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

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

Overview

- After becoming incoherent during early January, RMM observations show the MJO signal sharply regaining amplitude over the Western Hemisphere (phase 1) but has been somewhat slow to resume its eastward propagation.

- Dynamical models are unanimous in favoring a high amplitude MJO event that propagates from the Western Hemisphere and across the Indian Ocean during the next few weeks.
    - Of note is the accelerated phase speed in the RMM outlooks, which points to convectively coupled Kelvin Wave activity constructively interfering with the MJO through late January.

- The MJO also looks to constructively interfere with the emerging low frequency base state. This may lead to a westerly wind burst event in the Indian Ocean, as well as a trade wind surge event in the equatorial Pacific, which may lead to stronger La Nina conditions later this winter.

- The large-scale environment is expected to bring increased chances for tropical cyclone development in the Indian Ocean, with decreased chances over the South Pacific. Conditions may become more favorable for tropical cyclogenesis in the western Pacific by early February.

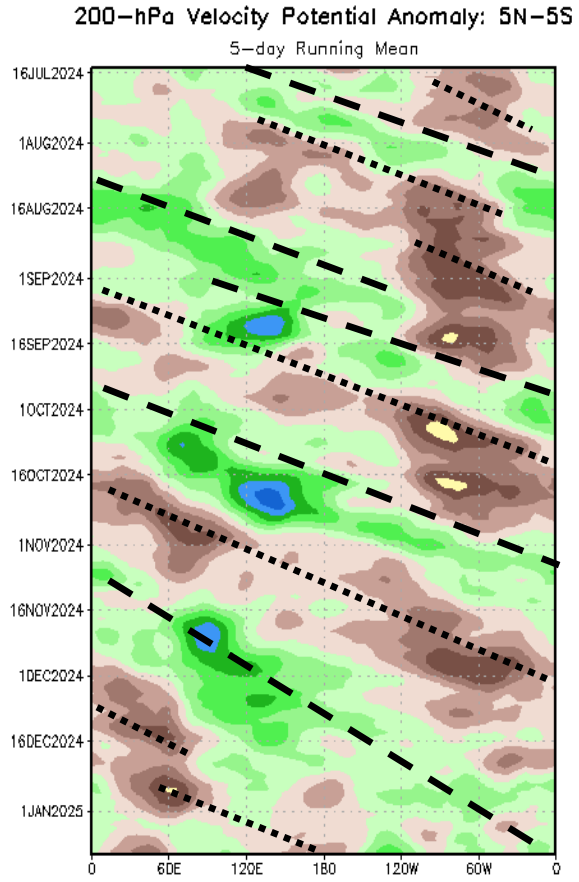
- An eastward propagating Indian Ocean and Maritime Continent MJO historically favors a warm response over the central and eastern CONUS, but this is at odds with substantially cold solutions in the dynamical model guidance through the end of January.

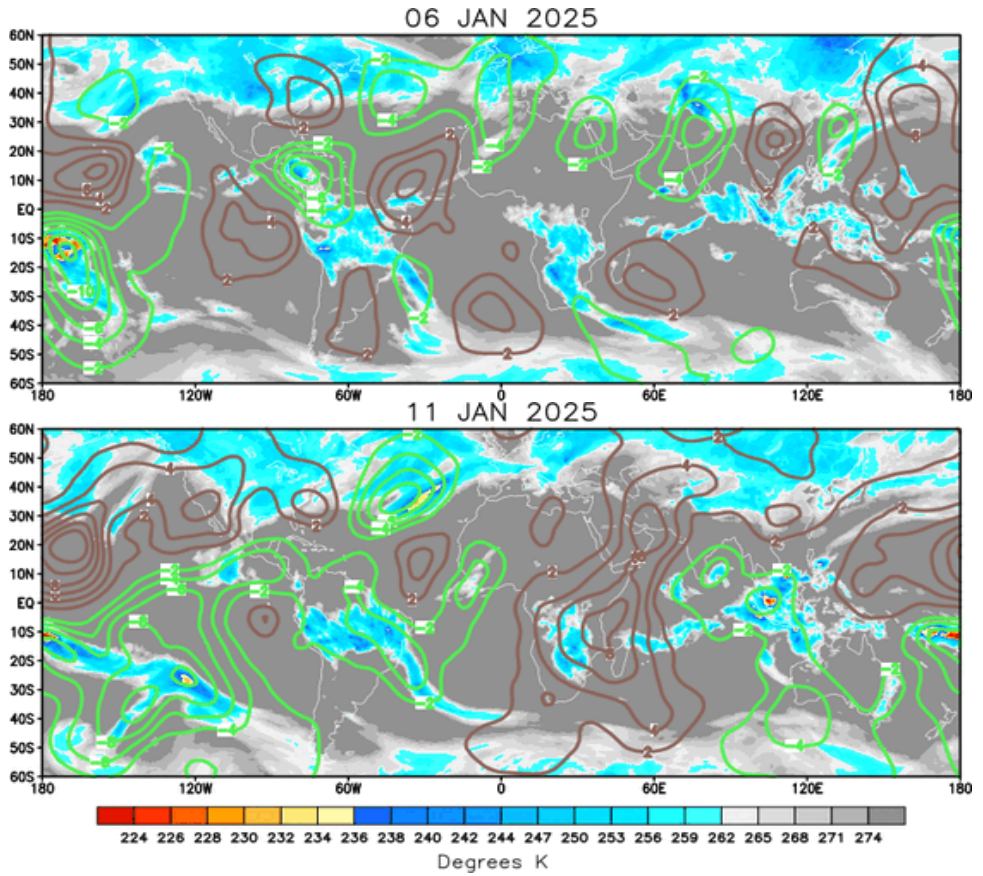
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

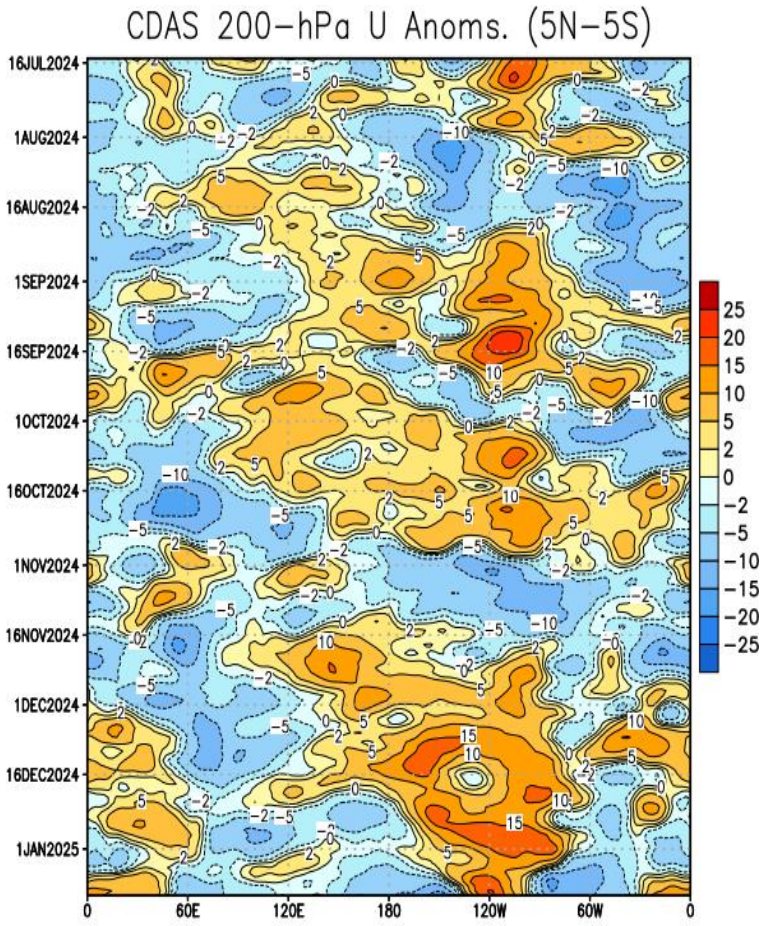


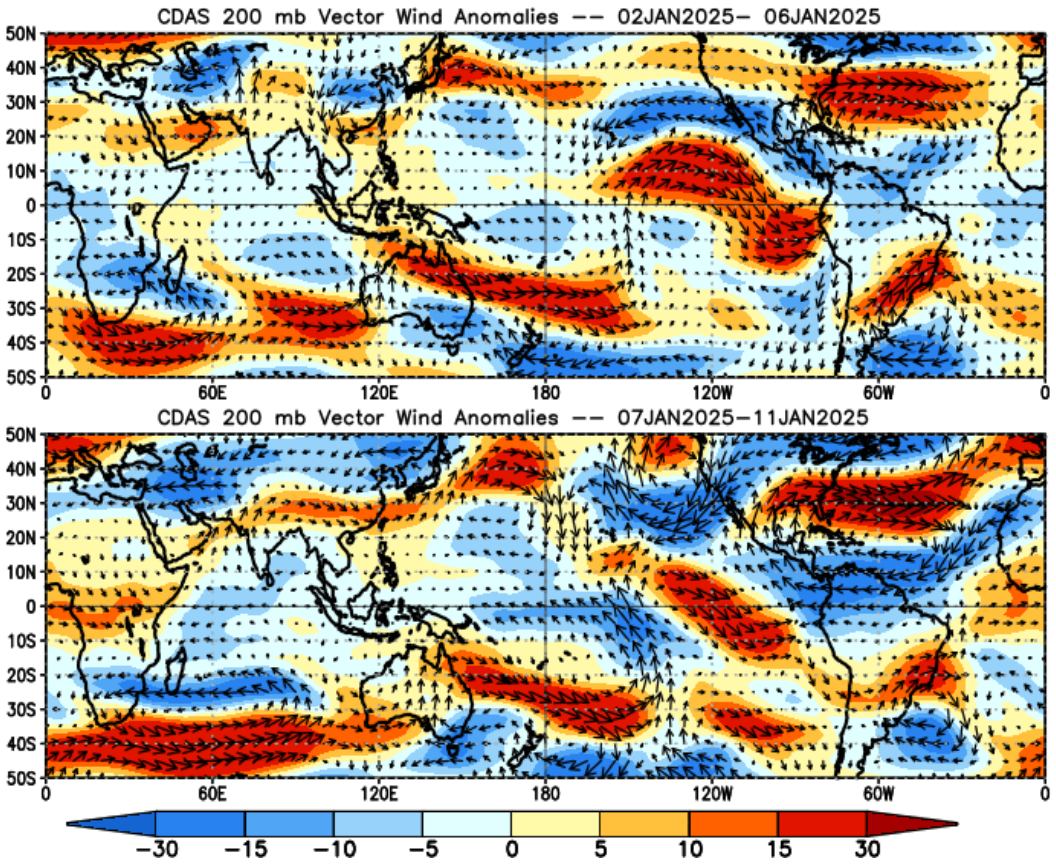


- The upper-level pattern became quite disorganized during early January likely due to competing tropical variability.
- More recently, subseasonal activity has shown better signs for reorganizing, with the enhanced envelope of divergence aloft becoming more spatially contiguous over Western Hemisphere. Low frequency footprints remain evident.

200-hPa Wind Anomalies

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

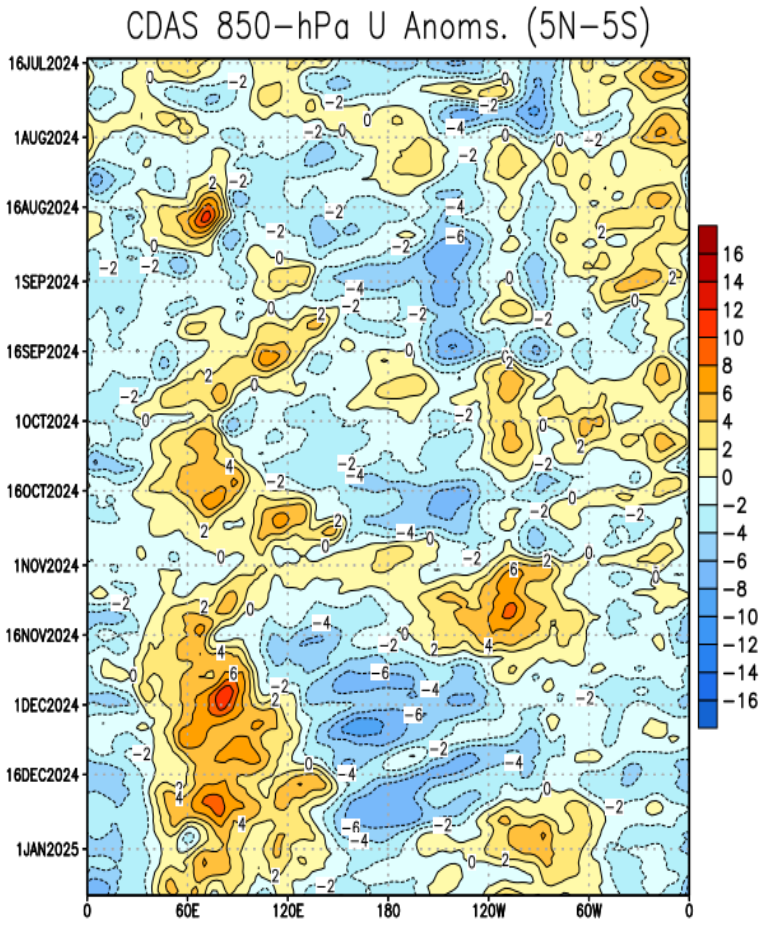


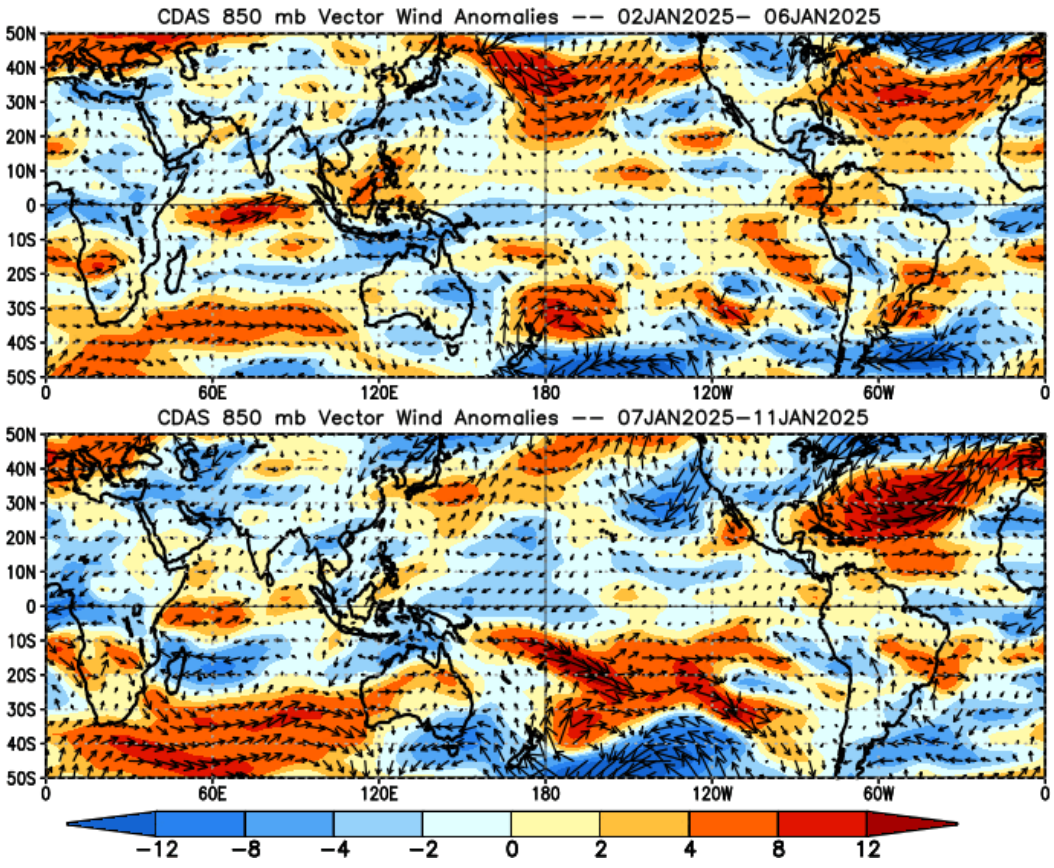


- Anomalous upper-level easterlies have strengthened along and to the east of the Date Line in the equatorial Pacific, destructively interfering and eroding the low frequency westerlies.
- Anomalous westerlies developed over equatorial Africa, aiding in the return of enhanced convergence aloft.
- Closer to North America, strong ridging is present over the eastern Pacific with broad troughing downstream over the central and eastern CONUS.

850-hPa Wind Anomalies

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

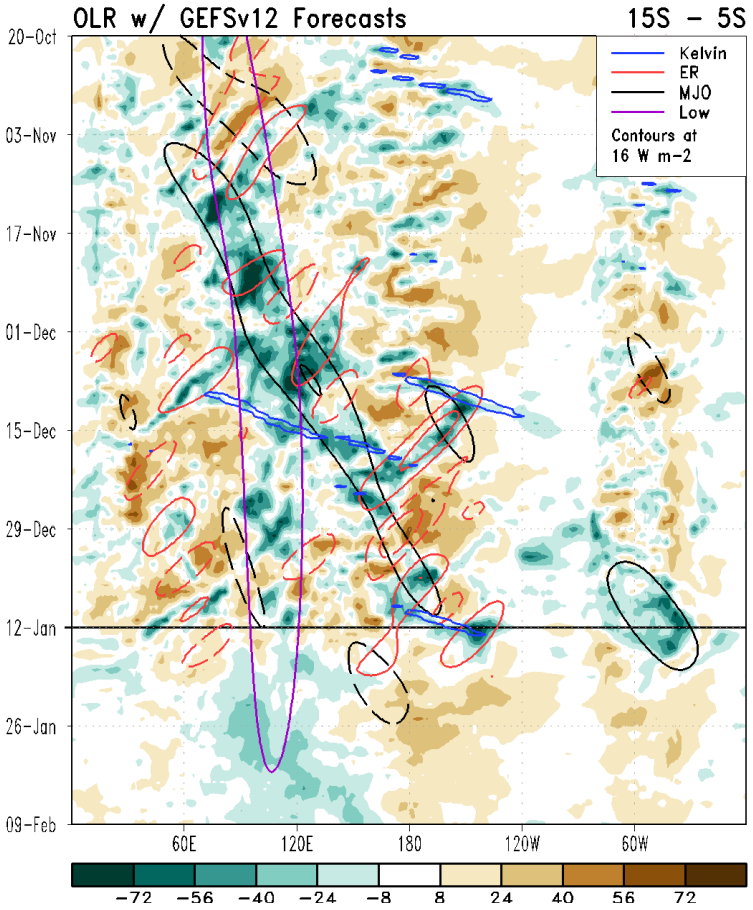


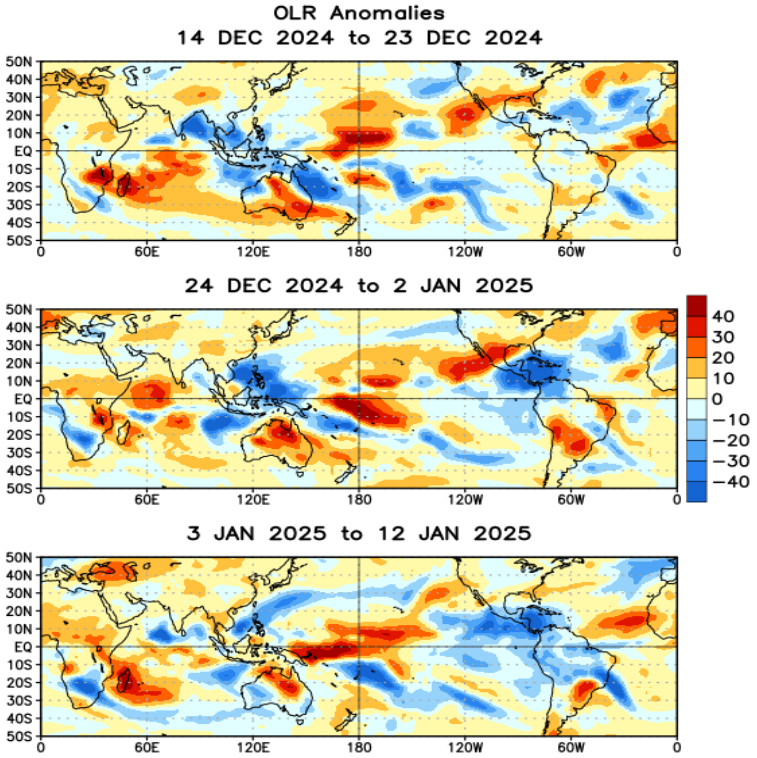


- Low-level westerlies persist, but have somewhat weakened across much of the equatorial Indian Ocean.
- The enhanced trade regime over the central Pacific has continued to ease, consistent with the MJO destructive interfering with the La Nina base state.
- In the South Pacific, a band of strong westerlies was observed and contributed to tropical cyclone development where the MJO appears to be expressing itself.

Outgoing Longwave Radiation (OLR) Anomalies

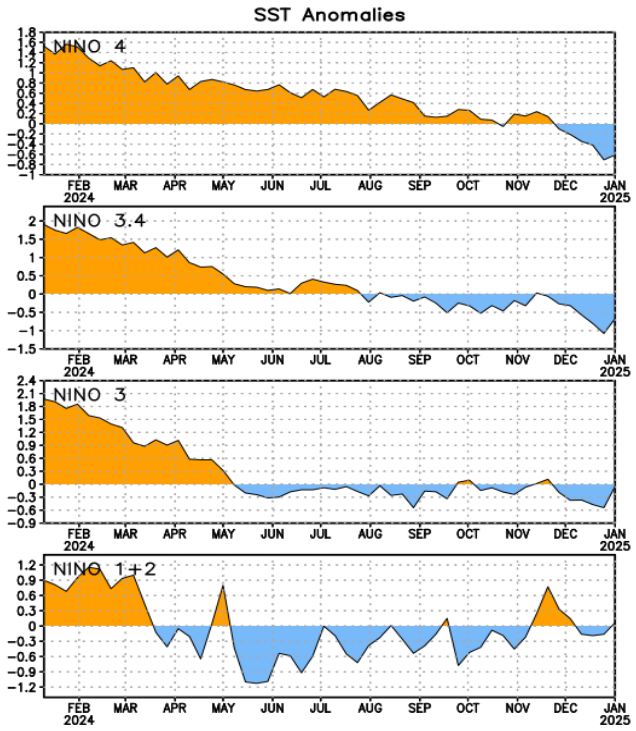
Green shades: Anomalous convection (wetness)
Brown shades: Anomalous subsidence (dryness)

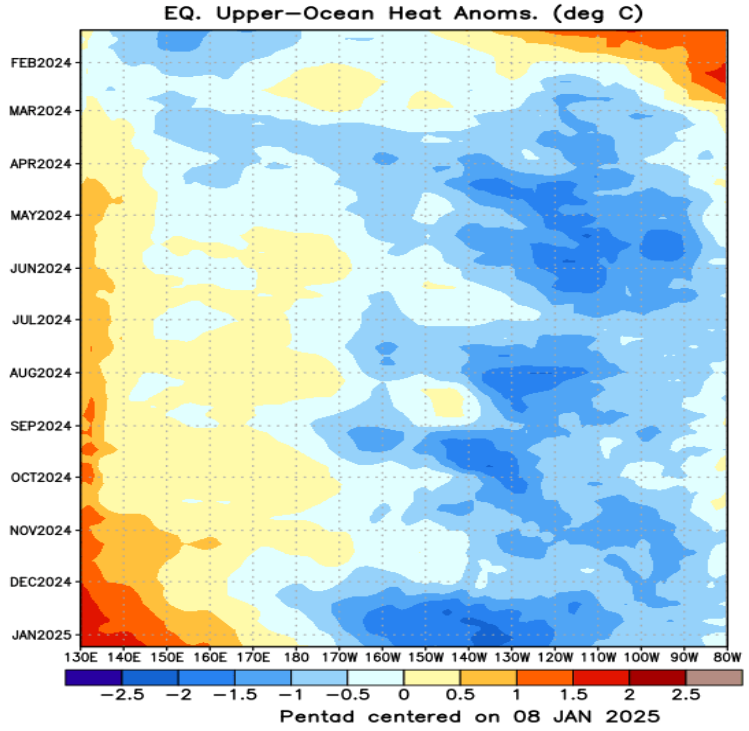




- Enhanced convection over the eastern Indian Ocean and Maritime Continent has become generally weaker compared to December.
- The suppressed convective footprint tied to La Nina has expanded further westward from the Date Line
- OLR forecasts from the GEFS show the low frequency convective dipole strengthening, suggestive of a constructively interfering MJO in the outlook. .

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

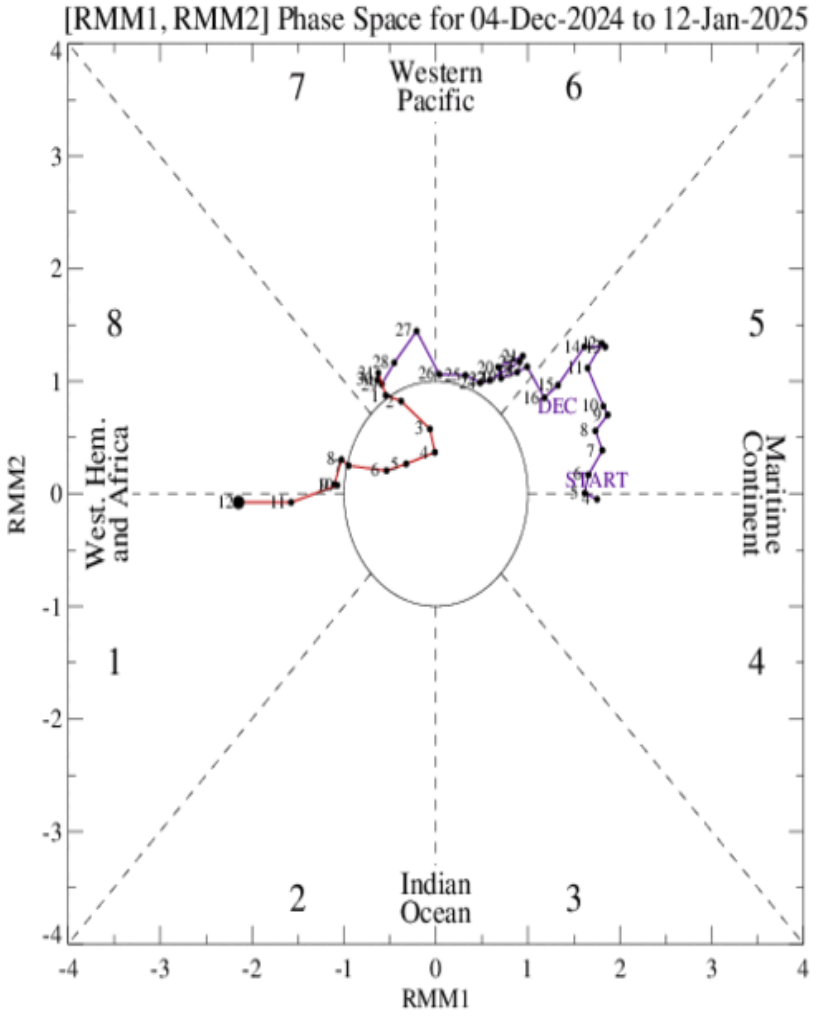




- Enhanced trades and subsequent upwelling during December resulted a sharp drop in sea surface temperatures across the Niño 3.4 and Niño 4 regions, but have rebounded slightly.
- Unlike the surface, subsurface anomalies exhibit less variability, with a noted strengthening and expansion of the Western Pacific Warm Pool.

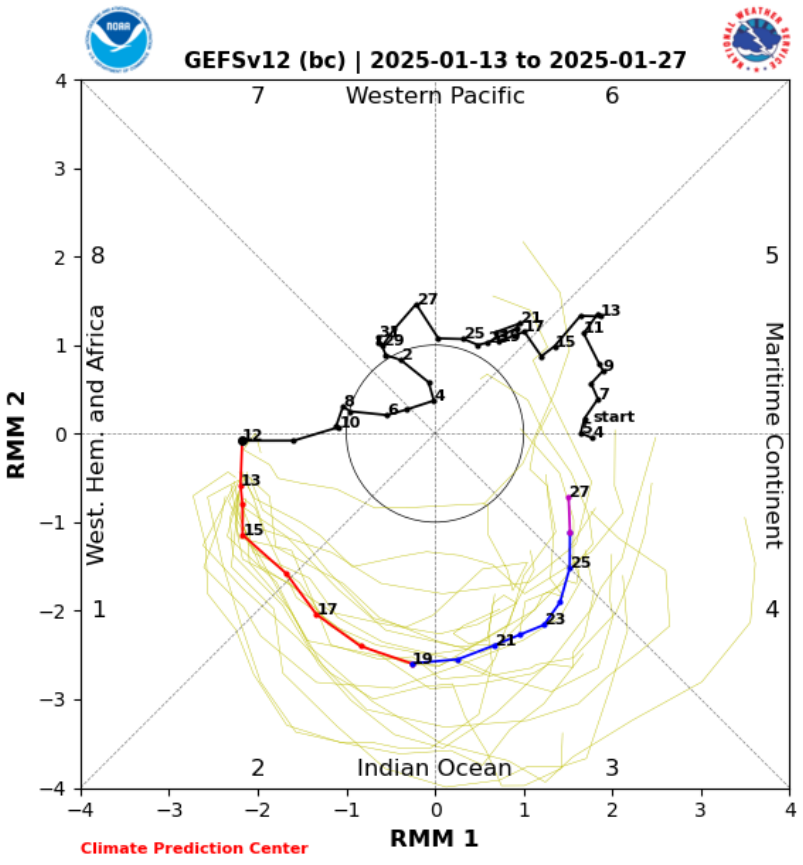
MJO Index: Recent Evolution

- 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.
- Eastward propagation has stalled somewhat, but has shifted into phase 1.

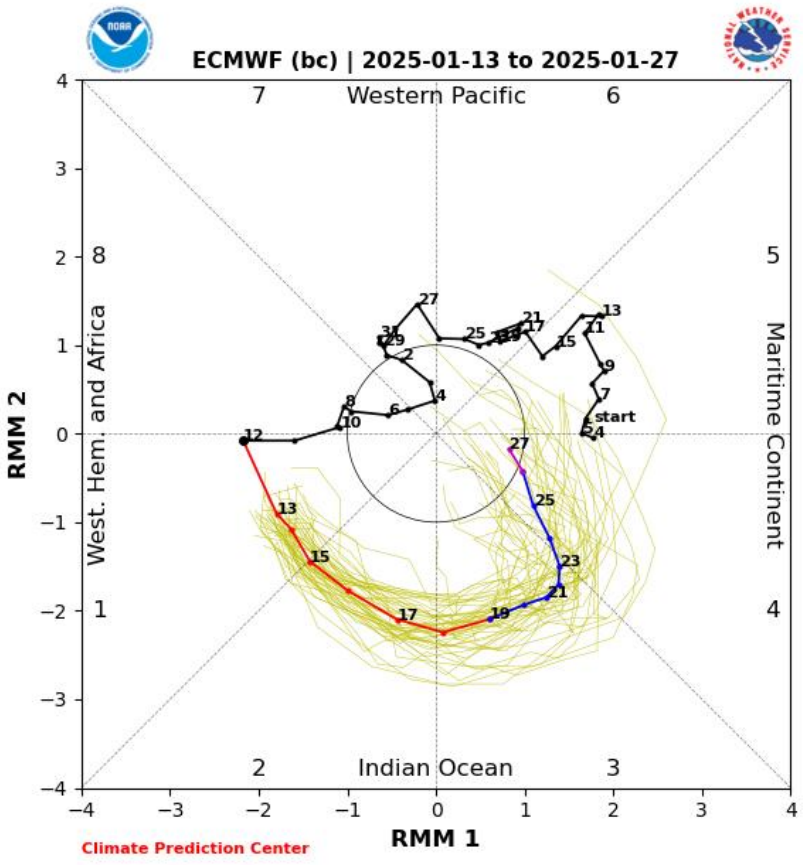


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast

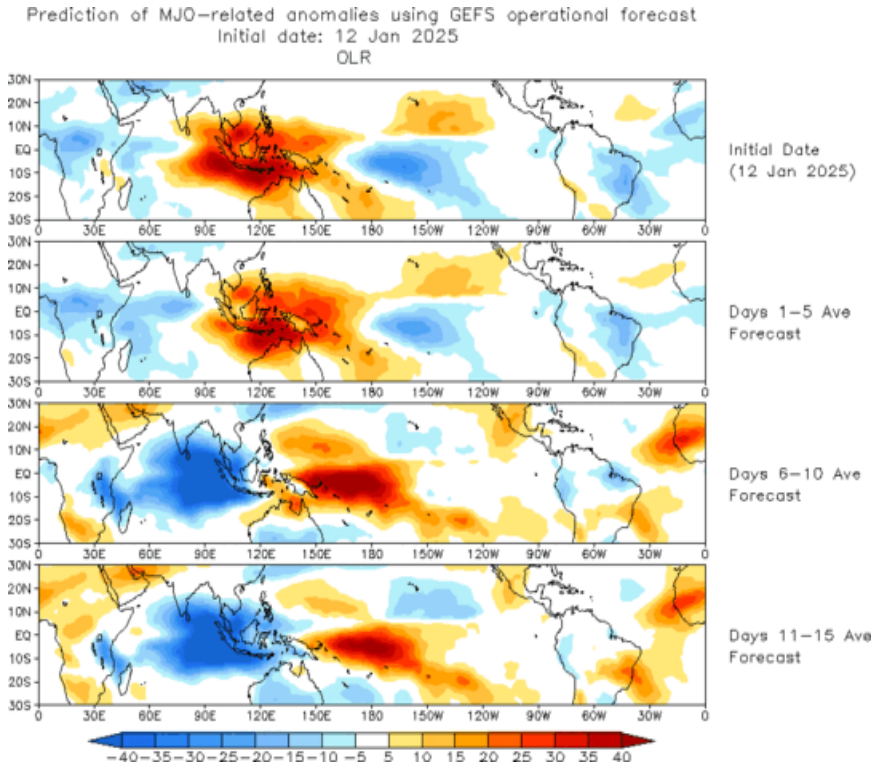


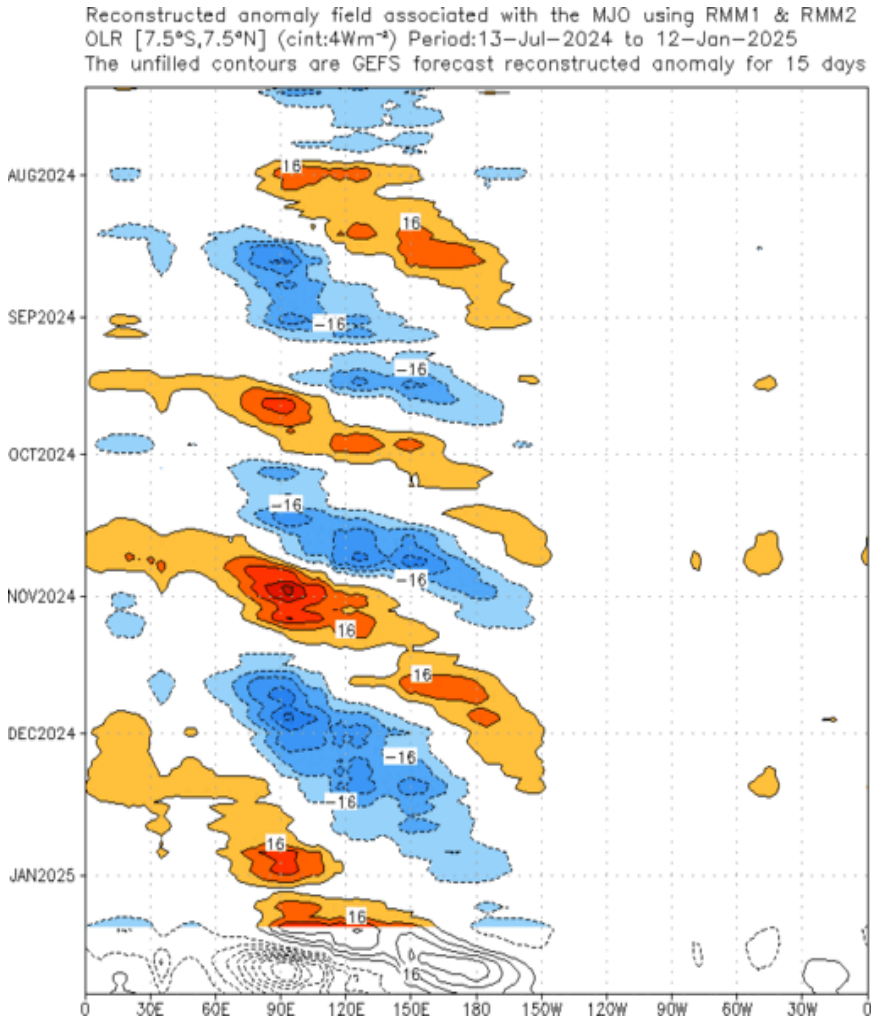
ECMWF Forecast

- Dynamical models are unanimous favoring a high amplitude MJO event that propagates from the Western Pacific and into the Indian Ocean during the next couple of weeks.
- Besides the high amplitude forecast in the ensemble means (and members), there is an accelerated phase speed evident (4 phases in 2 weeks) that is suggestive of convectively coupled Kelvin Wave activity. This activity is supported in the objective wave filtered velocity potential forecasts that is also constructively interfering with the MJO.

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.)

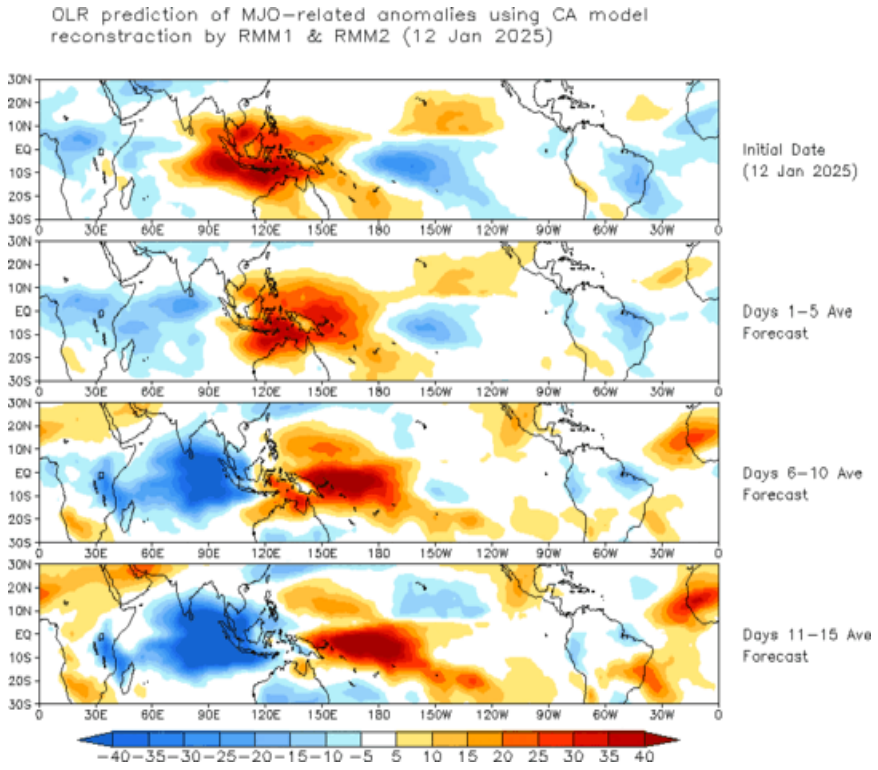


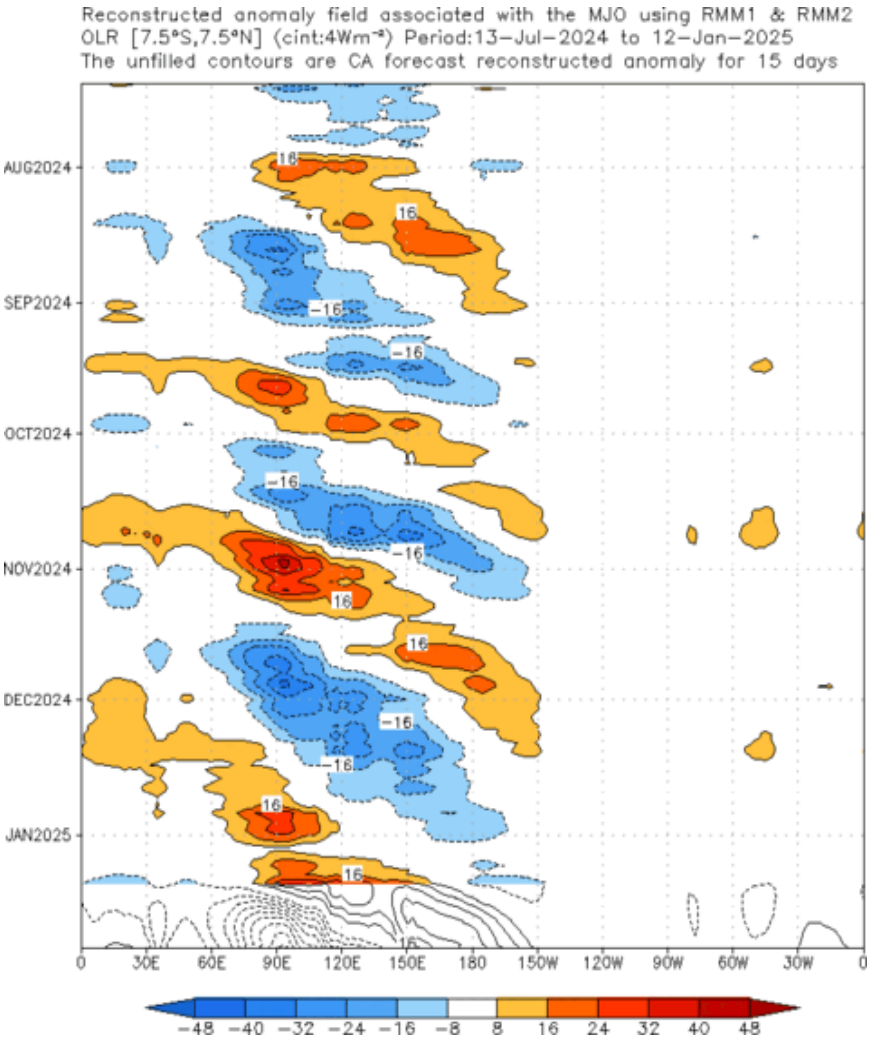


- The GEFS OLR anomaly forecast depicts a strengthening convective dipole consistent with a canonical Indian Ocean MJO.

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.)

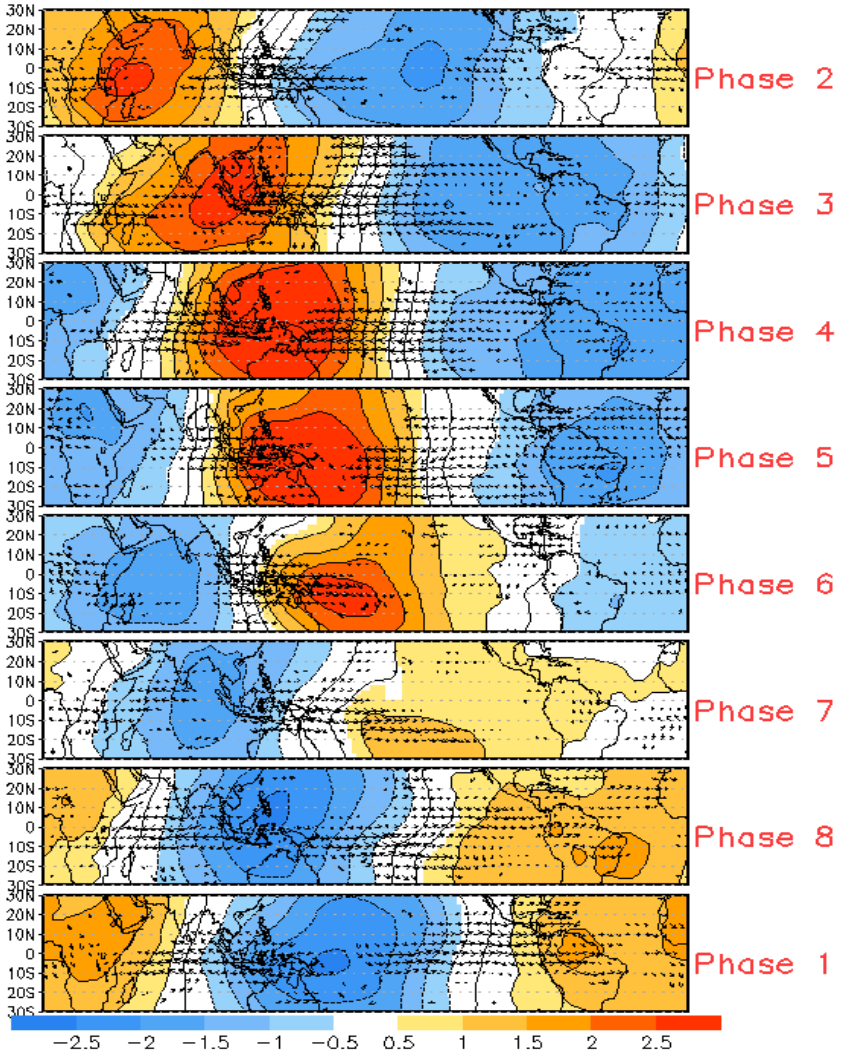




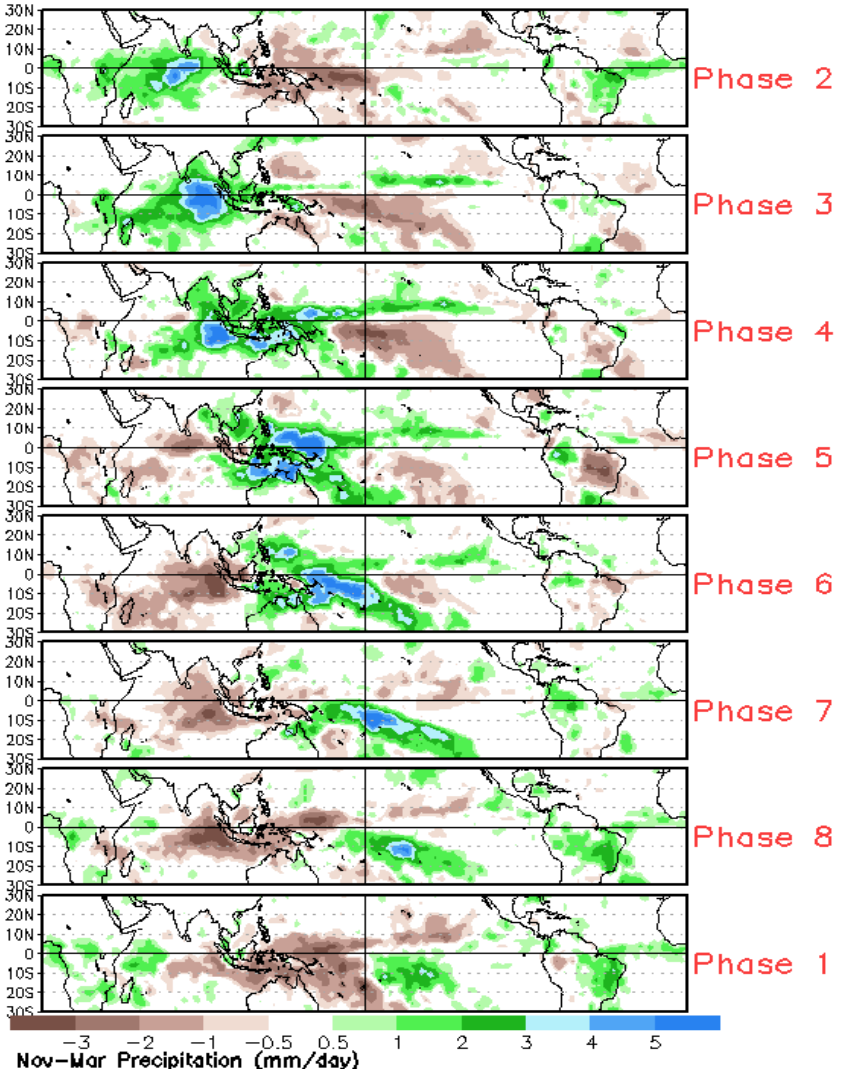
- The constructed analog forecast is nearly identical to the GEFS with the exception of a slower and stronger convective signal.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



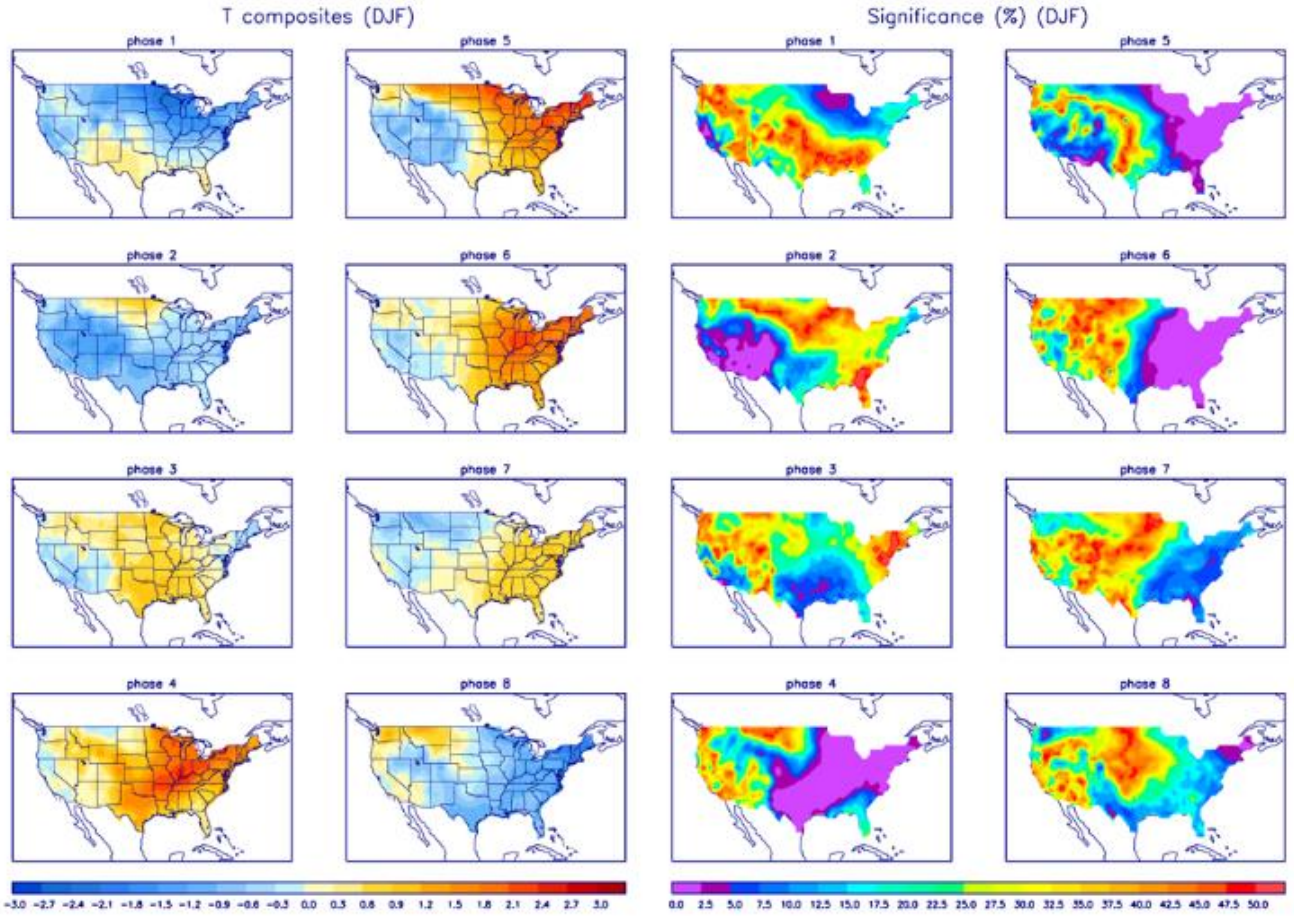
Precipitation Anomalies



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.

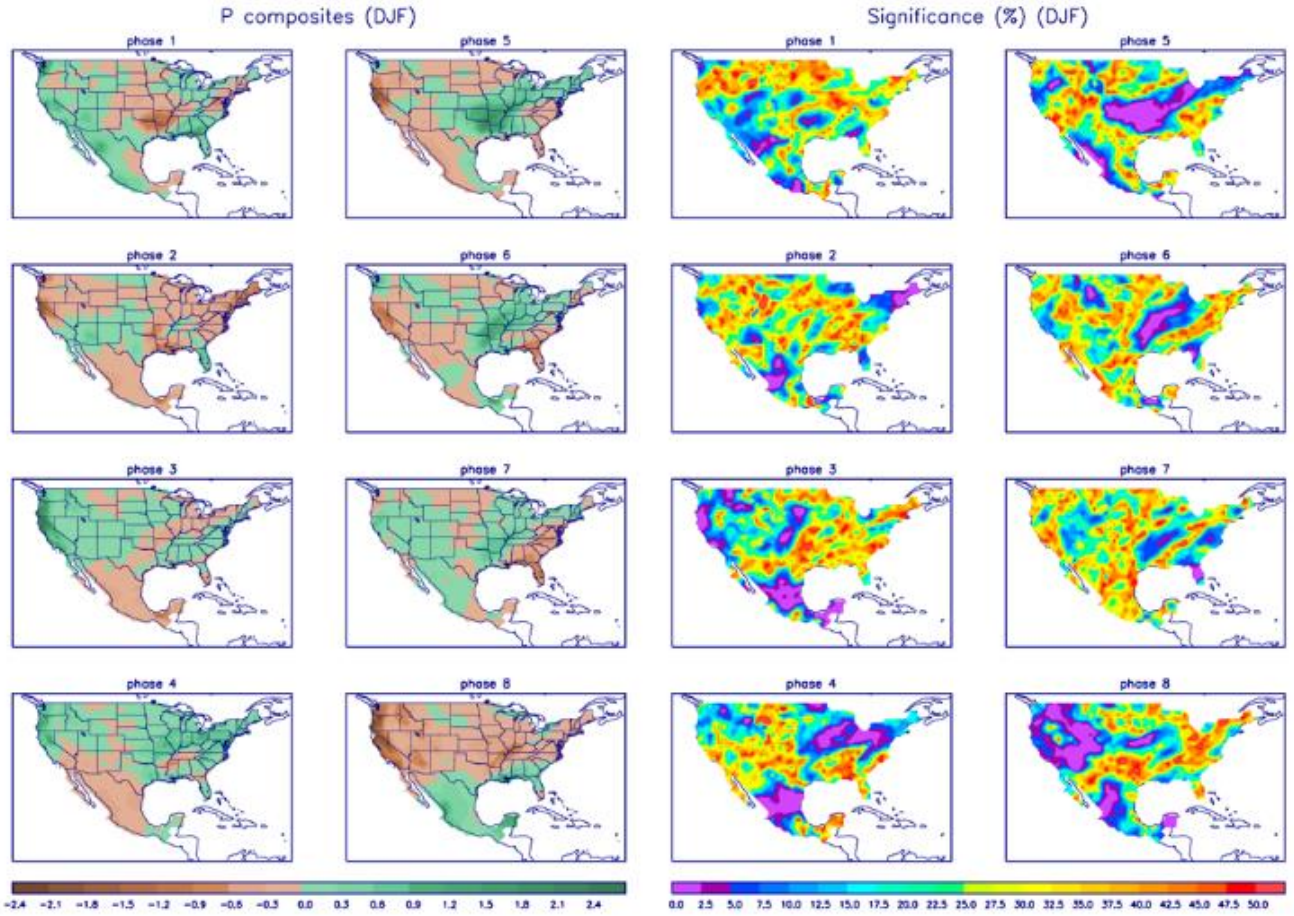


More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

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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