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

Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
20 January 2025

Overview

- After becoming incoherent during early January, RMM observations showed the MJO signal sharply regaining amplitude over the Western Hemisphere (phase 1) and then quickly propagating into the Indian Ocean.

- As the MJO moves from the Indian Ocean into the Maritime Continent constructive interference with the emerging La Nina base state would tend to amplify the MJO. However, dynamical model RMM forecasts indicate a weakening of the MJO signal precisely when that interference should occur.

- The large-scale environment is expected to bring increased chances for tropical cyclone development in the Indian Ocean particularly near the northwest coast of Australia, while TC activity tends to be suppressed over the South Pacific.

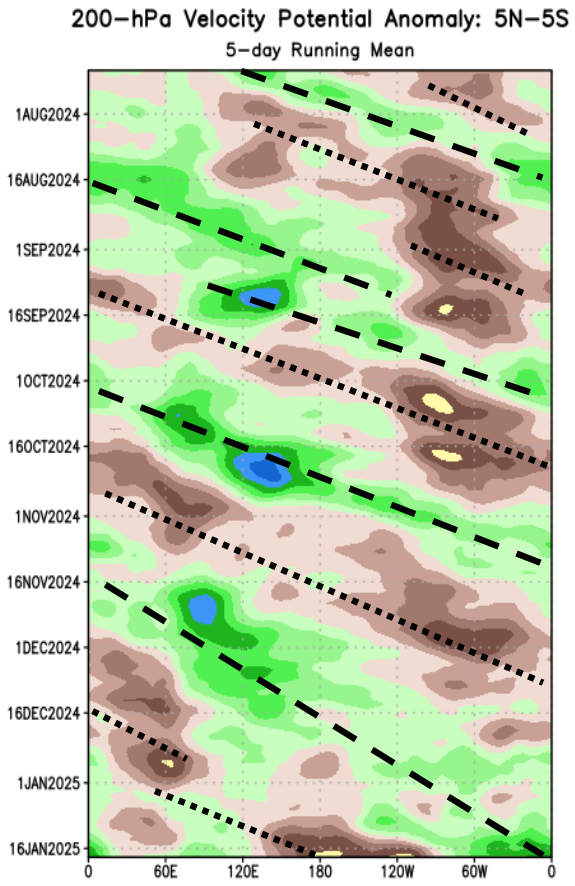
- An eastward propagating Indian Ocean and Maritime Continent MJO historically favors a warm response over the central and eastern CONUS, which would be a welcome change to the frigid conditions experienced recently for much of the Lower 48.

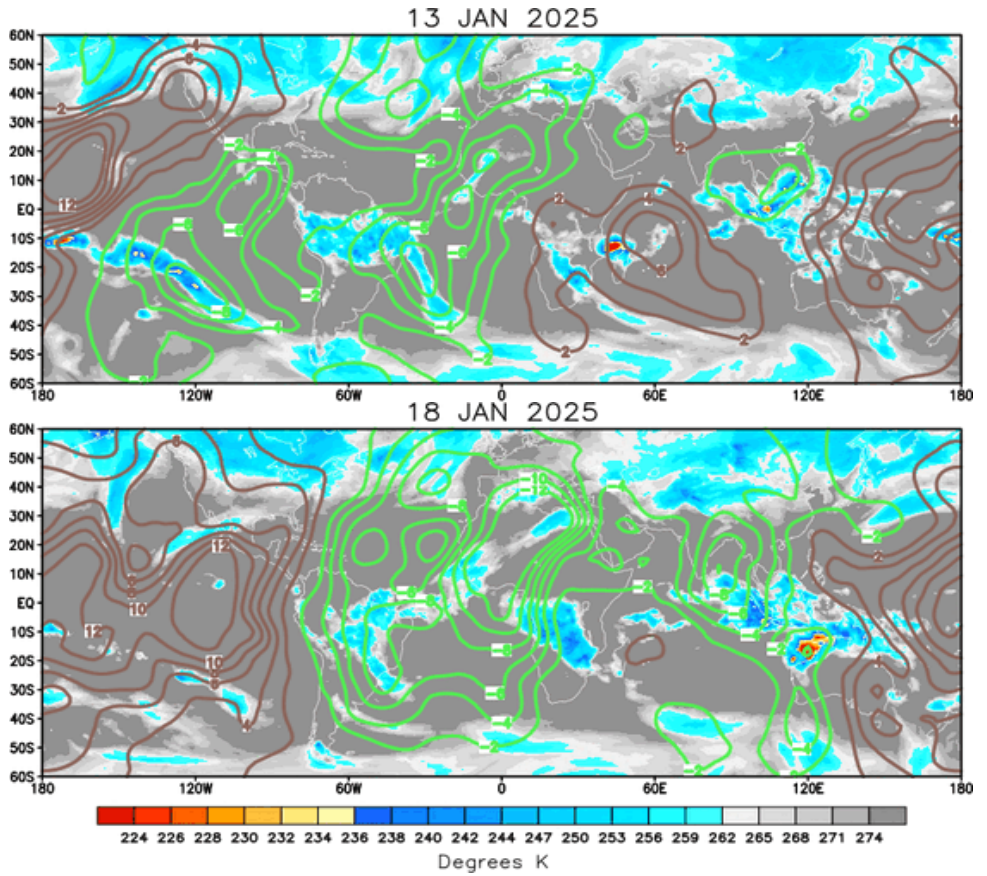
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

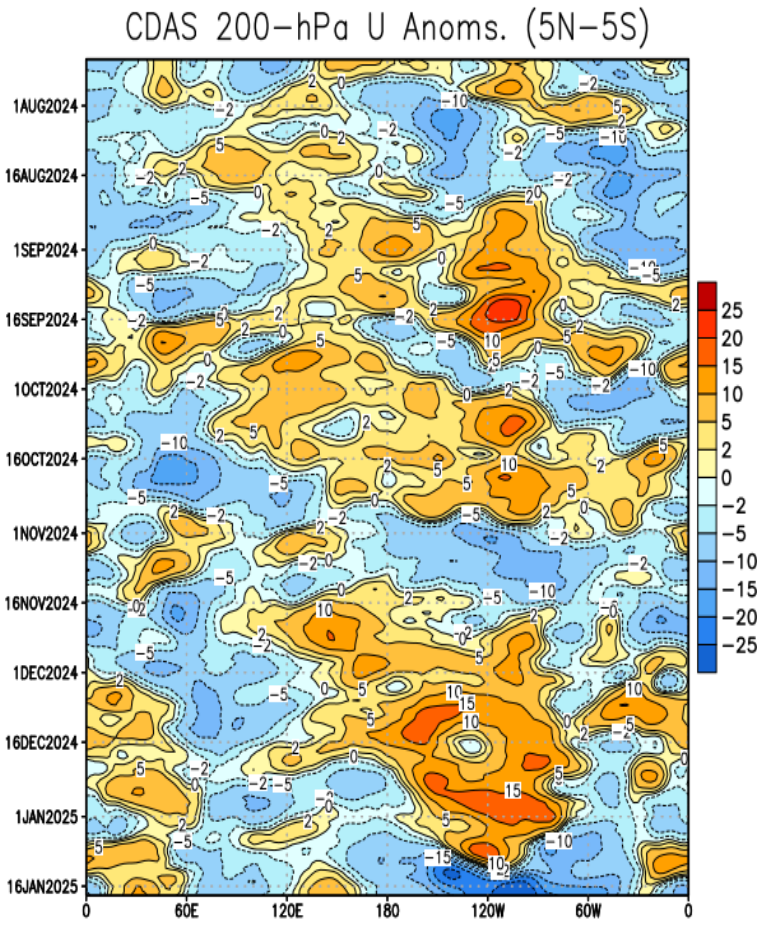


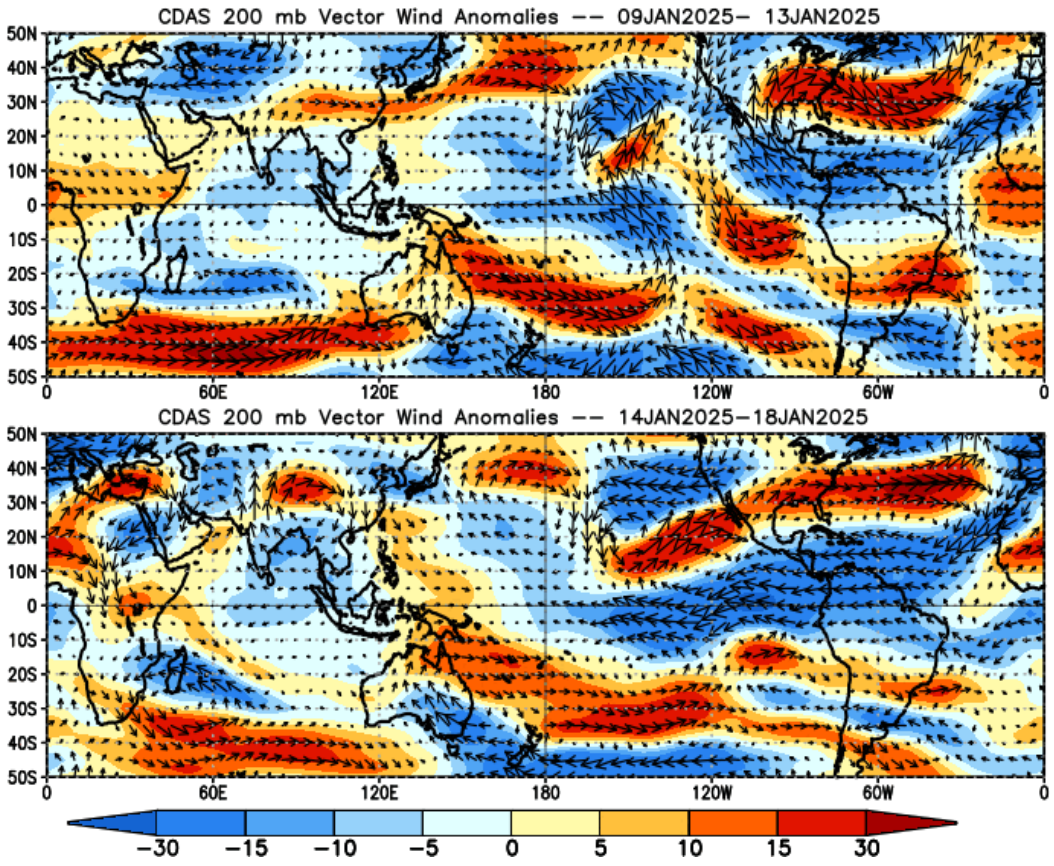


- The upper-level pattern became quite disorganized during early January but has since redeveloped the wave-1 asymmetry characteristic of MJO activity.
- Most recently, the convergence/divergence dipole has become very amplified over the Western Hemisphere, while the leading edge of the enhanced convective envelope has moved over the western Indian Ocean.

200-hPa Wind Anomalies

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

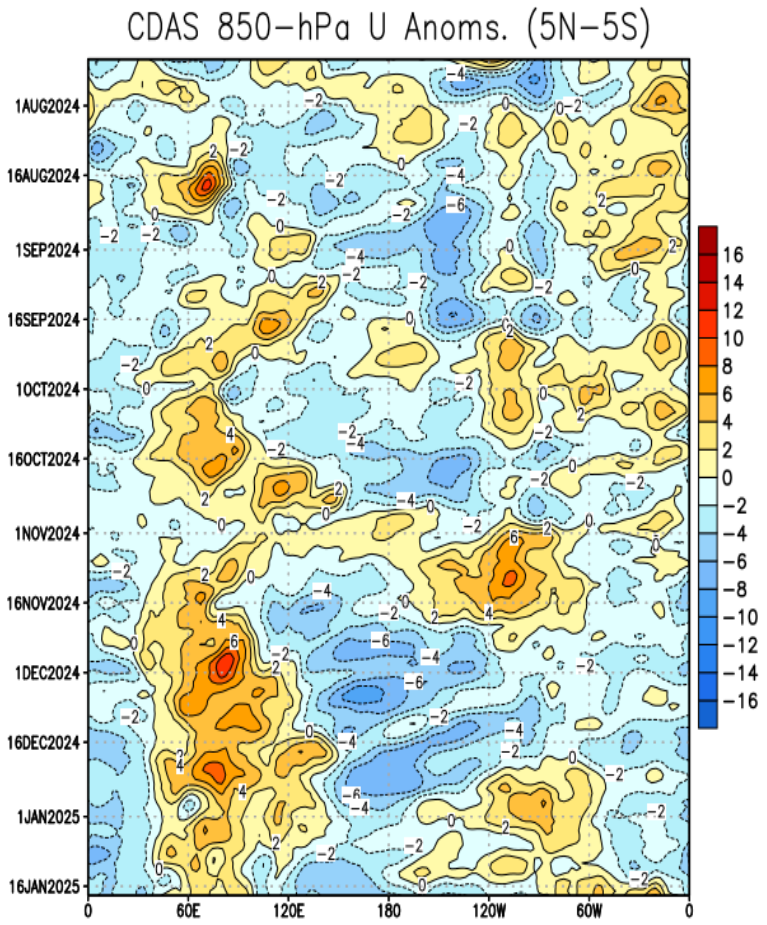


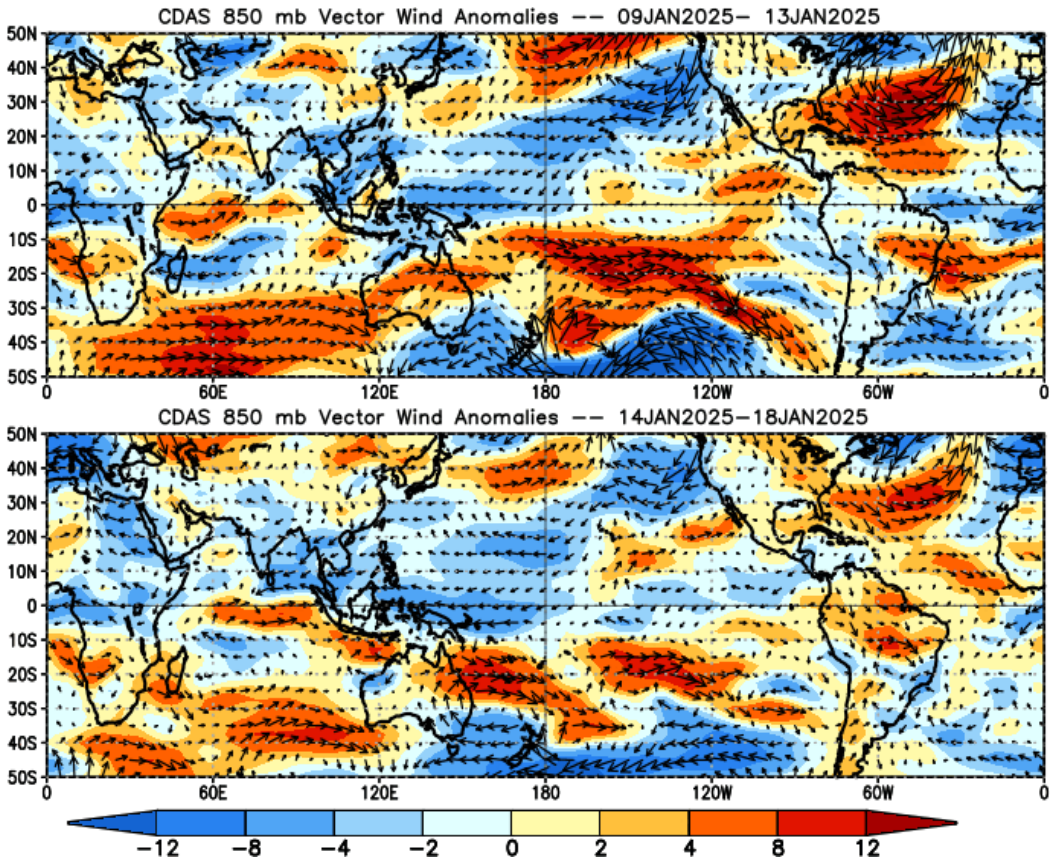


- Anomalous upper-level easterlies have become very strong near the amplified convergence/divergence dipole discussed previously, markedly reversing the low-frequency anomalous westerlies centered on 120W; this event is much stronger than previous MJO excursions through the Western Hemisphere.
- Persistent cyclonic circulation near Hawaii is noted, as well as a robust subtropical jet over the tropical eastern Pacific and southern U.S. in the most recent pentad.

850-hPa Wind Anomalies

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

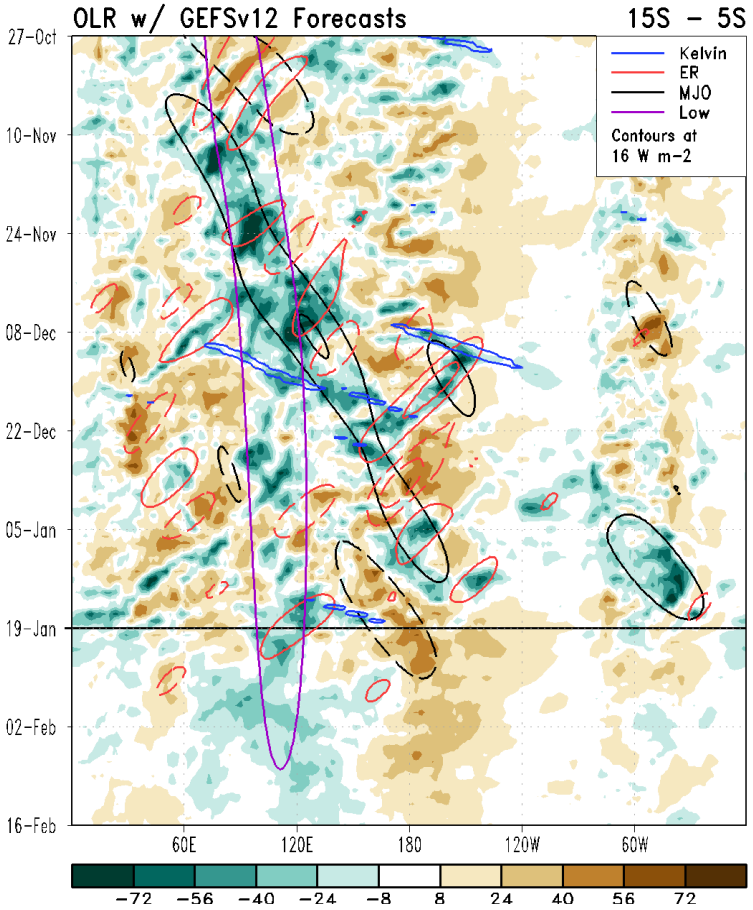


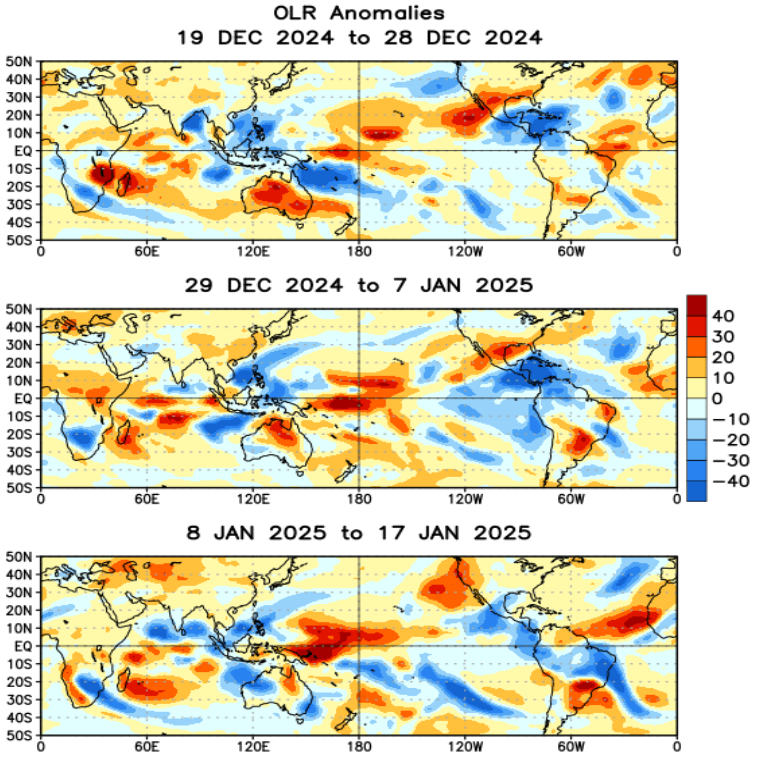


- Low-level westerlies persist, but remained weak across much of the equatorial Indian Ocean relative to much for December. These westerly anomalies may increase as the MJO moves back into the Eastern Hemisphere.
- The enhanced trade regime over the central Pacific is slowly returning as MJO interference with the La Nina base state has been reduced.

Outgoing Longwave Radiation (OLR) Anomalies

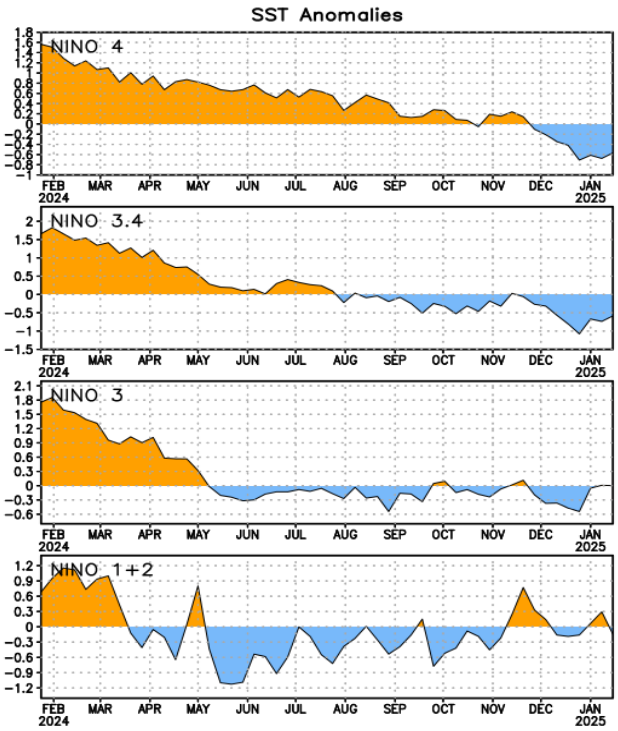
Green shades: Anomalous convection (wetness)
Brown shades: Anomalous subsidence (dryness)

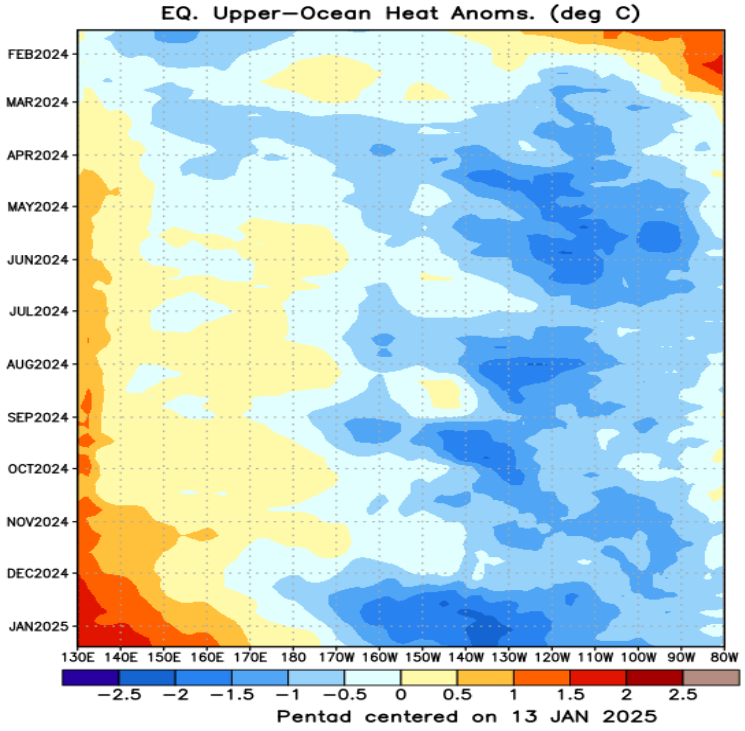




- Tropical convection became quite incoherent early in January, but organized MJO structures have come through the objective filtering recently, indicating increased MJO activity.
- The suppressed convective footprint tied to La Nina has expanded further westward from the Date Line
- OLR forecasts from the GEFS show the low frequency convective dipole strengthening, suggestive of a constructively interfering MJO in the outlook. .

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

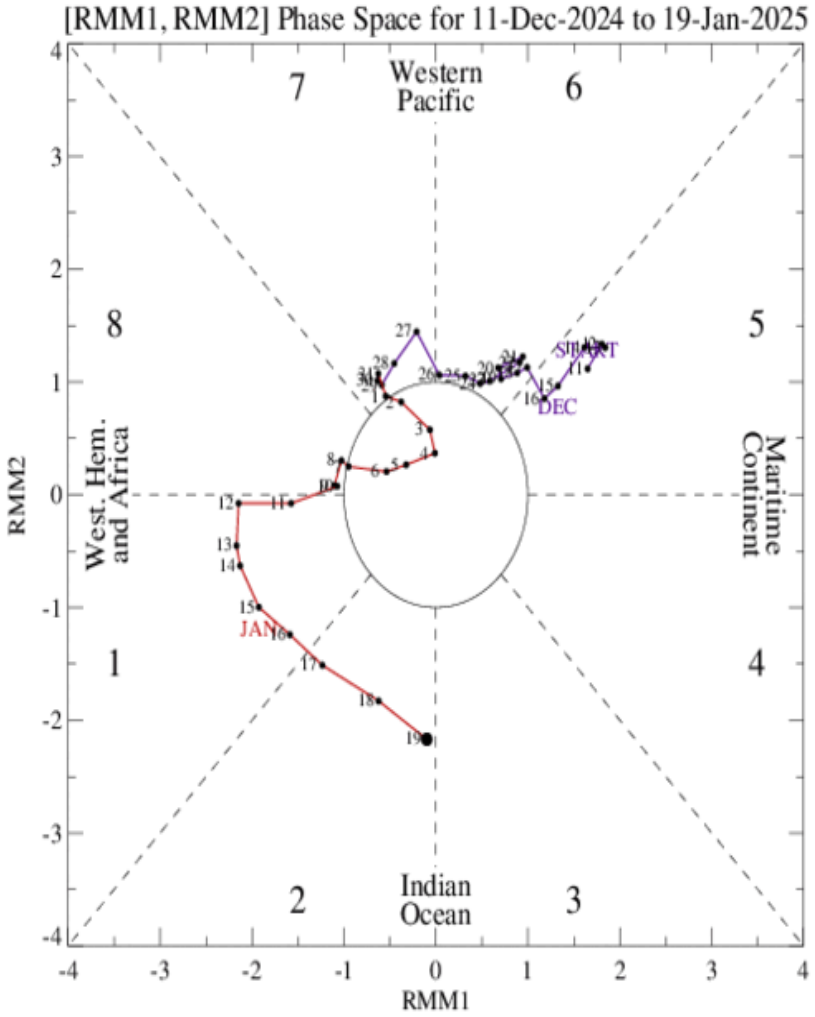




- Enhanced trades and subsequent upwelling during December resulted a sharp drop in sea surface temperatures across the Niño 3.4 and Niño 4 regions, but have rebounded slightly.
- Subsurface heat content of the Equatorial Pacific also indicates a continued development of La Nina conditions, with a noted strengthening and expansion of the Western Pacific Warm Pool and deepening cold anomalies east of the Date Line.

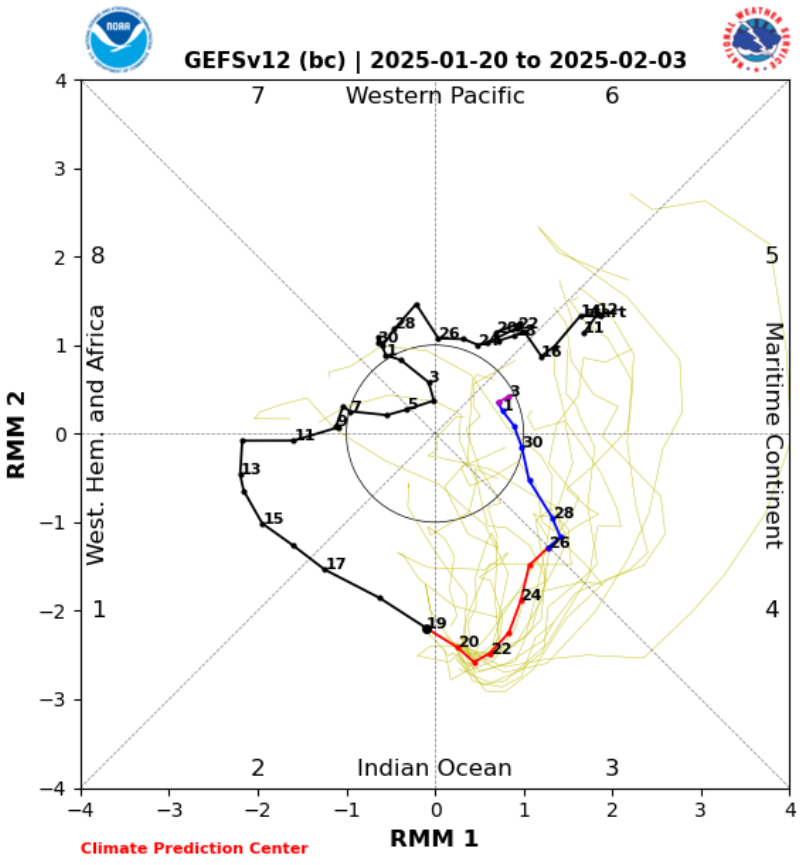
MJO Index: Recent Evolution

- Since weakening and falling within the RMM unit circle during early January, the MJO signal has strengthened considerably, with an increase in amplitude of ~ 2 standard deviations in about a week.
- Over the last week the RMM index has moved swiftly from phases 8-1 to phases 2-3, placing the MJO over the Indian Ocean.

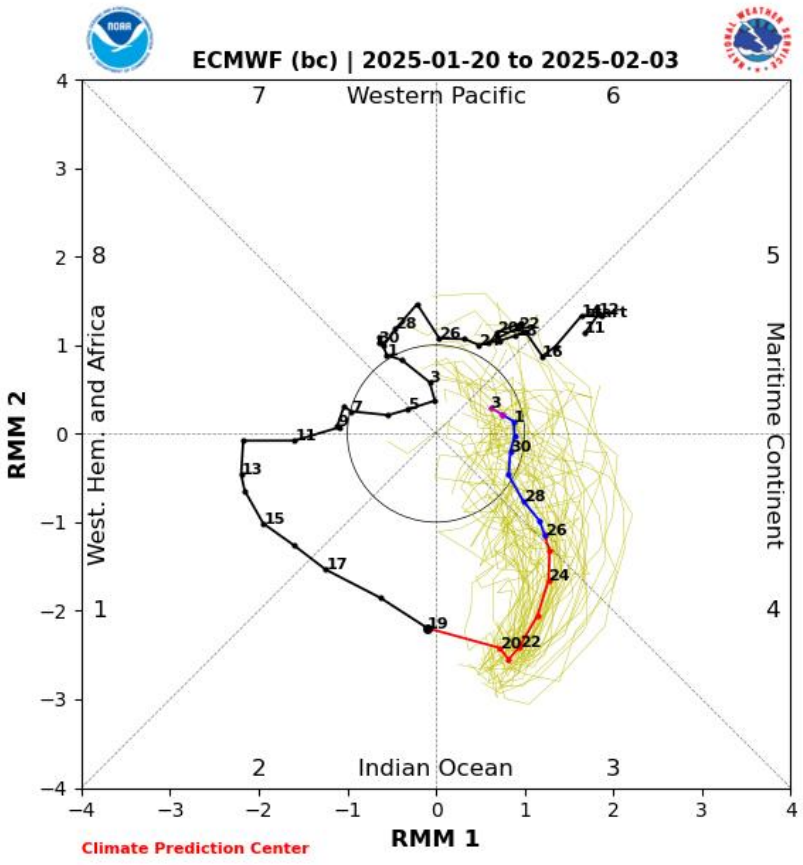


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast

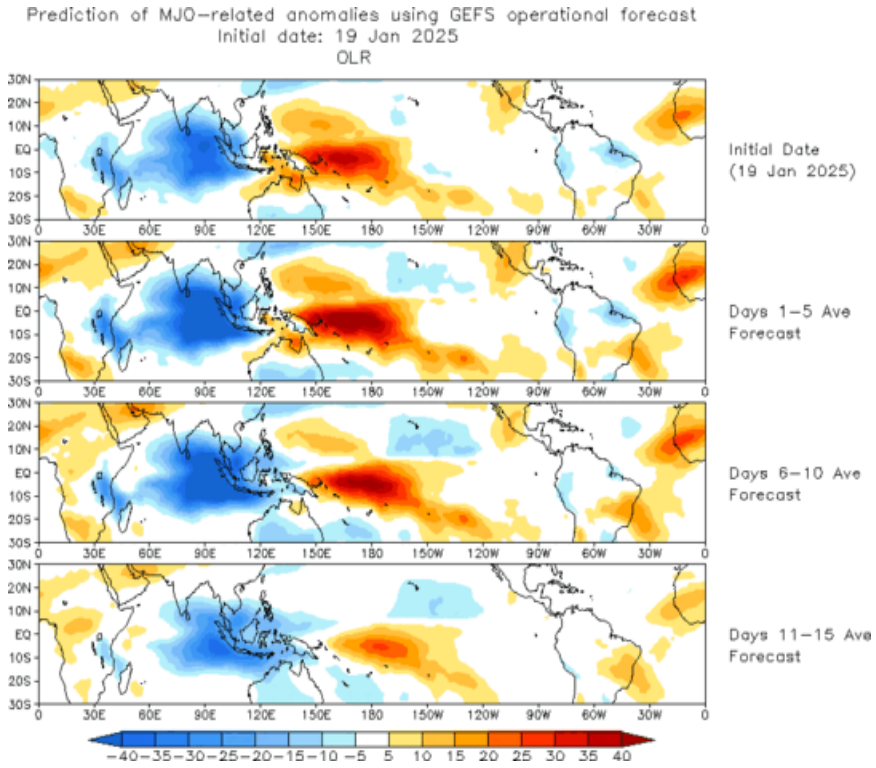


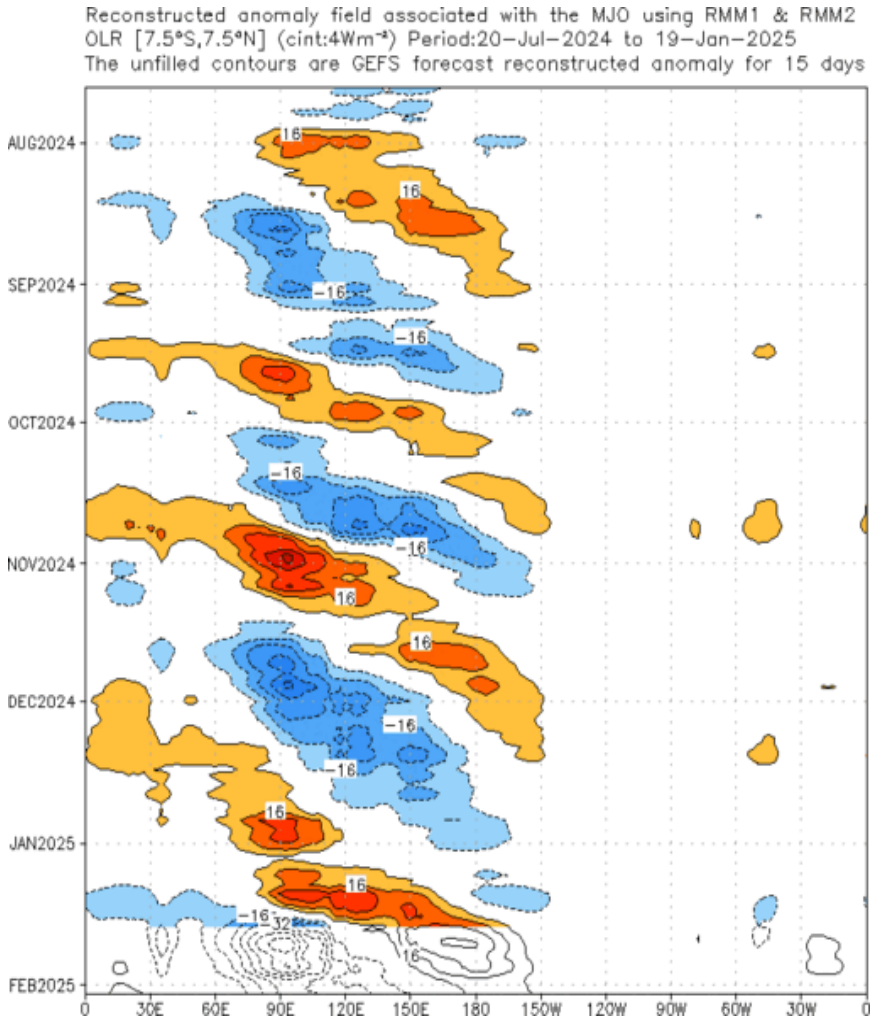
ECMWF Forecast

- Dynamical models are unanimous favoring a reduction of amplitude in the MJO as it propagates into the Maritime Continent, at odds with the potential for constructive interference with the La Nina base state.
- Both the GEFS and ECMWF also indicate a slowing of eastward propagation of the RMM signal after very quick movement over the last week or so.

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.)

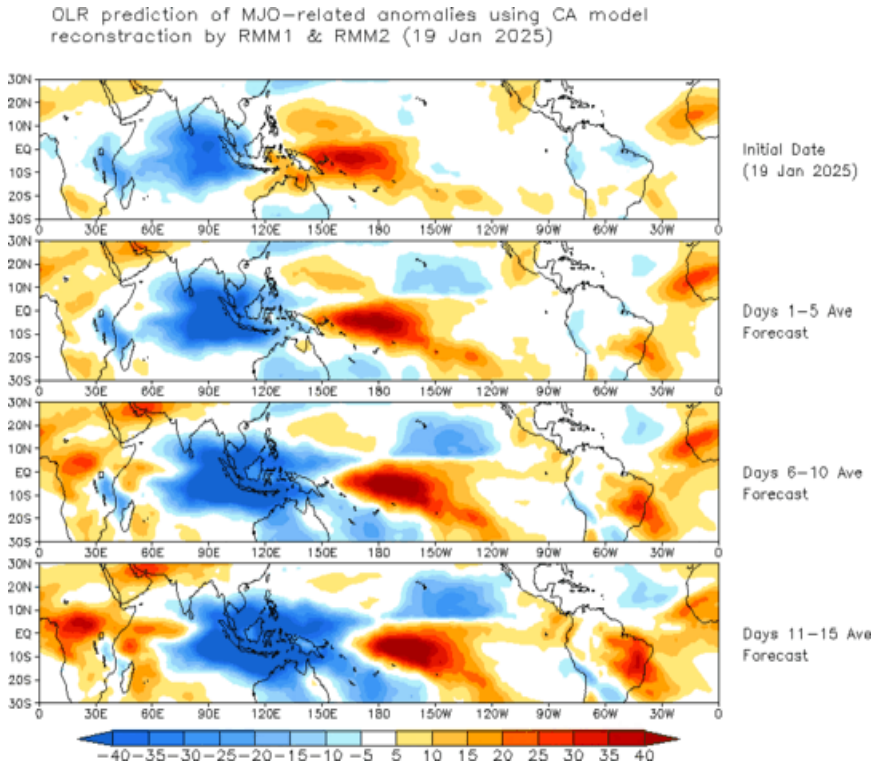


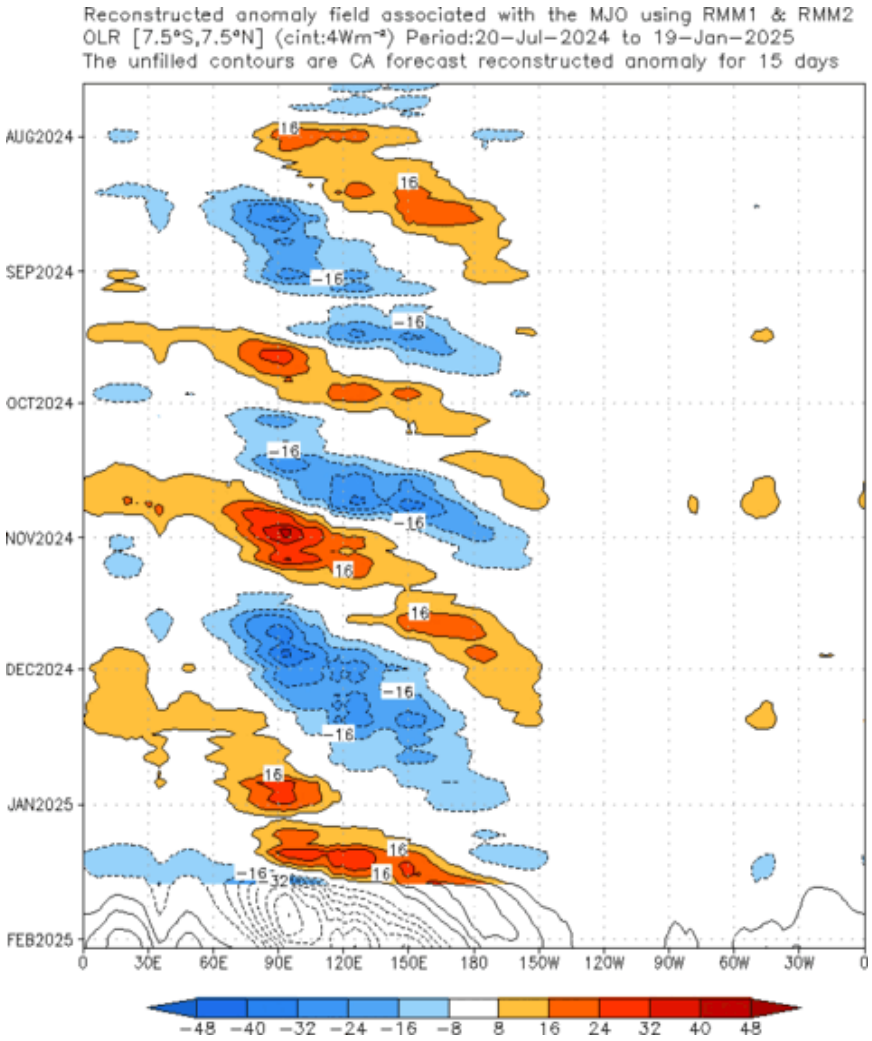


- The GEFS OLR anomaly forecast depicts a strengthening convective dipole consistent with constructive interference involving the La Nina base state, again at odds with the RMM forecast, although the dipole does weaken later in week-2.

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.)

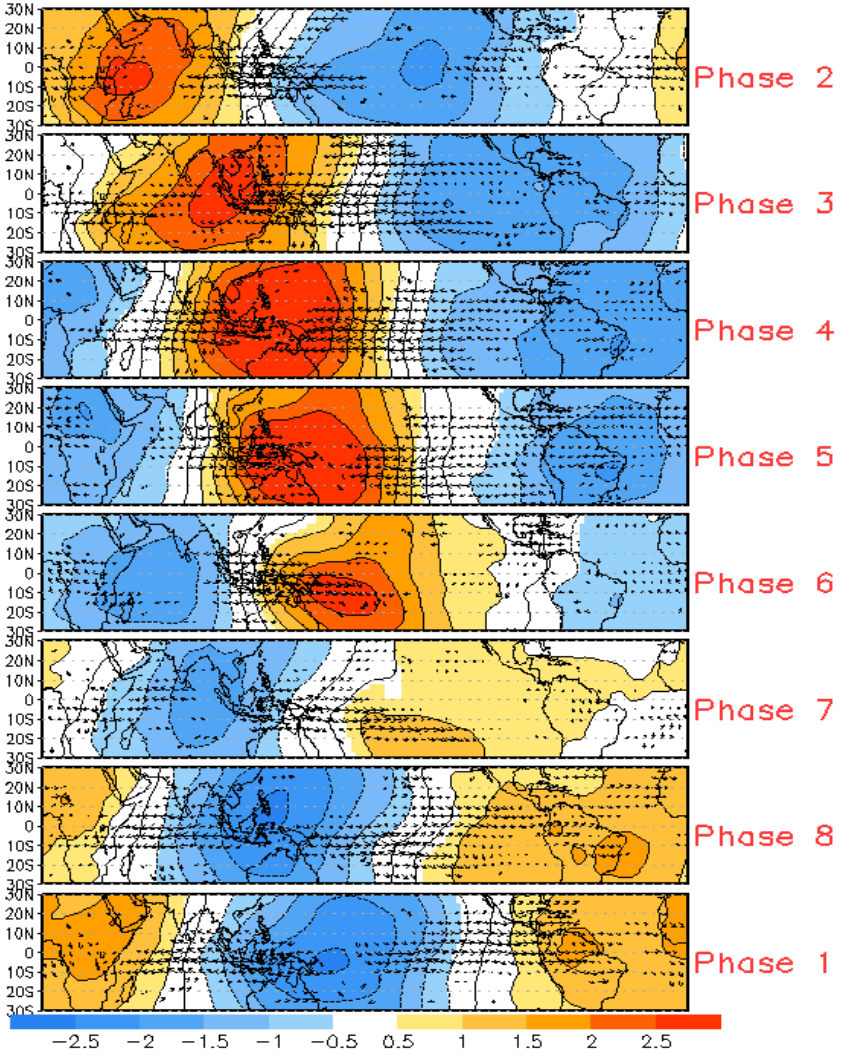




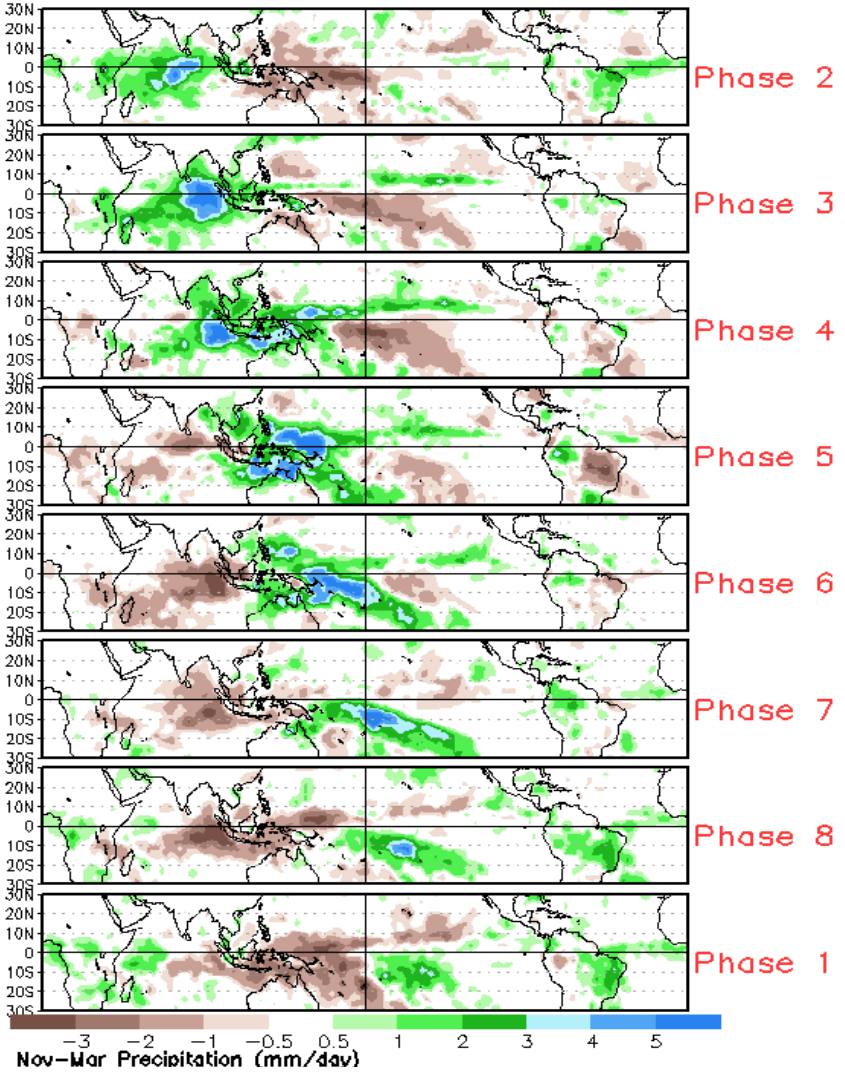
- The constructed analog forecast on the other hand depicts a very amplified and amplifying MJO as it moves from the Indian Ocean into the Maritime Continent.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



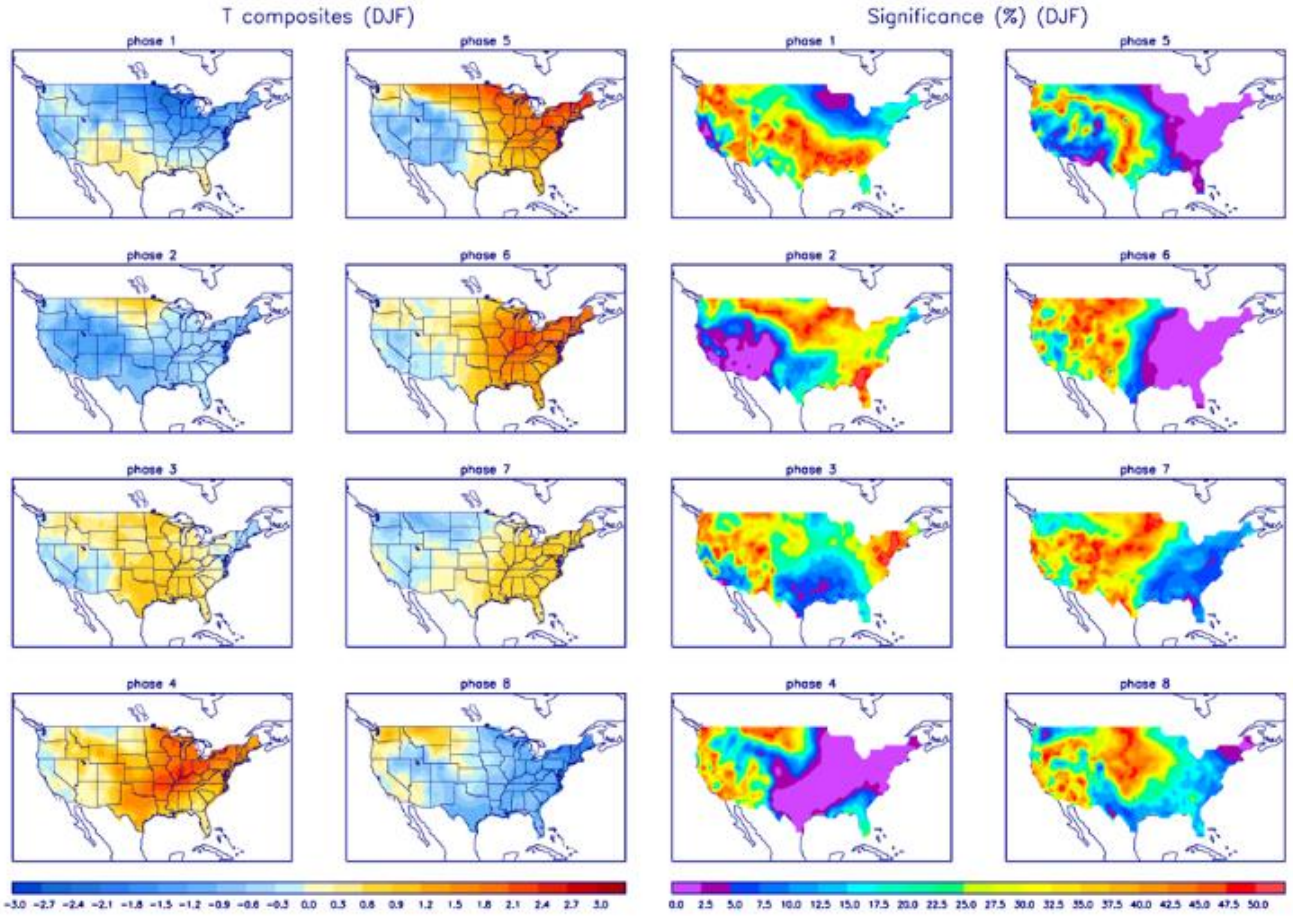
Precipitation Anomalies



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.

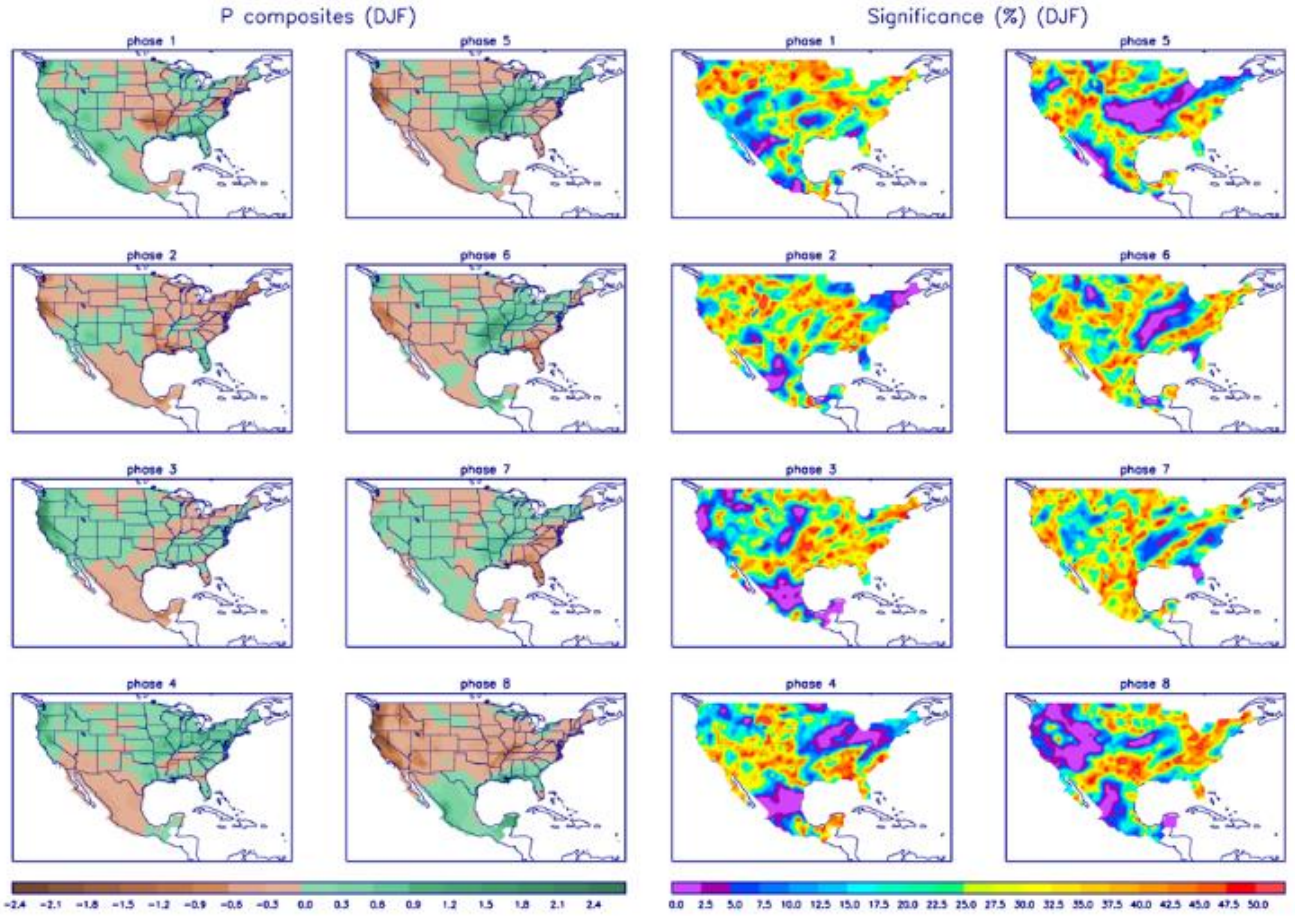


More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

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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