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

Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
15 January 2024

Overview

- Following a period of competing interference with other modes of tropical variability, the MJO became more coherent over the Indian Ocean and propagated eastward into the Maritime Continent.

- Very good agreement exists in the dynamical models, which heavily favor a high amplitude Maritime Continent and Western Pacific MJO event through the end of January.

- While there is some uncertainty in the strength of the MJO in the extended range, the MJO appears more likely to again constructively interfere with the El Nino response over the equatorial Pacific.

- A healthy, eastward propagating MJO is expected to provide increasingly favorable conditions for Tropical Cyclone development over southeastern Indian Ocean, and the western Pacific on both sides of the equator. Conversely, more unfavorable conditions for development are anticipated over the southern Indian Ocean.

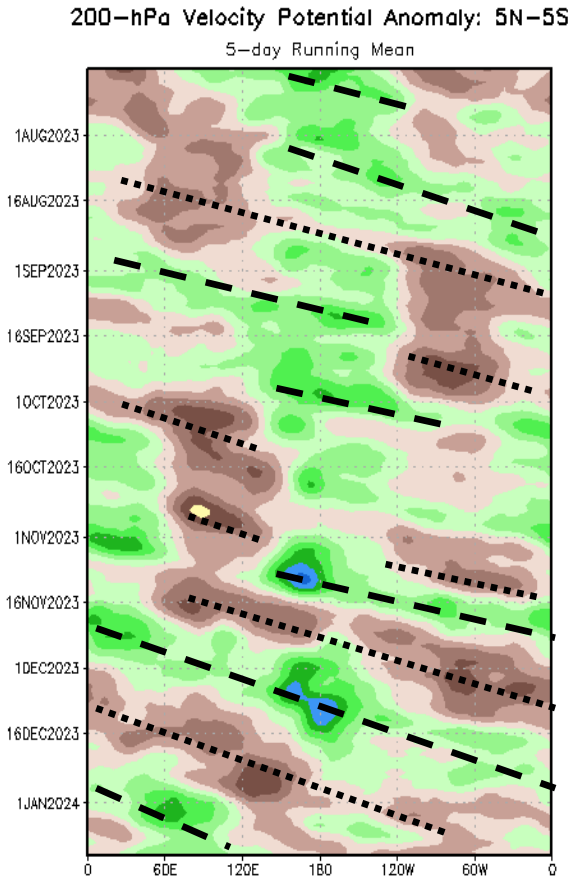
- The extratropical response with wintertime Maritime Continent and West Pacific MJO events typically leads to the development of warmer than normal temperatures over the central and eastern U.S. However, there is also historical support for the associated mid-level ridging to retrograde over western North America with time, allowing for the potential return of colder than normal temperatures over the U.S.

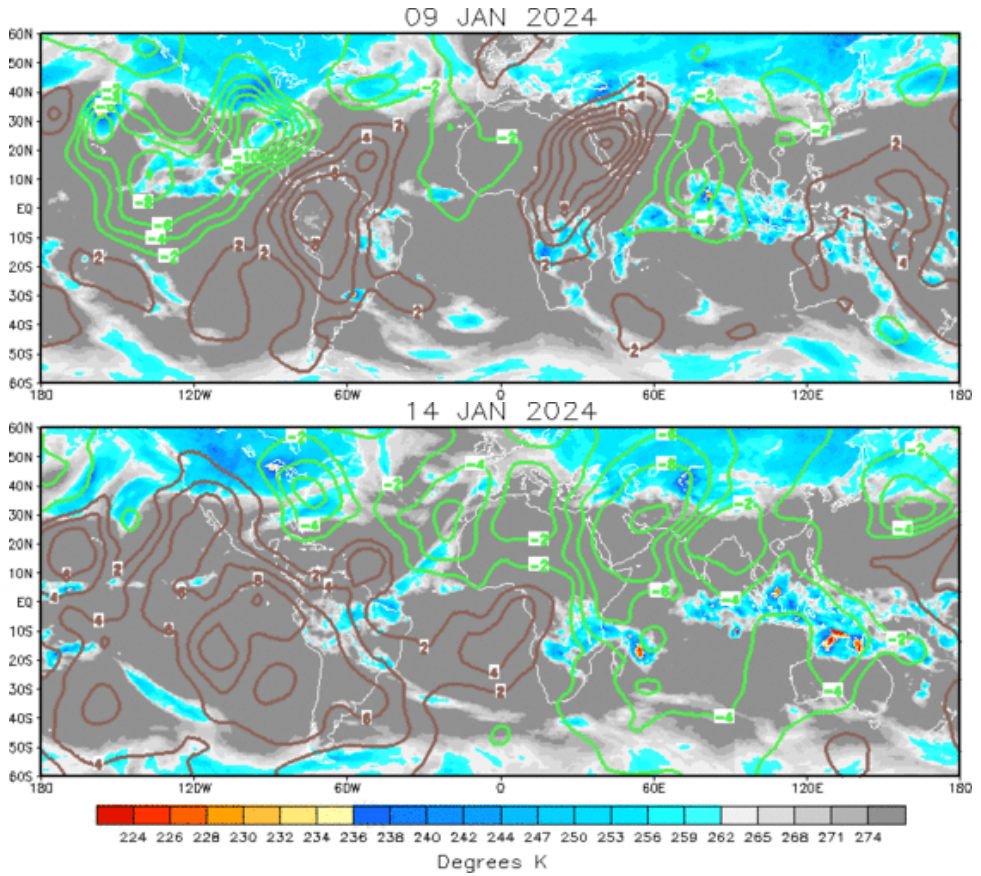
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)



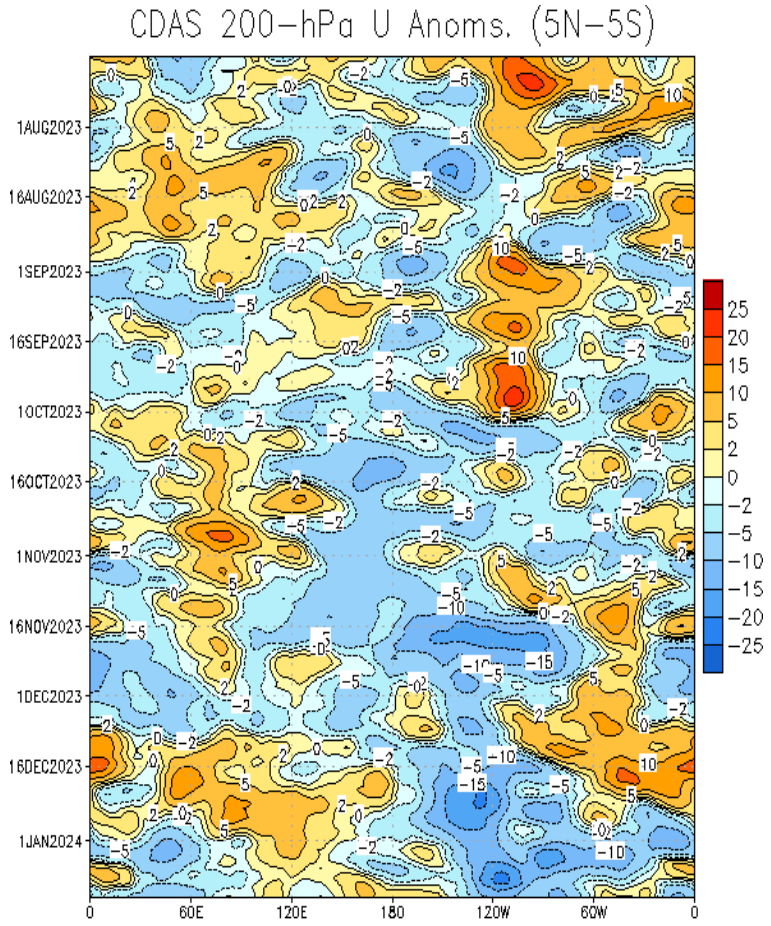


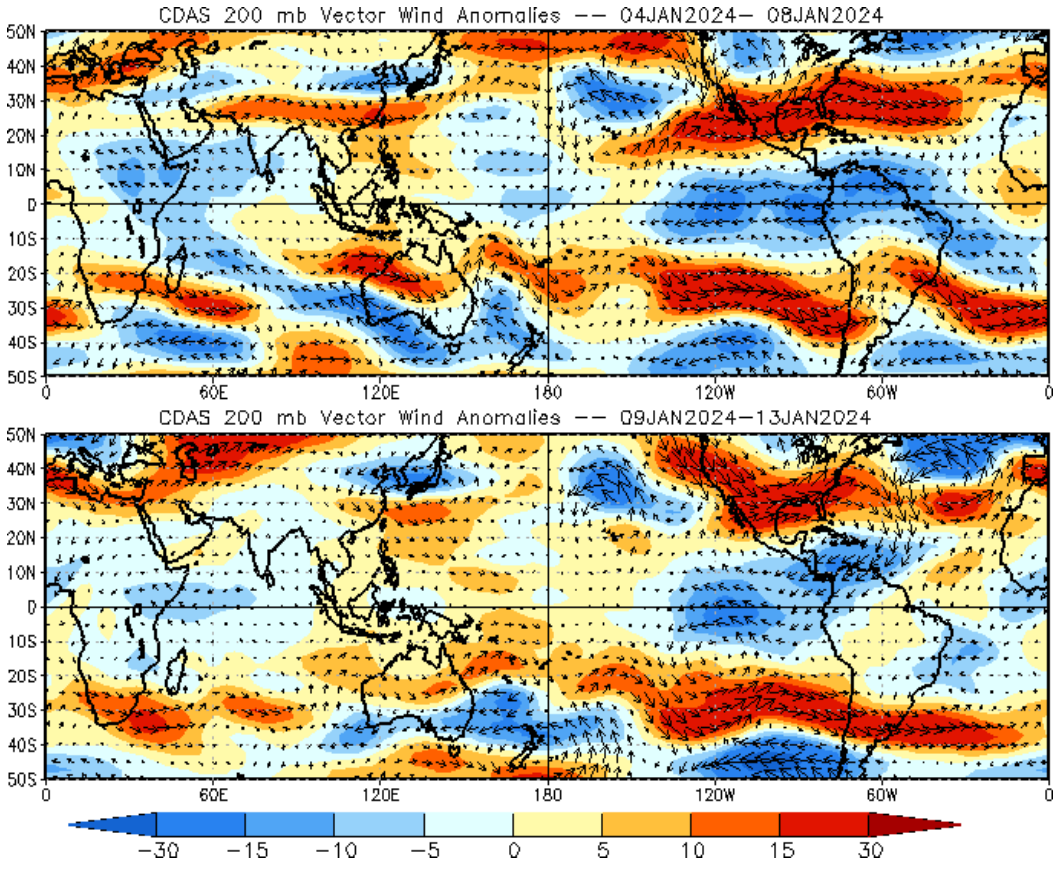
- Following a brief period of competing interference with other tropical modes of variability last week, the upper-level velocity potential anomaly fields reveal more of a more wave-1 pattern.

- The leading edge of the enhanced convective envelope shifted eastward into the Maritime Continent with better spatial uniformity of the suppressed envelope over the Western Hemisphere.

200-hPa Wind Anomalies

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

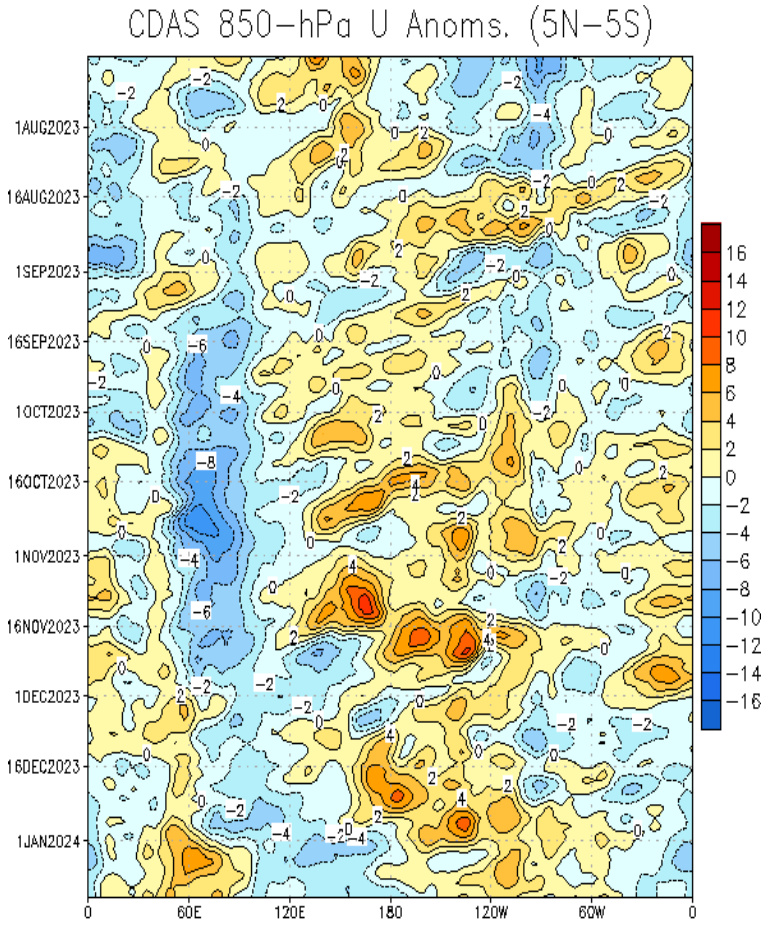


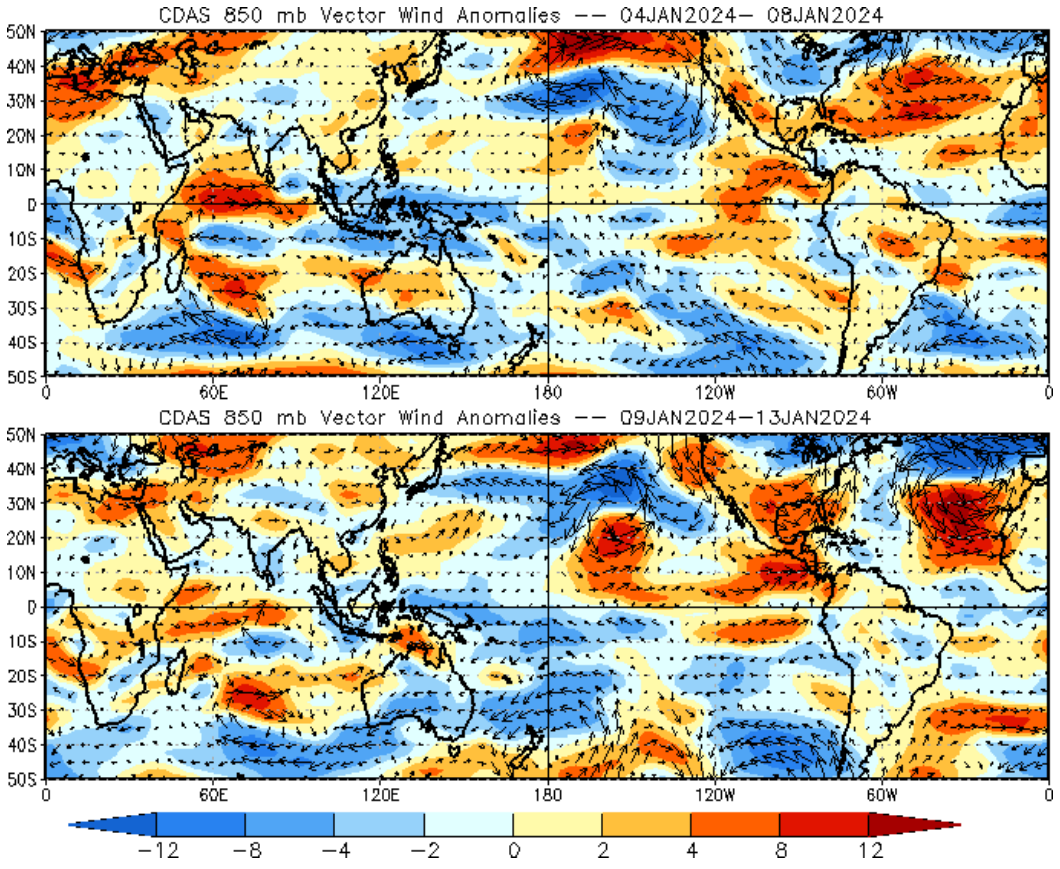


- The westerly phase of the MJO shifted eastward into the central Pacific, is beginning to destructively interfere with persistently strong easterlies tied to the atmospheric response of El Niño.
- Although weak in anomaly space, enhanced easterlies overspread the equatorial Indian Ocean, consistent with ongoing MJO activity.
- An enhanced jet remains evident over the southern U.S., with an anomalous cyclonic circulation upstream over the Hawaiian Islands contributing to a Kona Low event.

850-hPa Wind Anomalies

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

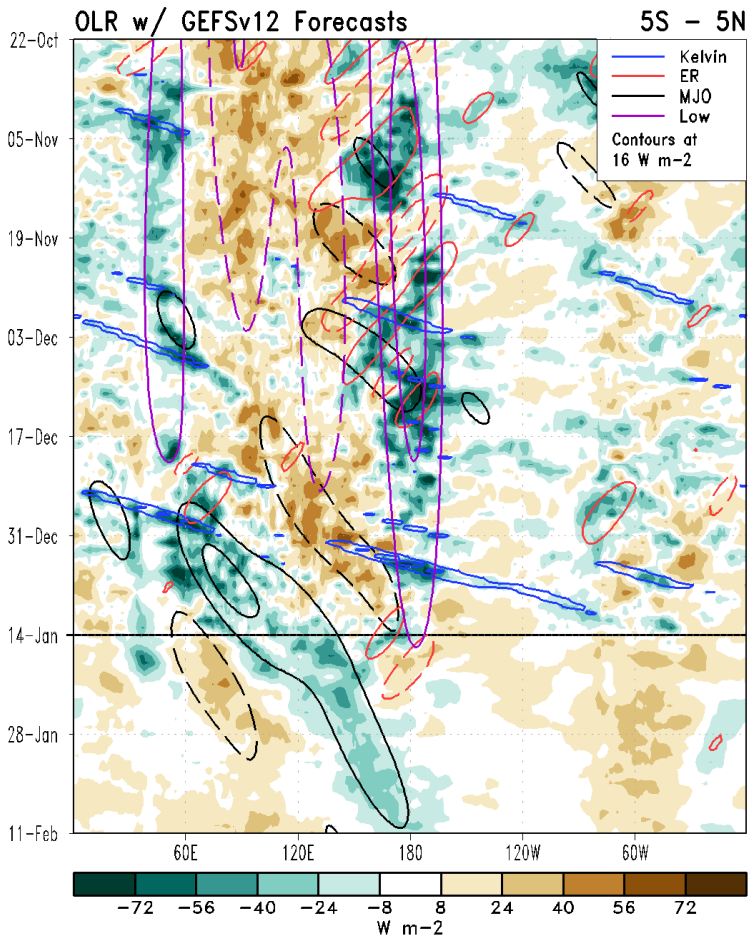


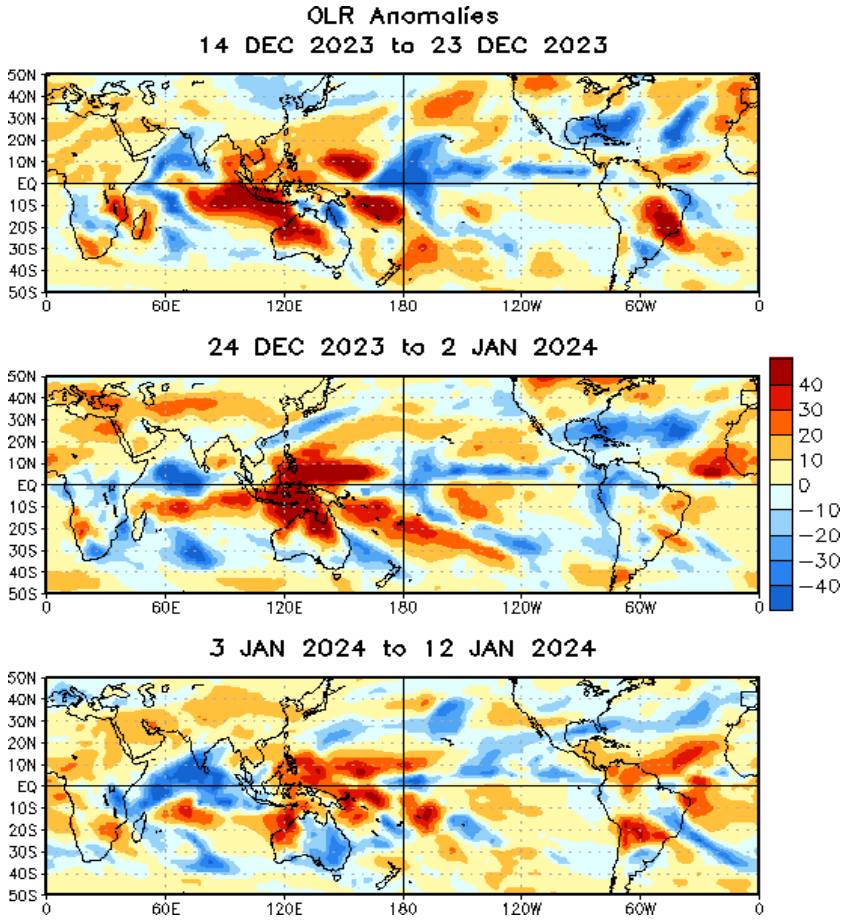


- The eastward propagation of anomalous westerlies stalled over the Indian Ocean, possibly due to Rossby wave interference with the MJO during the last week.
- Anomalous easterlies strengthened over the central Pacific, also consistent with the MJO destructively interfering with El Nino. These easterlies appear to have further diminished the low frequency footprint mostly south of the equator.

Outgoing Longwave Radiation (OLR) Anomalies

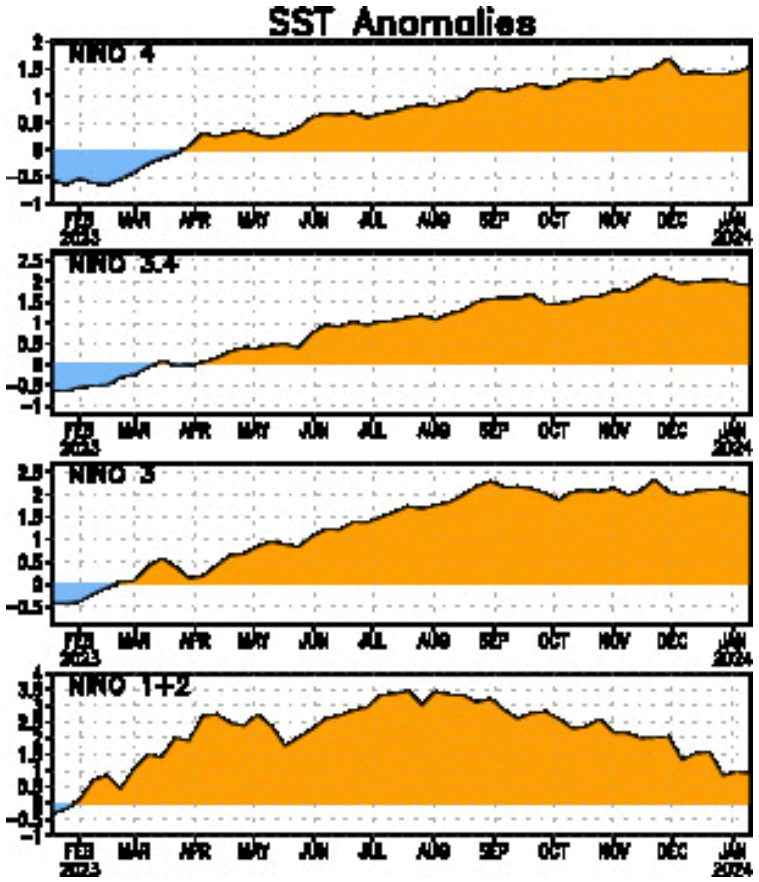
Green shades: Anomalous convection (wetness)
Brown shades: Anomalous subsidence (dryness)

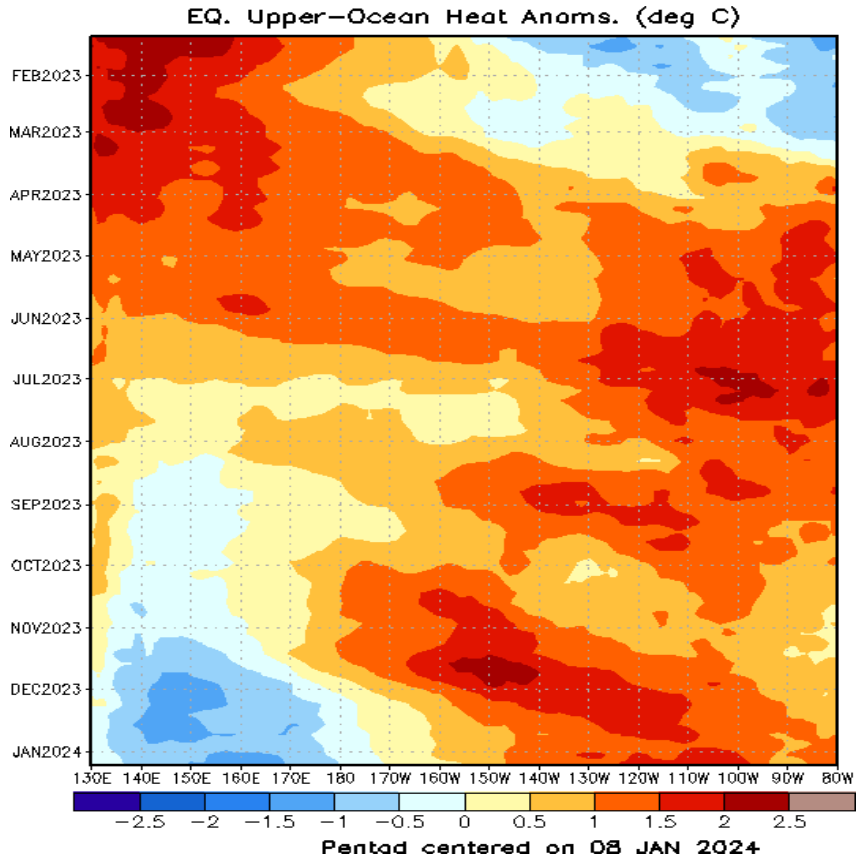




- Continued MJO activity resulted in the reversal of the convective pattern over the eastern Indian Ocean and Maritime Continent, with a weaker low frequency convective response along the Date Line.
- OLR forecasts show an envelope of enhanced convection propagating eastward into the western Pacific during the next several weeks, as the MJO looks to again constructively interfere with El Nino response heading into February.

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

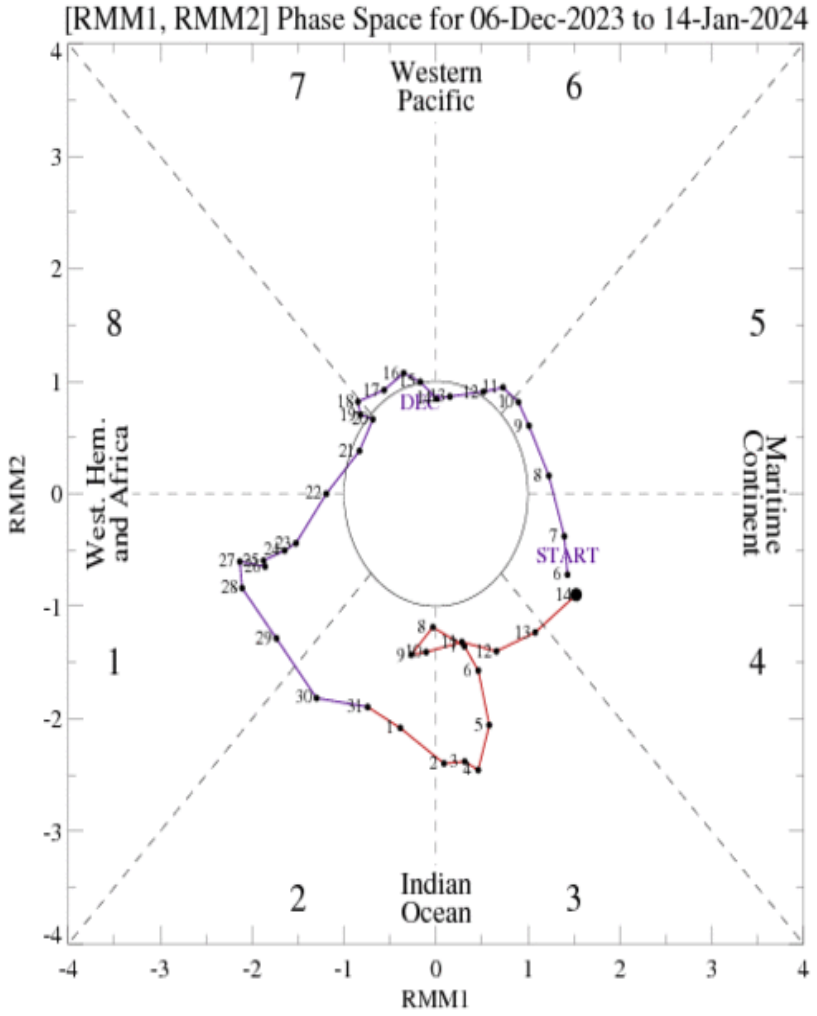




- The strongly anomalous SSTs associated with El Nino have been fairly stable throughout much of the Pacific since last year, except for Nino 1+2 which continues to weaken and trend towards neutral.
- Tied to the upwelling phase of an oceanic Kelvin wave, negative upper-oceanic heat anomalies expanded eastward beyond the Date Line, with strongly positive subsurface anomalies persisting over the eastern Pacific.

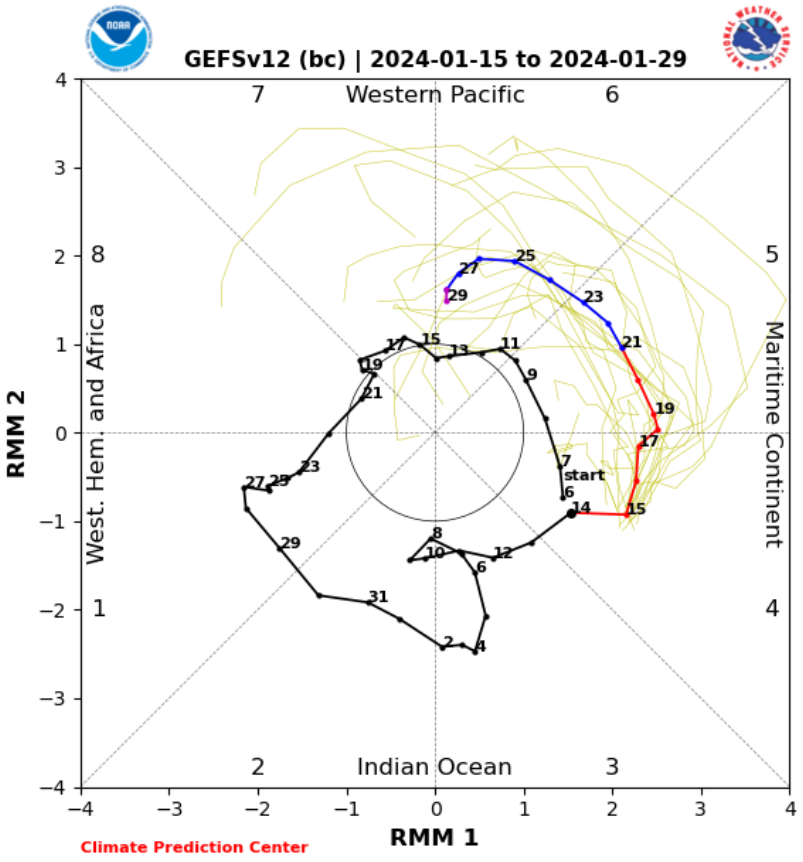
MJO Index: Recent Evolution

- Following a period where the MJO signal weakened and retreated westward over the Indian Ocean, it has since resumed its eastward propagation over the Indian Ocean and is gaining amplitude over the Maritime Continent.

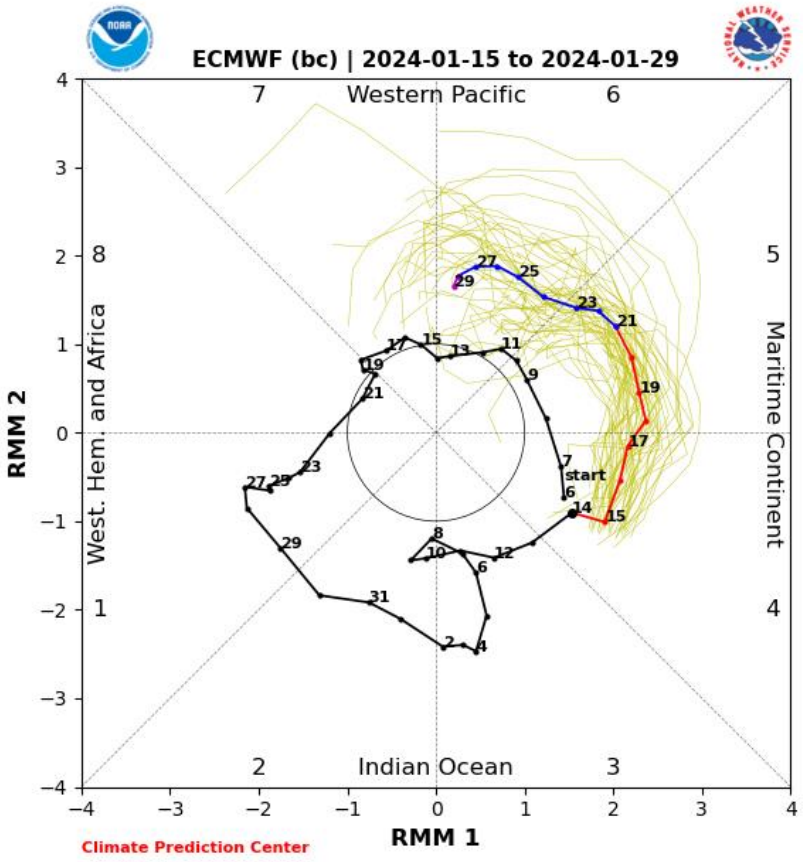


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast

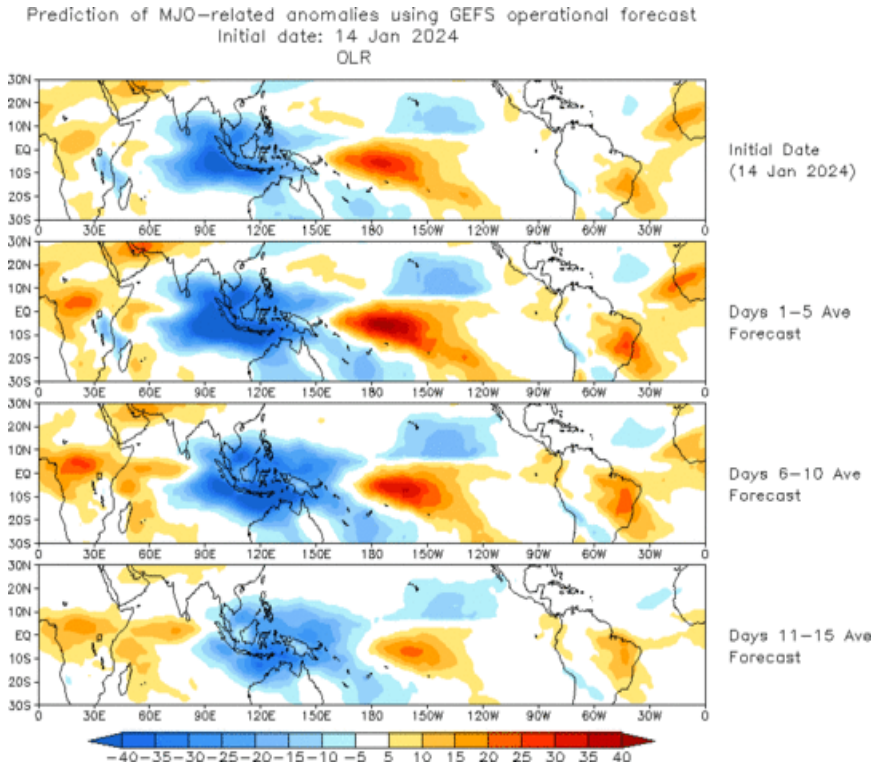


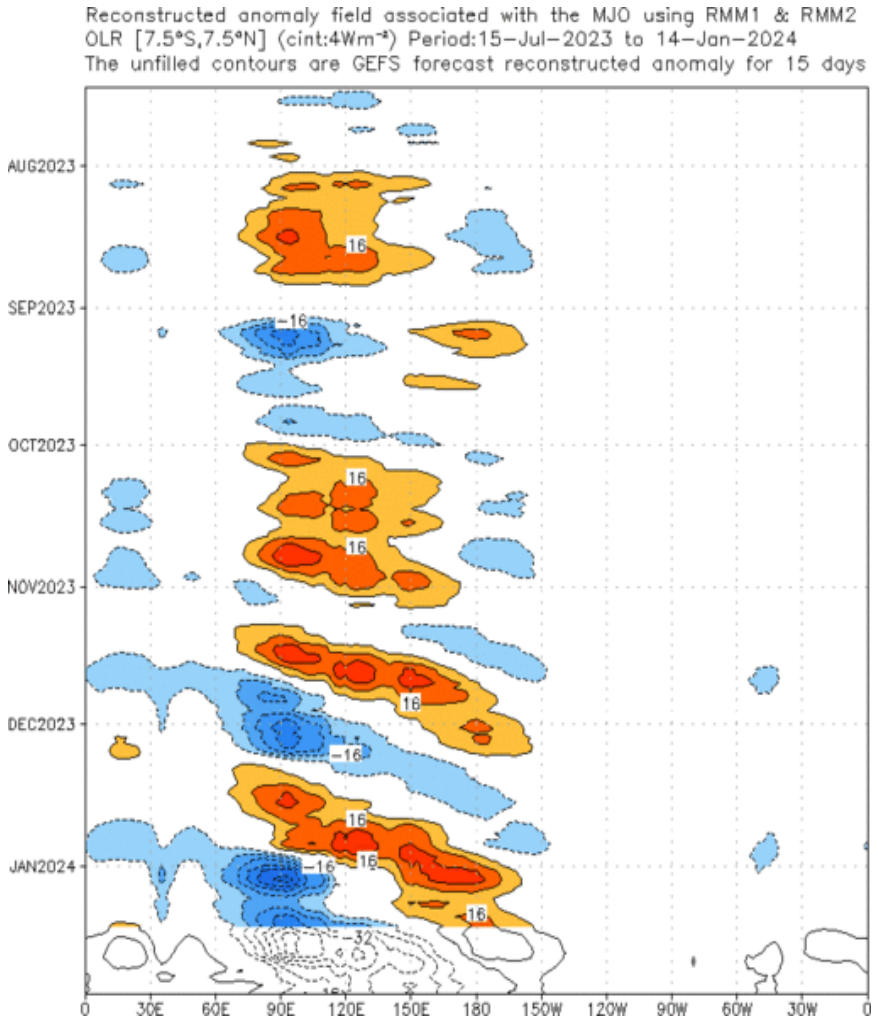
ECMWF Forecast

- There is excellent agreement in the dynamical models favoring a high amplitude MJO event over the Maritime Continent and Western Pacific through the end of January. Uncertainty increases in the extended range, with some ensemble members either favoring a much weakened signal or a continued strong event as it crosses the equatorial Pacific during early February.
- Much of the amplitude increase during week-1 is likely tied to constructive interference with Kelvin Wave activity over the Maritime Continent.

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.)

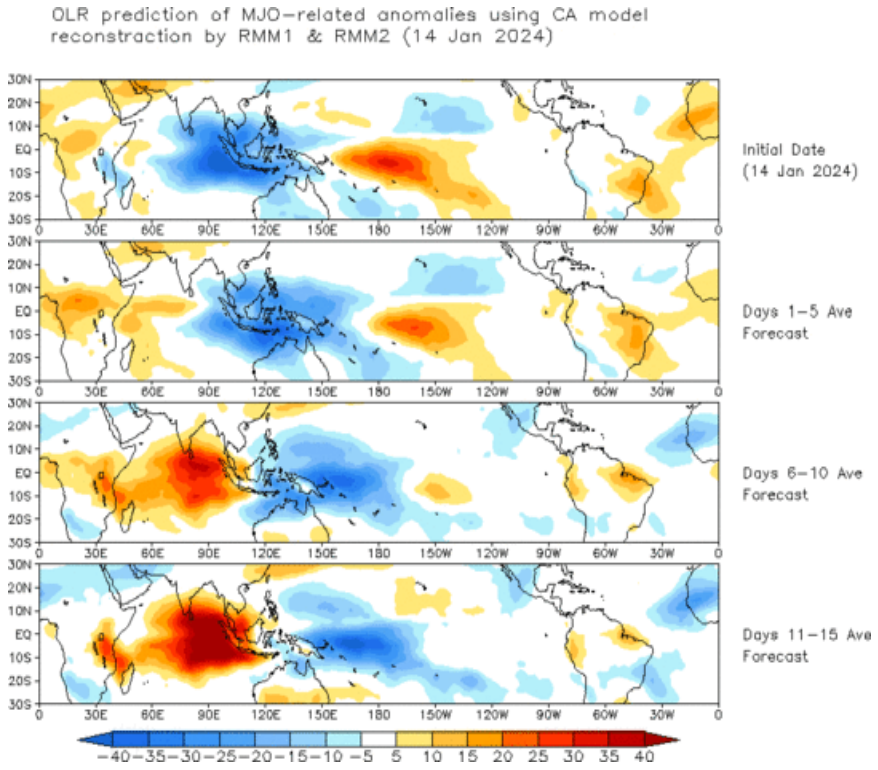


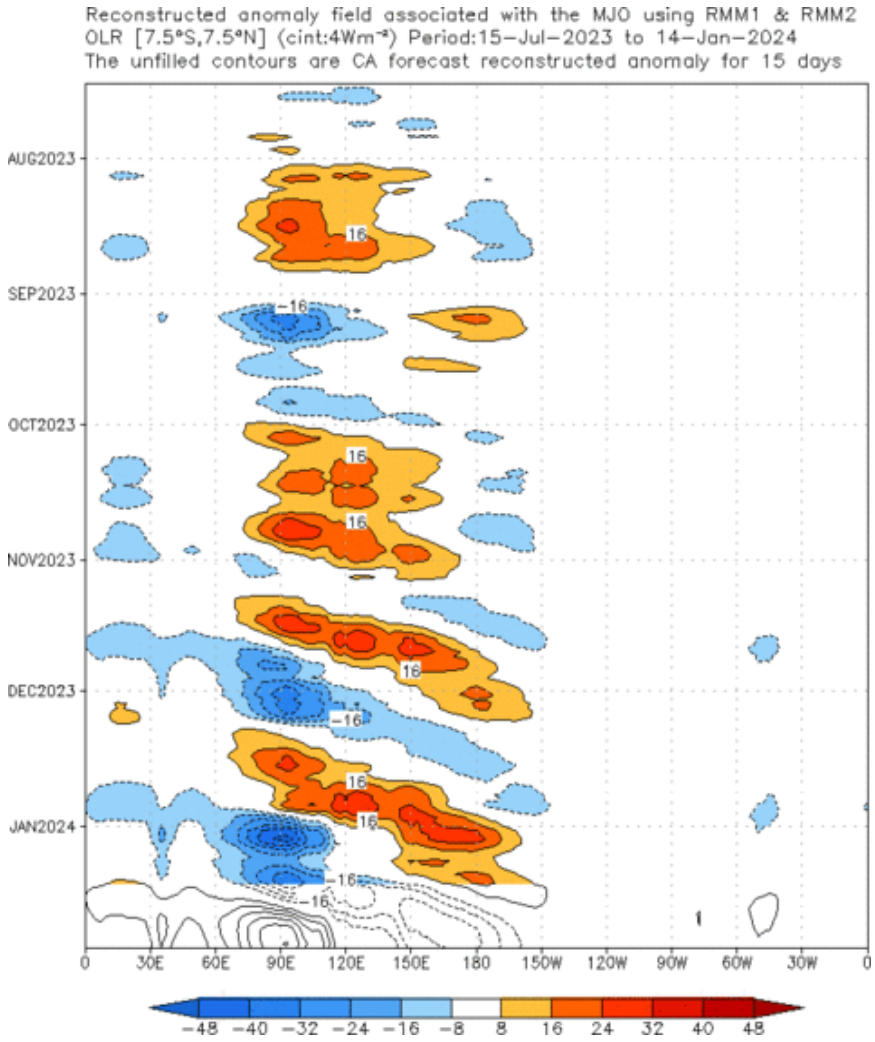


- The GEFS RMM-based OLR forecast depicts a canonical MJO event crossing the Maritime Continent and Western Pacific during the next two weeks.

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.)

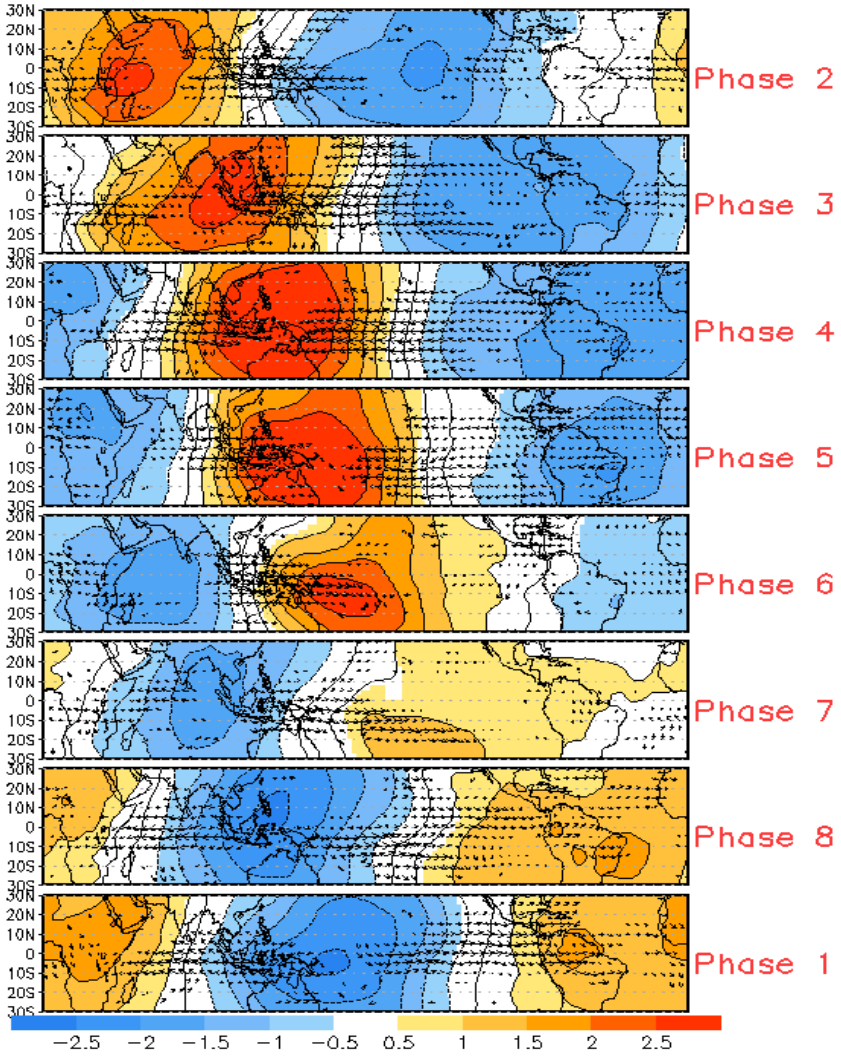




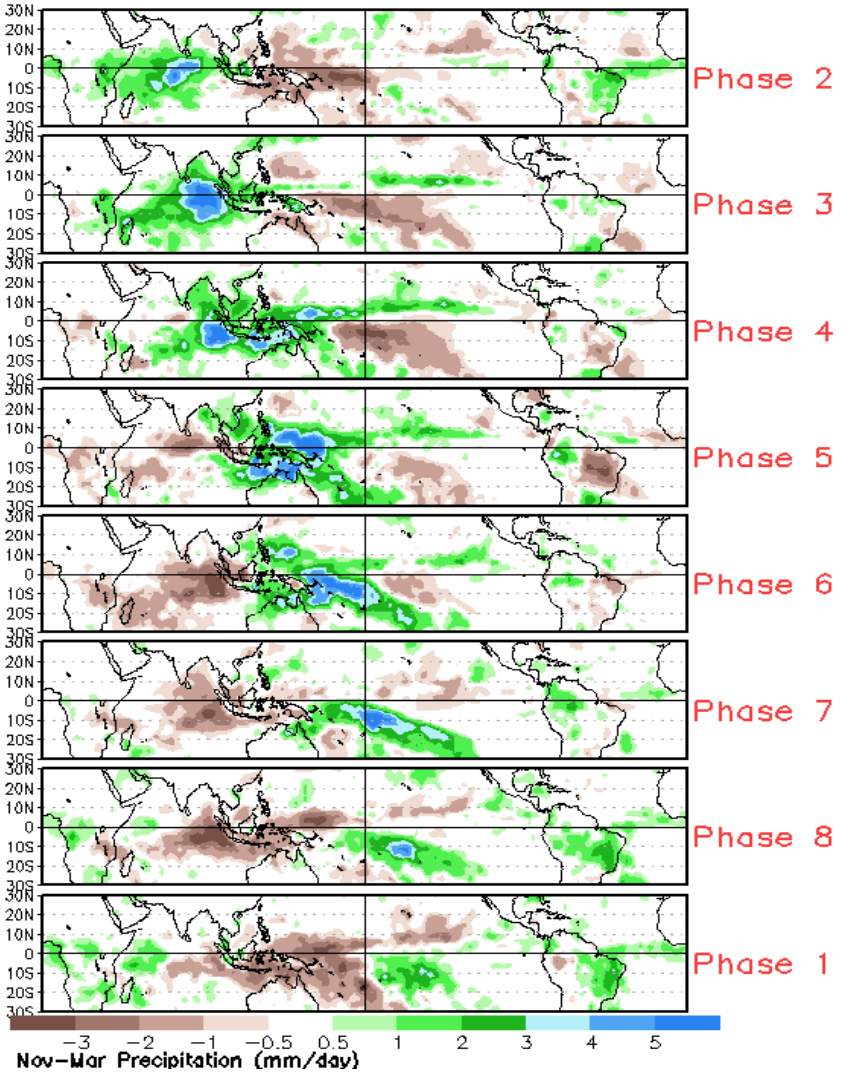
- The constructed analog (CA) RMM-based forecast is similar to the GEFS, but is more progressive and favors more suppressed convection developing over the Indian Ocean.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



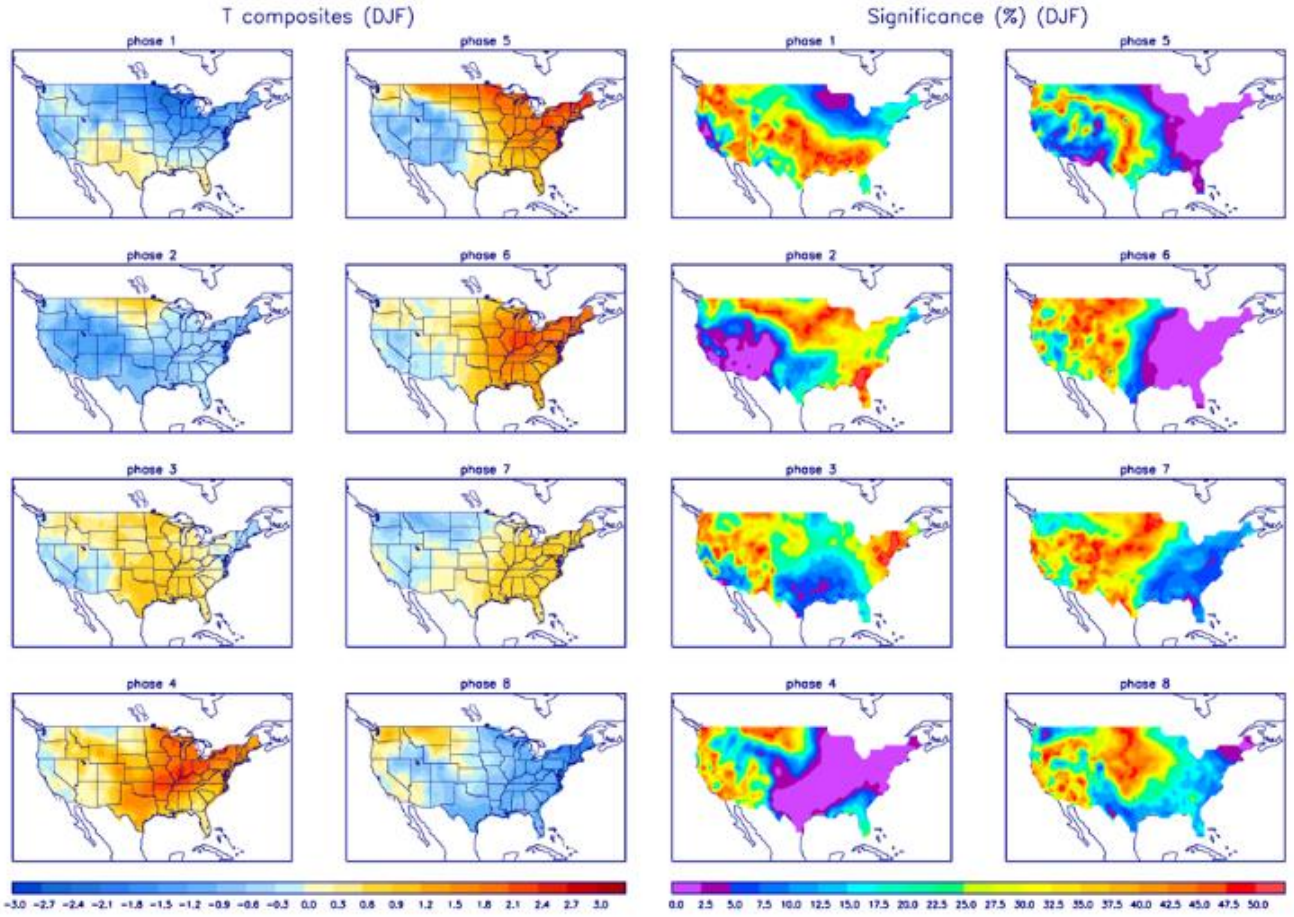
Precipitation Anomalies



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.

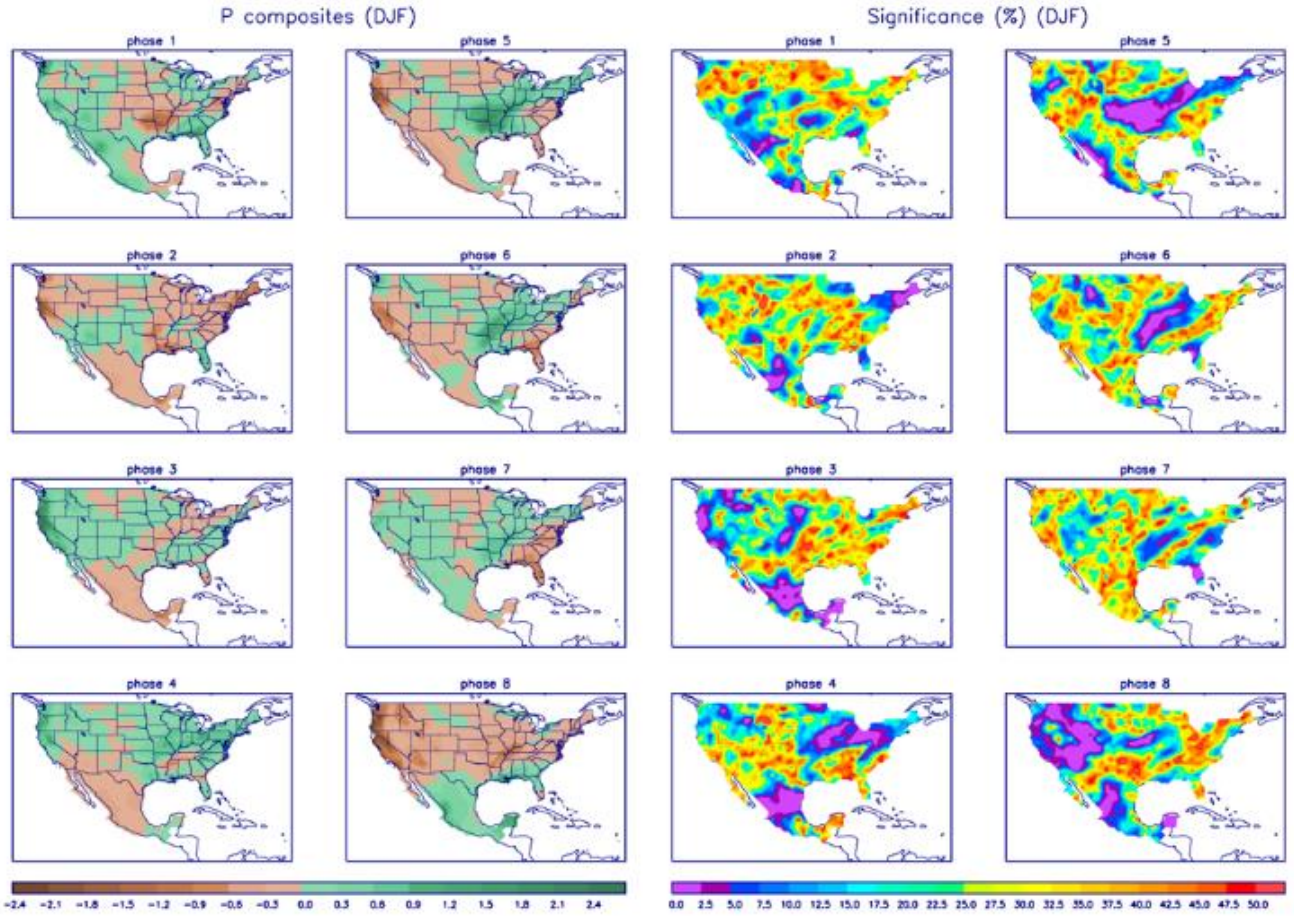


More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

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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