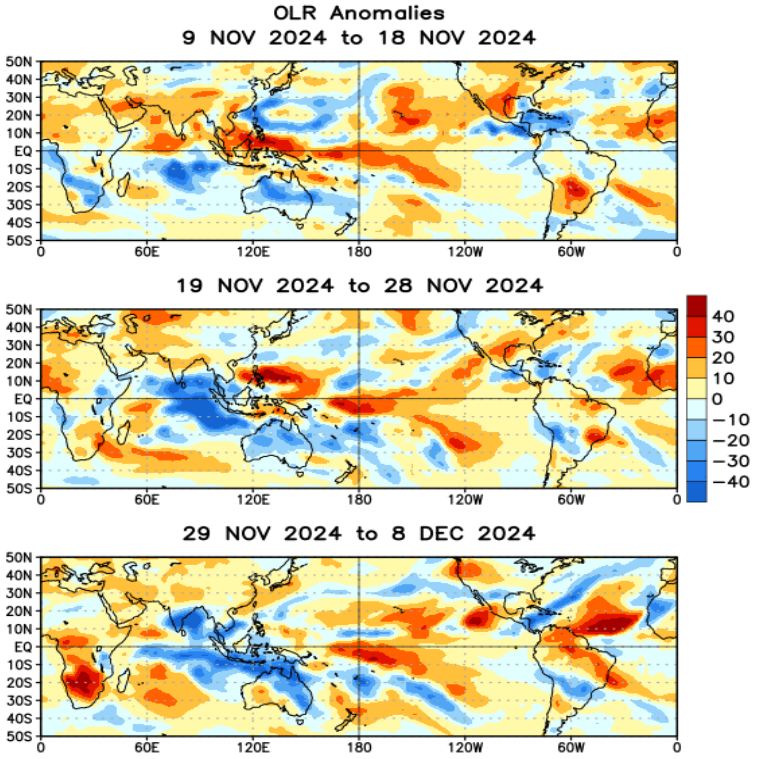


- Unlike the upper-level fields, the low-level wind field exhibits little to no eastward propagation.
- A strong westerly wind burst (WWB) occurred over the eastern Indian Ocean at the beginning of December, which provided a favorable environment for tropical cyclone development over the South Indian Ocean.
- In contrast, a trade wind surge is underway across the central Pacific, though anomalies are smaller for the far eastern Pacific.

Outgoing Longwave Radiation (OLR) Anomalies

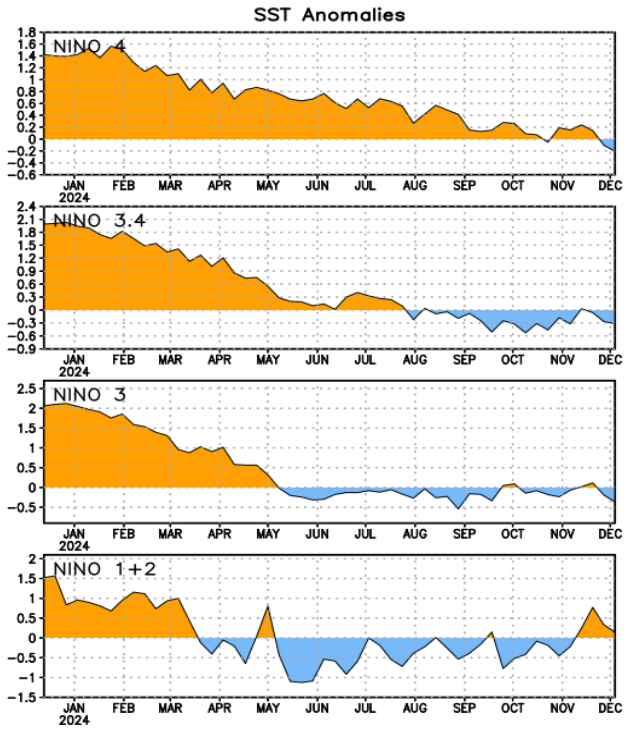
Green shades: Anomalous convection (wetness)
Brown shades: Anomalous subsidence (dryness)

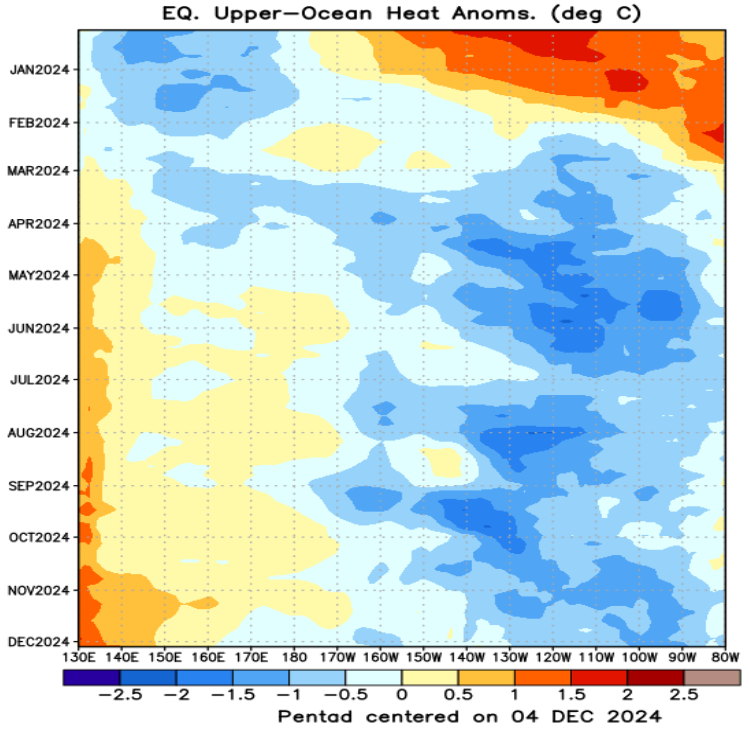




- Negative OLR anomalies associated with the MJO enhanced phase increased over the Indian Ocean during late November and more recently overspread the Maritime Continent and northern Australia.
- GEFS-based OLR anomaly forecasts depict enhanced convection persisting over the Maritime Continent and far West Pacific through late December, and suppressed convection near the Date Line. This pattern is more consistent with a La Niña type response.

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

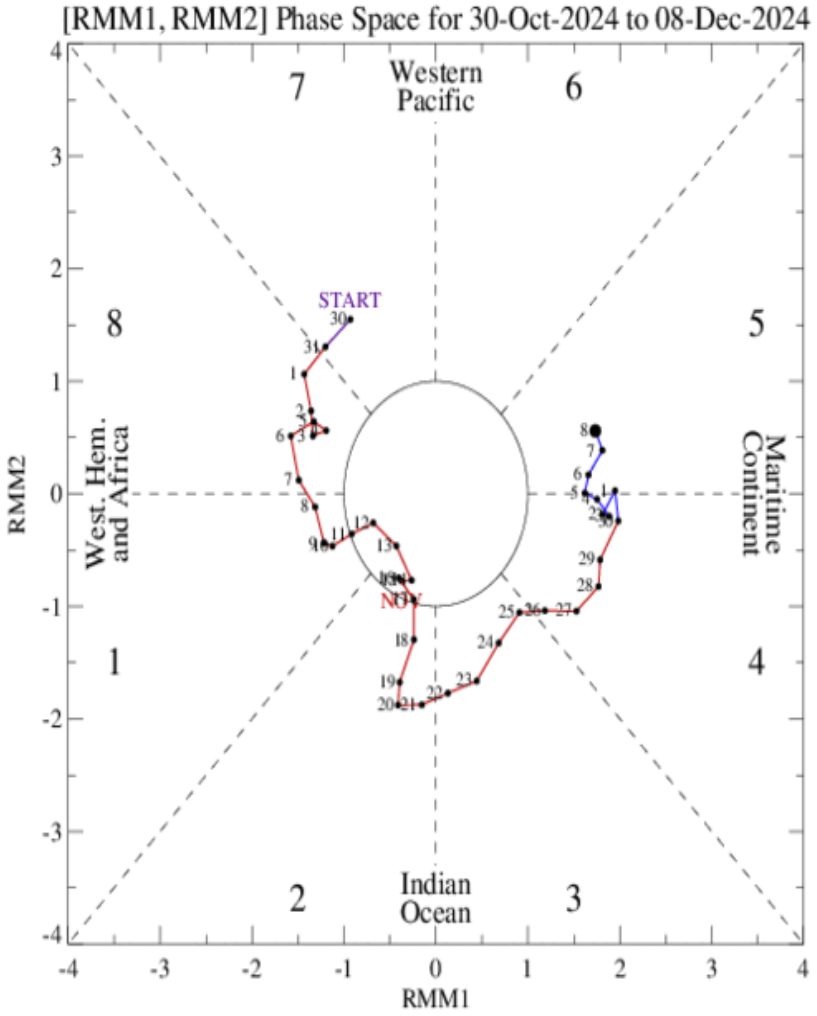




- SST anomalies remain slightly below average across most of the Pacific basin, though recent MJO activity resulted in a surge of warmer SSTs across the far eastern Pacific.
- Upper-ocean heat anomalies recently trended at and just west of the Date Line, likely as a result of the MJO and enhanced trade winds.

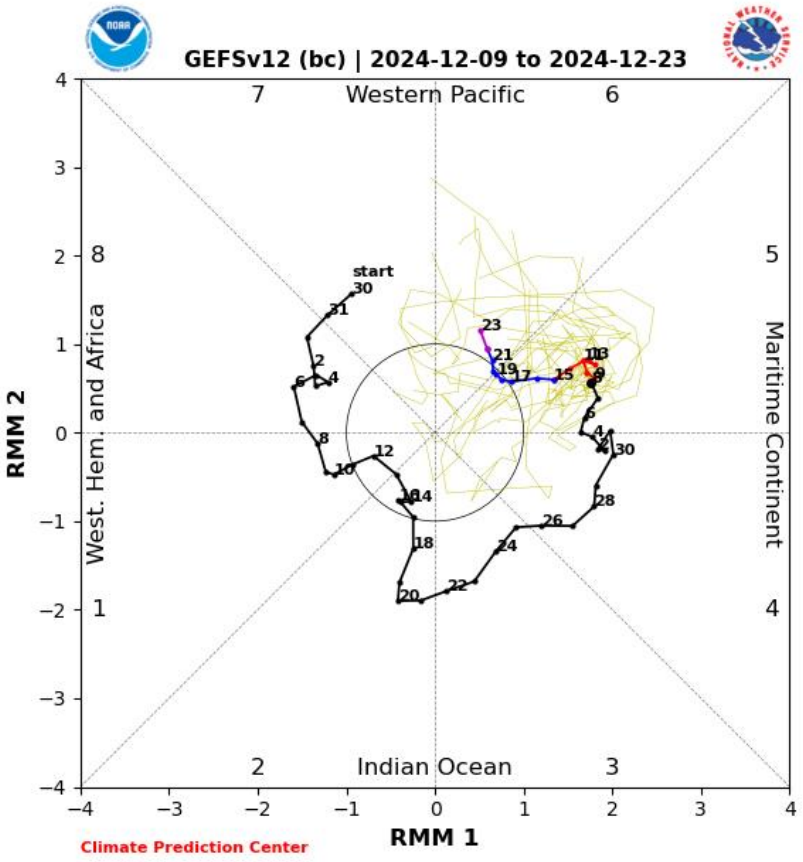
MJO Index: Recent Evolution

- Steady eastward propagation of the MJO was observed during the past two weeks, with the enhanced convective signal now crossing the Maritime Continent.

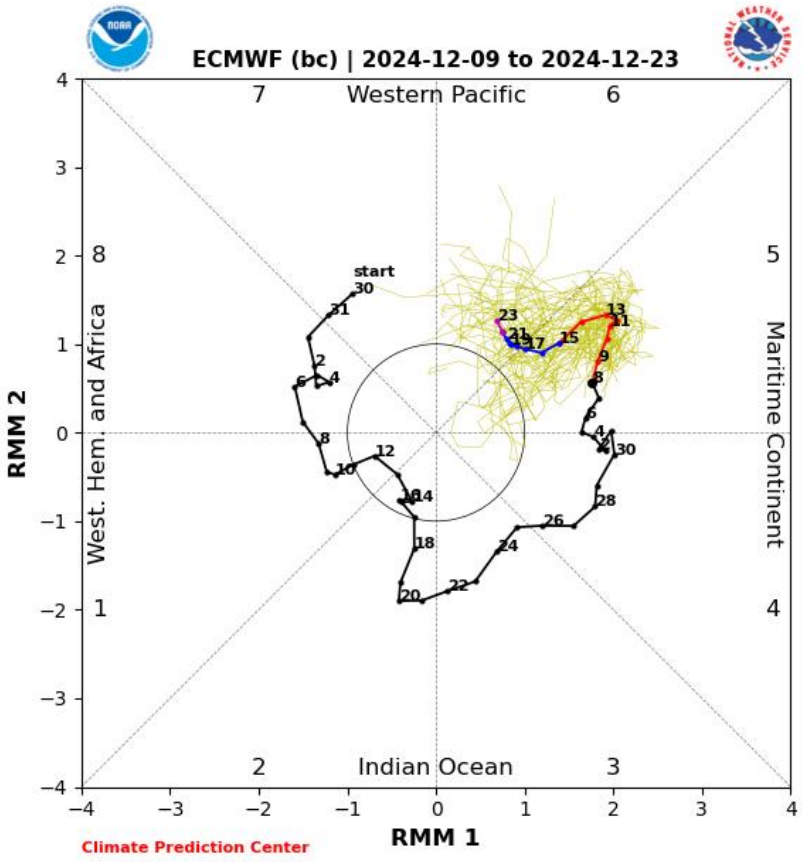


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast

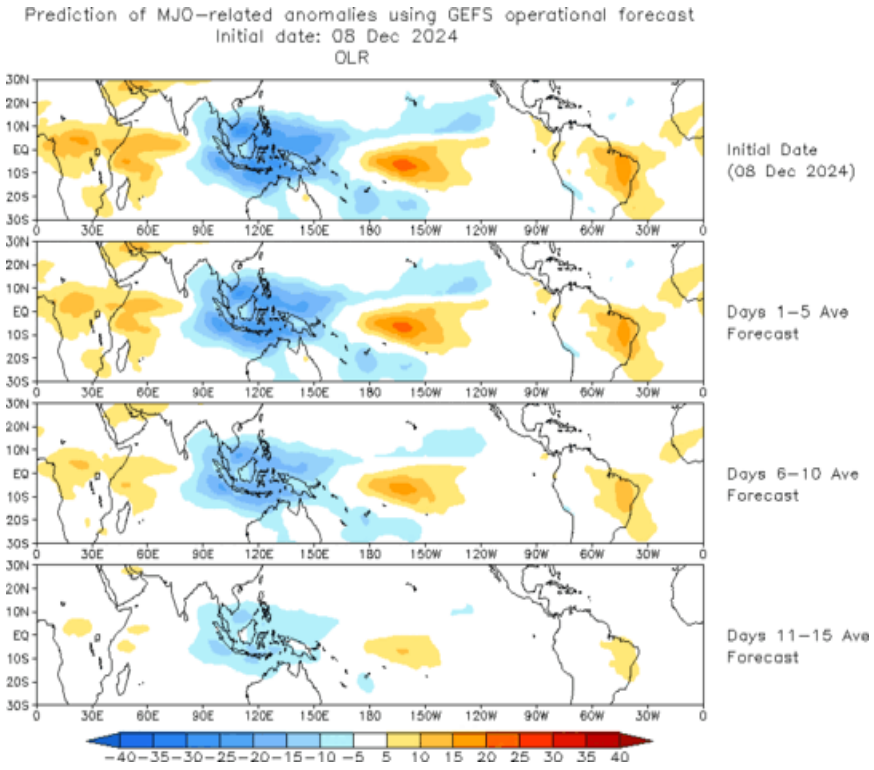


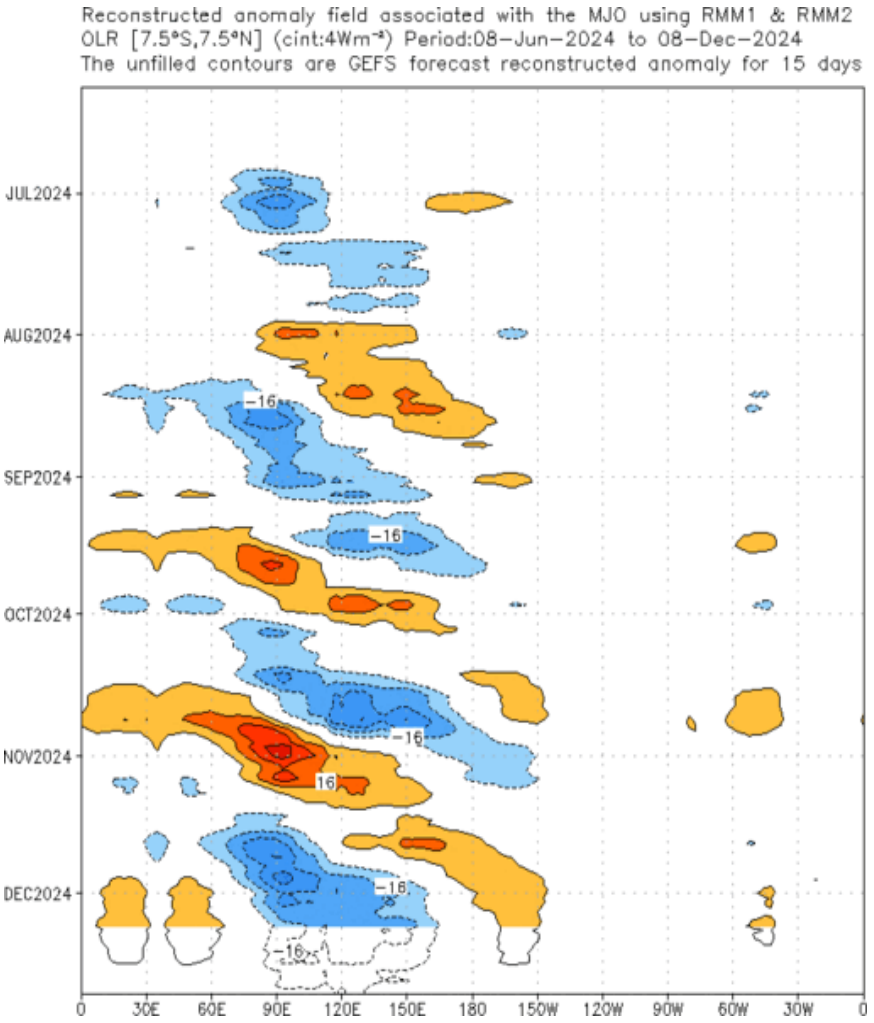
ECMWF Forecast

- Both the GEFS and ECMWF depict continued eastward propagation of the MJO signal, but with a slower phase speed due to interference from the emerging low frequency base state.
- The extended GEFS and ECMWF ensemble mean forecasts (not pictured) show slow eastward propagation across the West Pacific during December with the RMM index returning to phase 7 by the beginning of January 2025.

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.)

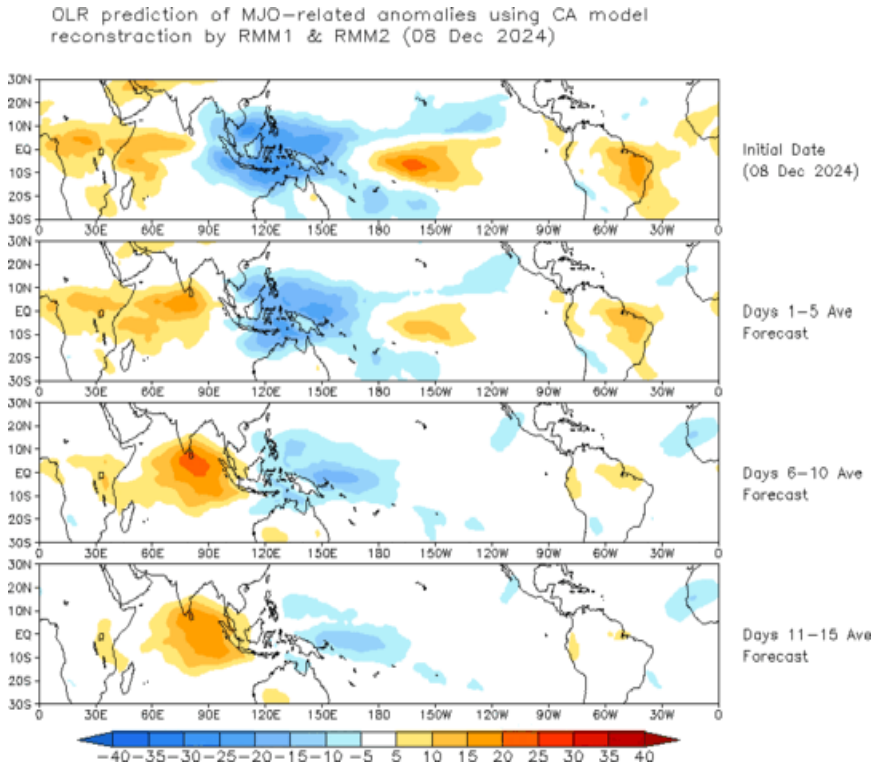


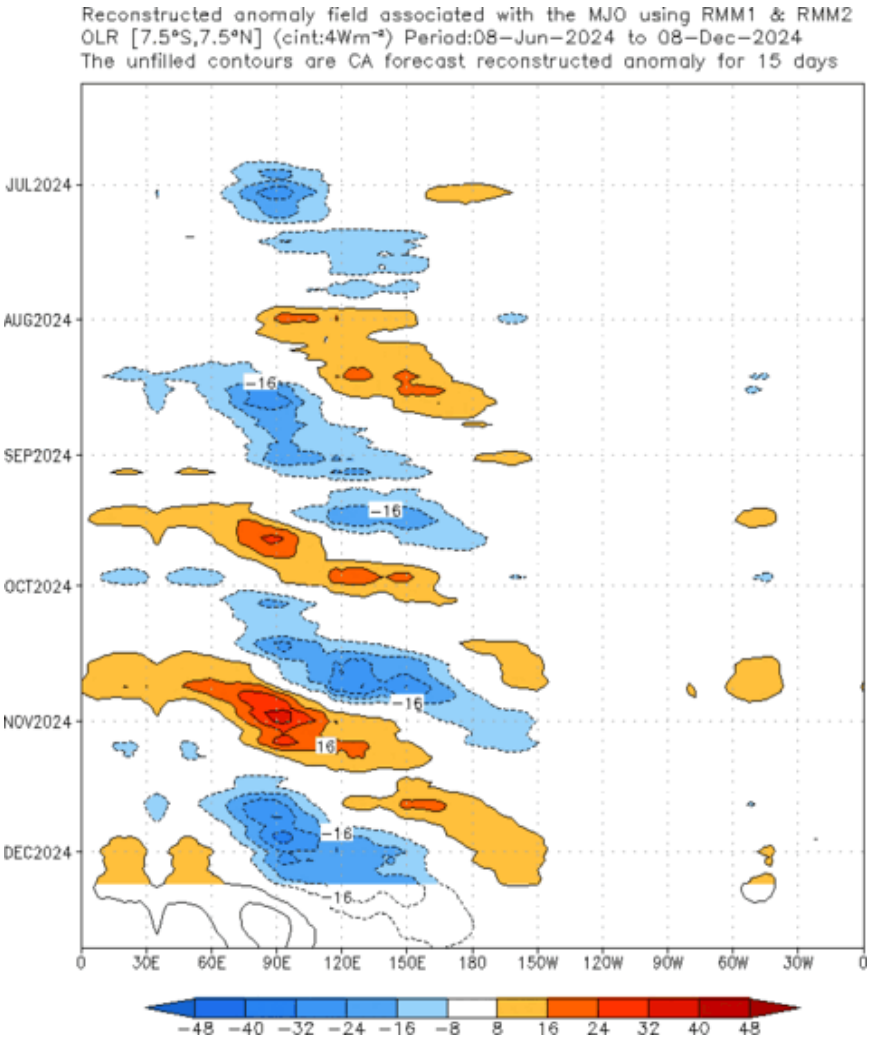


- The GEFS OLR anomaly forecast based on the RMM index shows a nearly stationary signal with diminishing anomalies.

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.)

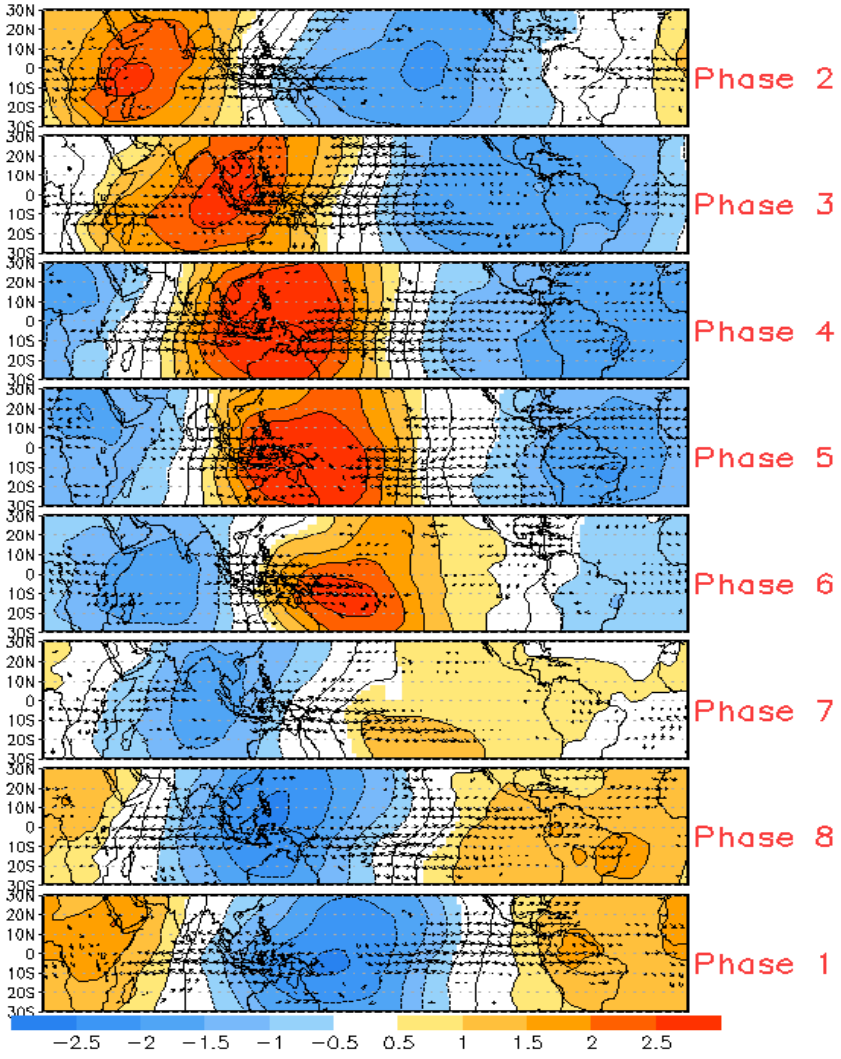




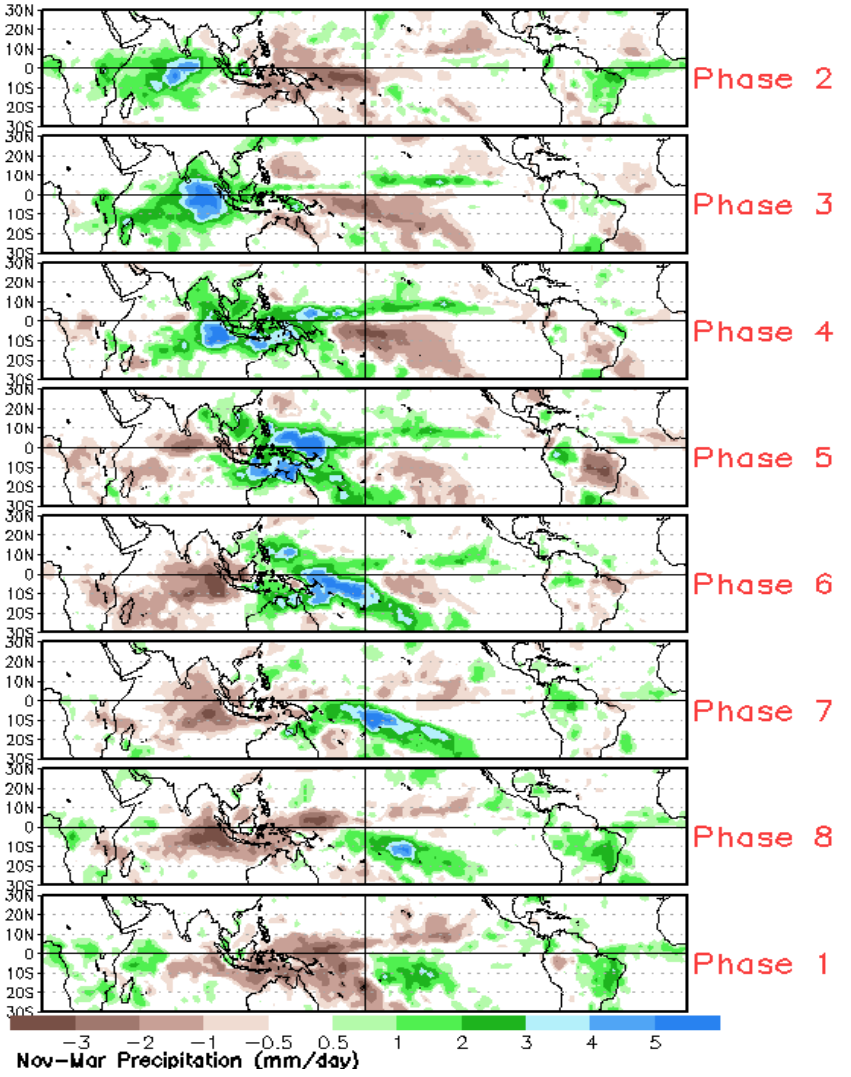
- The constructed analog forecast depicts more eastward propagation, especially with the suppressed phase shifting east from Africa to the Indian Ocean and western Maritime Continent.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



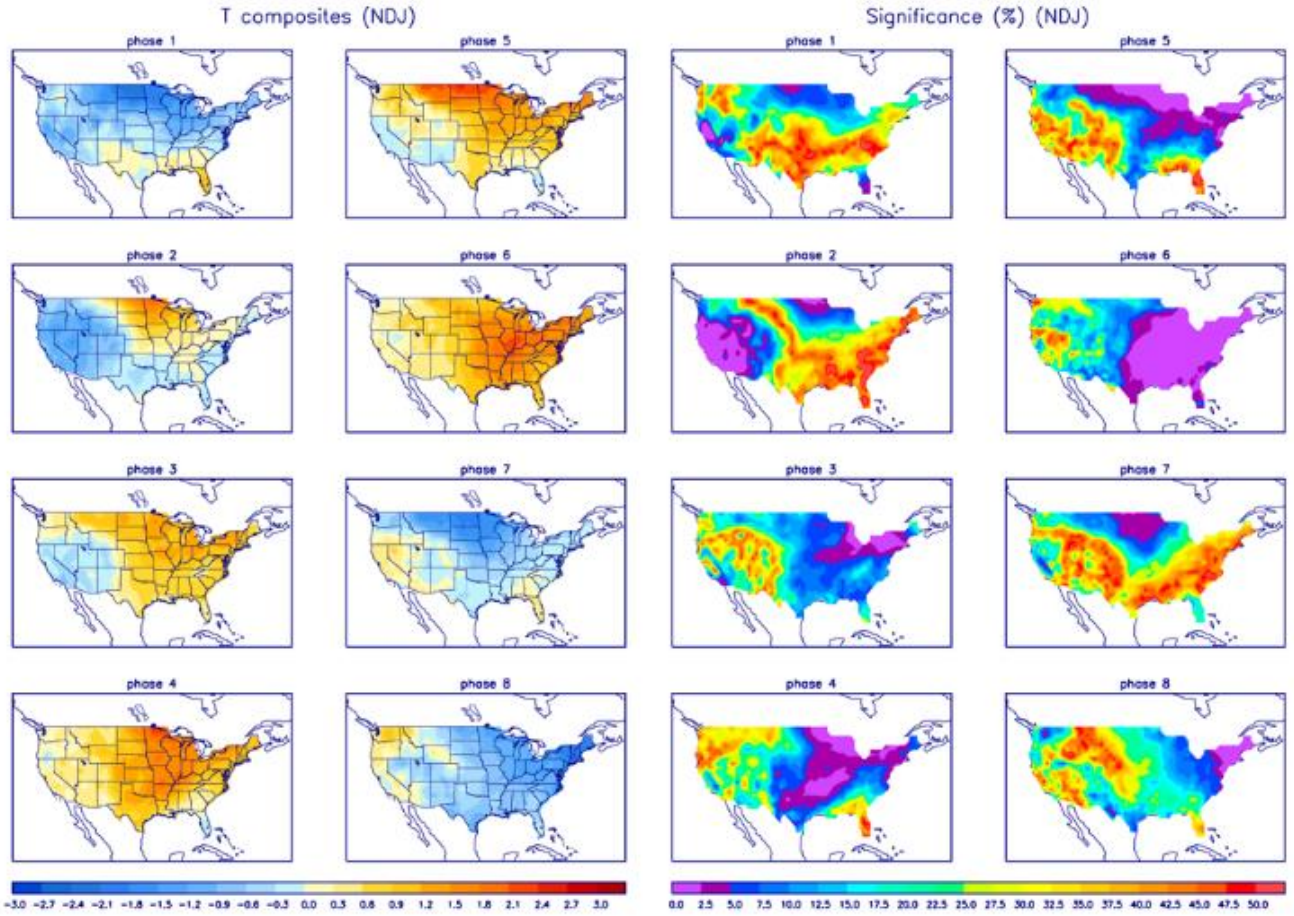
Precipitation Anomalies



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.

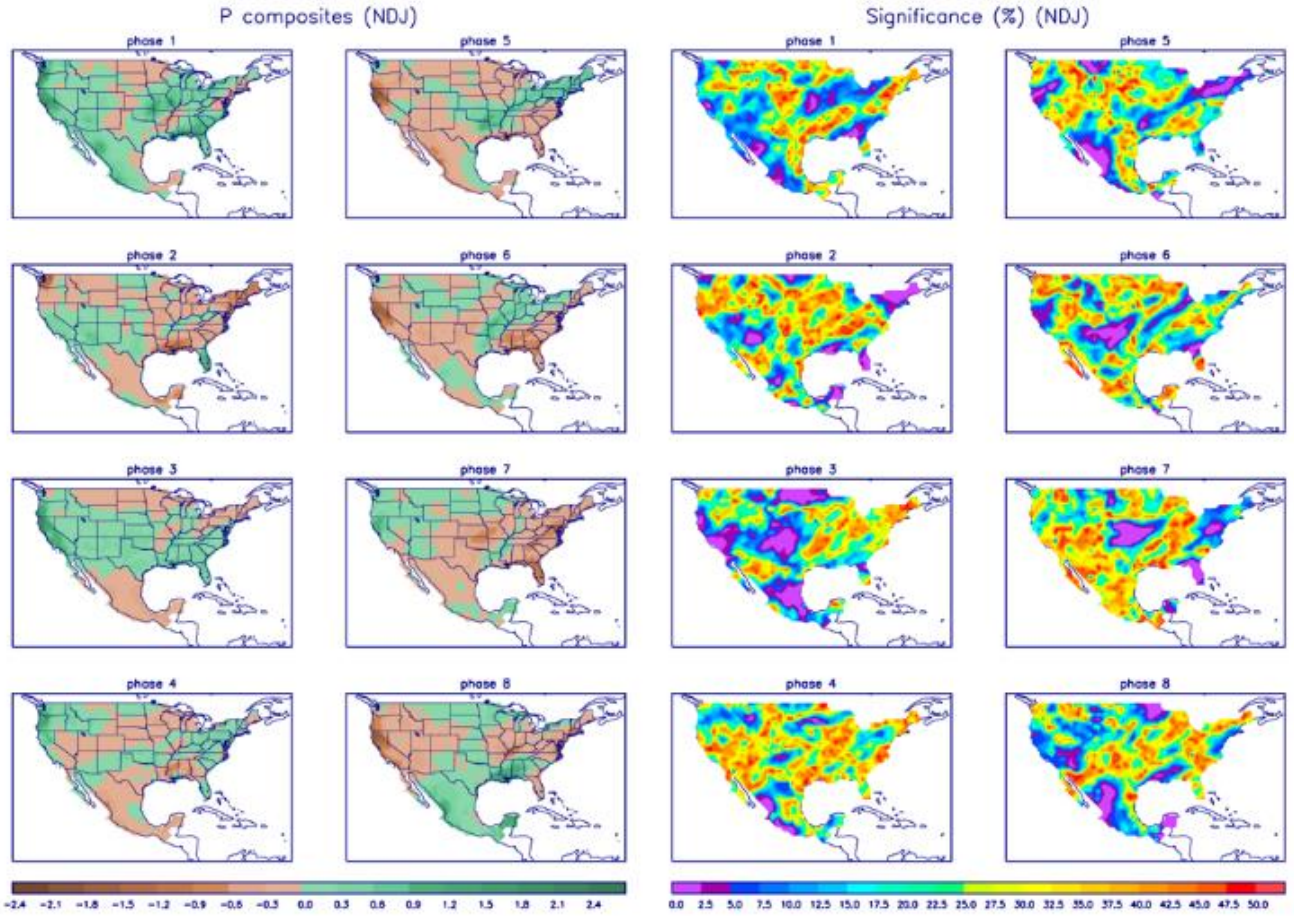


More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

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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