

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



Update prepared by the Climate Prediction Center  
NWS / NCEP / CPC  
19 December 2022

# Overview

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- Although the RMM index indicates a poorly organized MJO, upper-level velocity potential anomaly fields reveal a more coherent, eastward propagating interseasonal signal over the Indian Ocean during the past week.
- Dynamical model RMM forecasts are in fair agreement with the MJO signal reemerging over the Maritime Continent, and propagating eastward into the Western Pacific through the end of the year.
  - While there is much uncertainty on the strength of the MJO due to high ensemble spread and the potential for destructive interference with the low frequency base state, OLR and lower-level zonal wind forecasts focused south of the equator evince a more coherent MJO signal in the outlook.
- With the MJO likely contributing to the formation of a pair of tropical cyclones (TCs) over the Indian Ocean during the past week, the large scale environment is anticipated to be favorable for additional TC development over the eastern Indian Ocean and Pacific during the next several weeks.
- Should the MJO become better organized over the Maritime Continent, the extratropical response historically favors the development of above-normal temperatures over eastern North America.

A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:

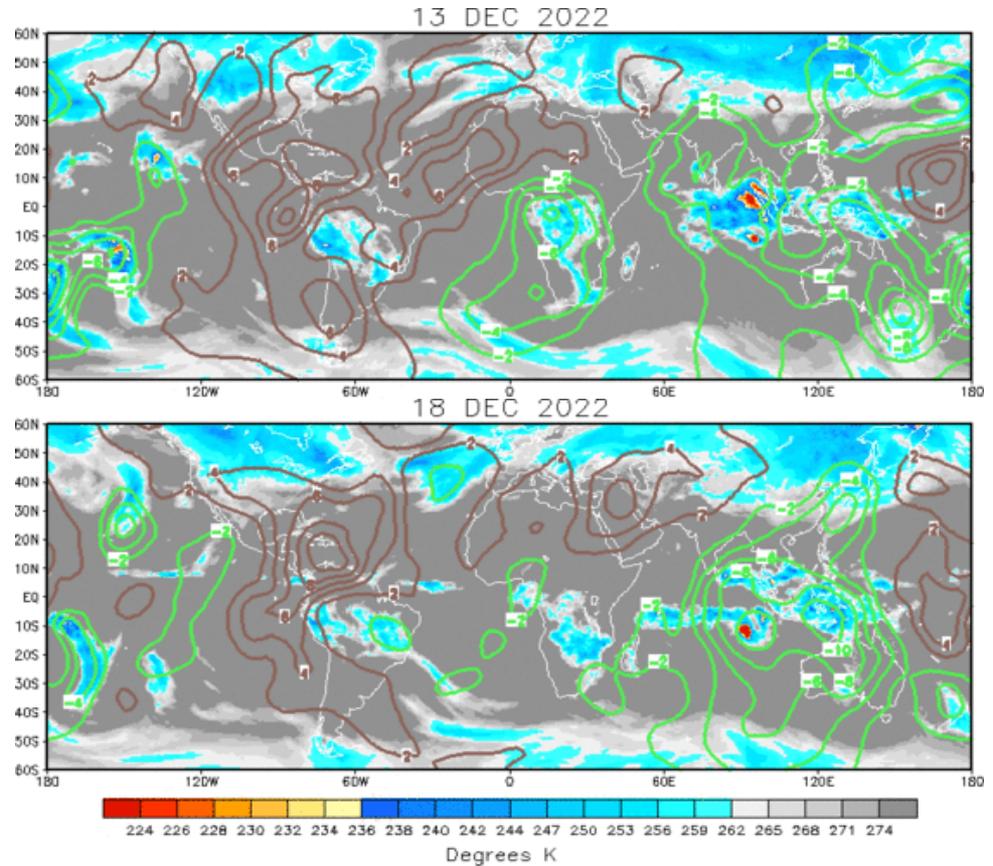
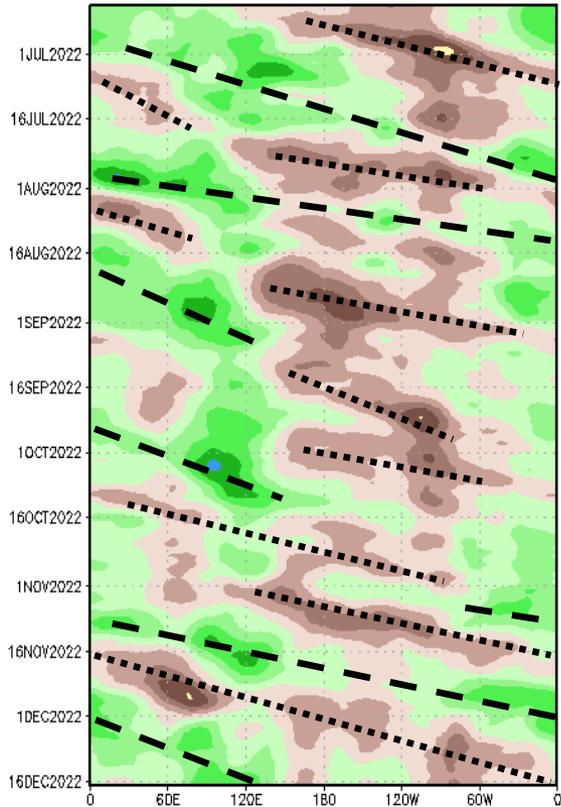
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

# 200-hPa Velocity Potential Anomalies

**Green shades: Anomalous divergence (favorable for precipitation)**

**Brown shades: Anomalous convergence (unfavorable for precipitation)**

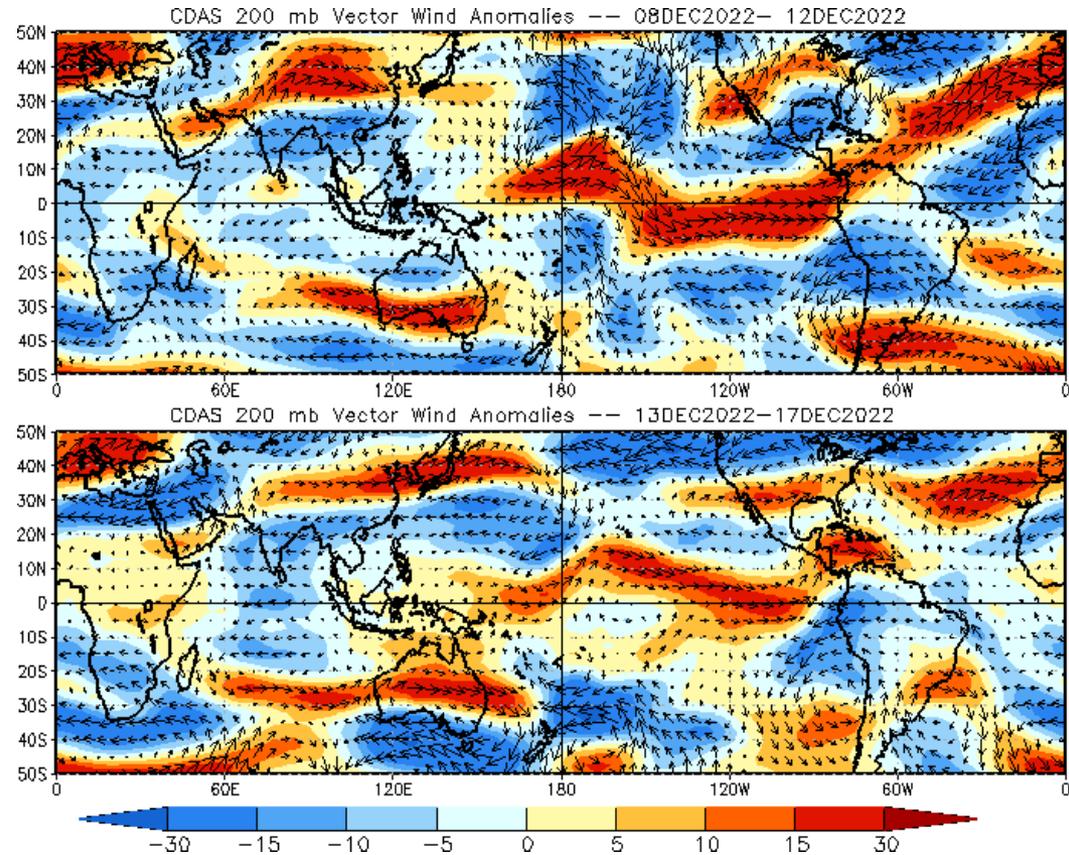
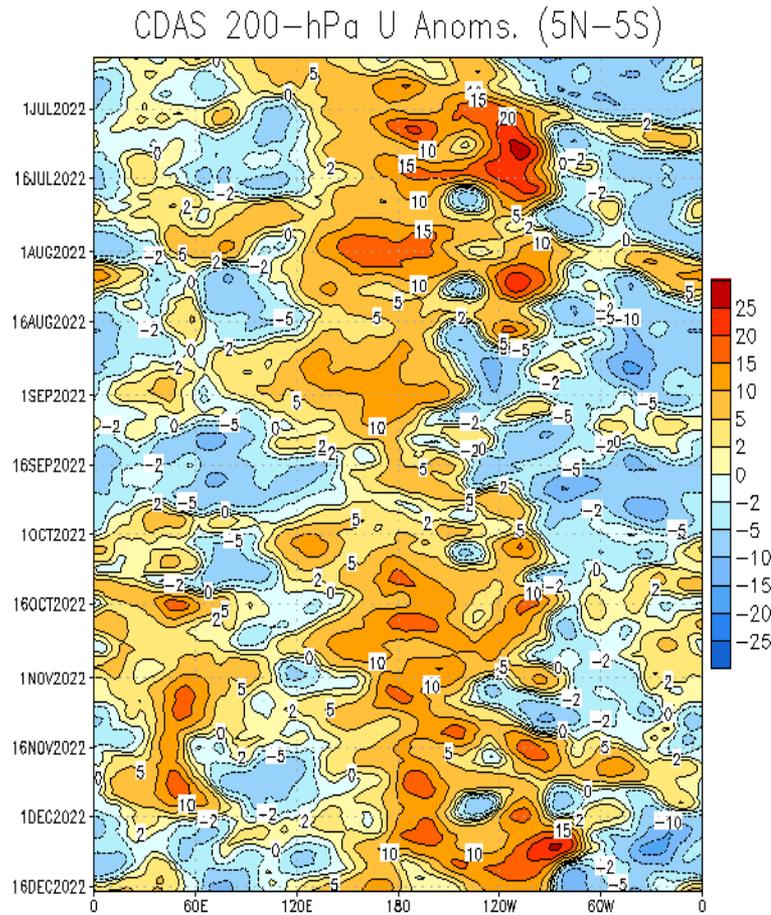
200-hPa Velocity Potential Anomaly: 5N-5S  
5-day Running Mean



- Although upper-level velocity potential spatial pattern is not particularly well-defined, there is a clear eastward propagating couplet of enhanced and suppressed conditions continuing into mid-December.
- Constructive interference with the low frequency La Niña base state resulted into convection overspreading the eastern Indian Ocean and Maritime Continent.

# 200-hPa Wind Anomalies

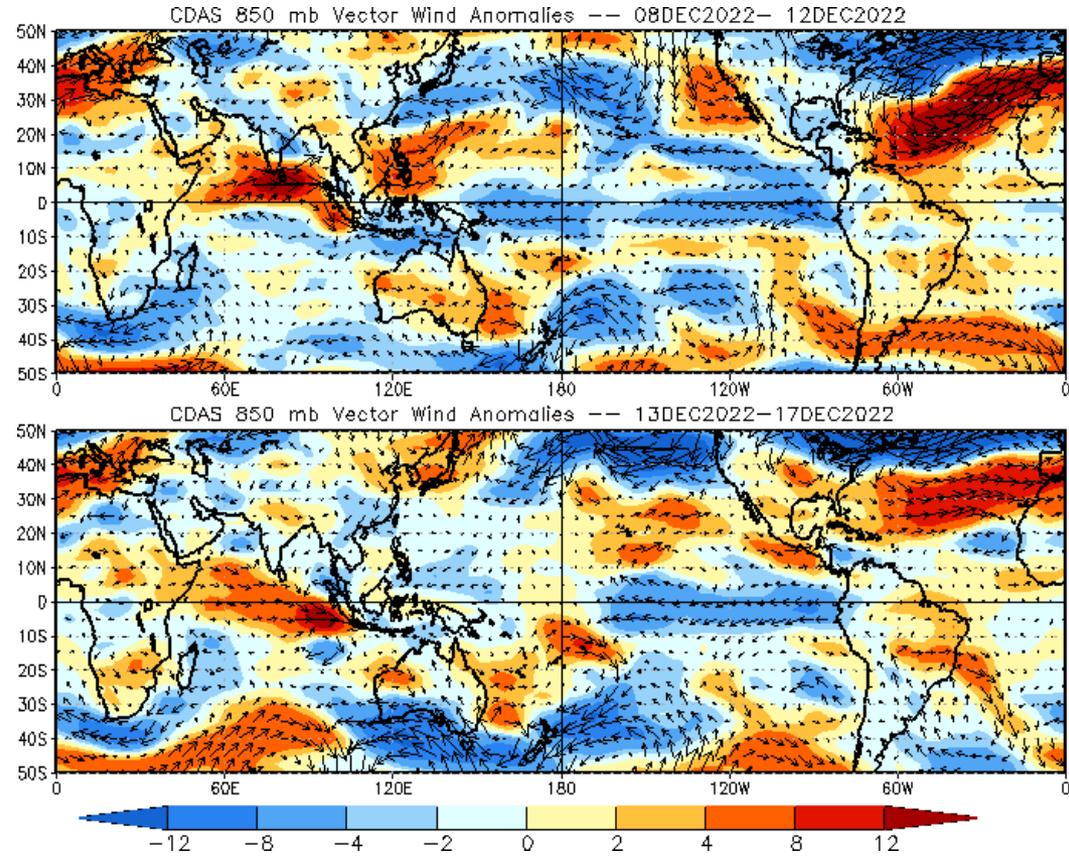
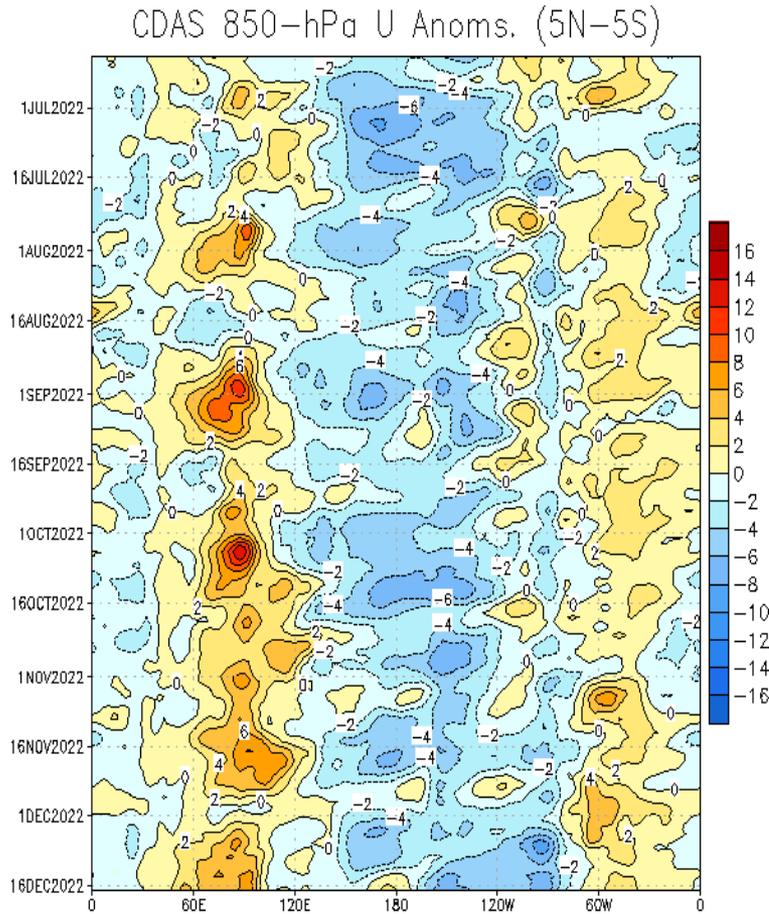
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Strong upper-level westerly anomalies continue to dominate the tropical Pacific, though a surge of anomalous easterlies is observed over the equatorial eastern Pacific tied to an anomalous anticyclonic circulation aloft over western South America.
- Anomalous easterlies strengthened over the equatorial Indian Ocean providing increased divergence aloft.

# 850-hPa Wind Anomalies

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

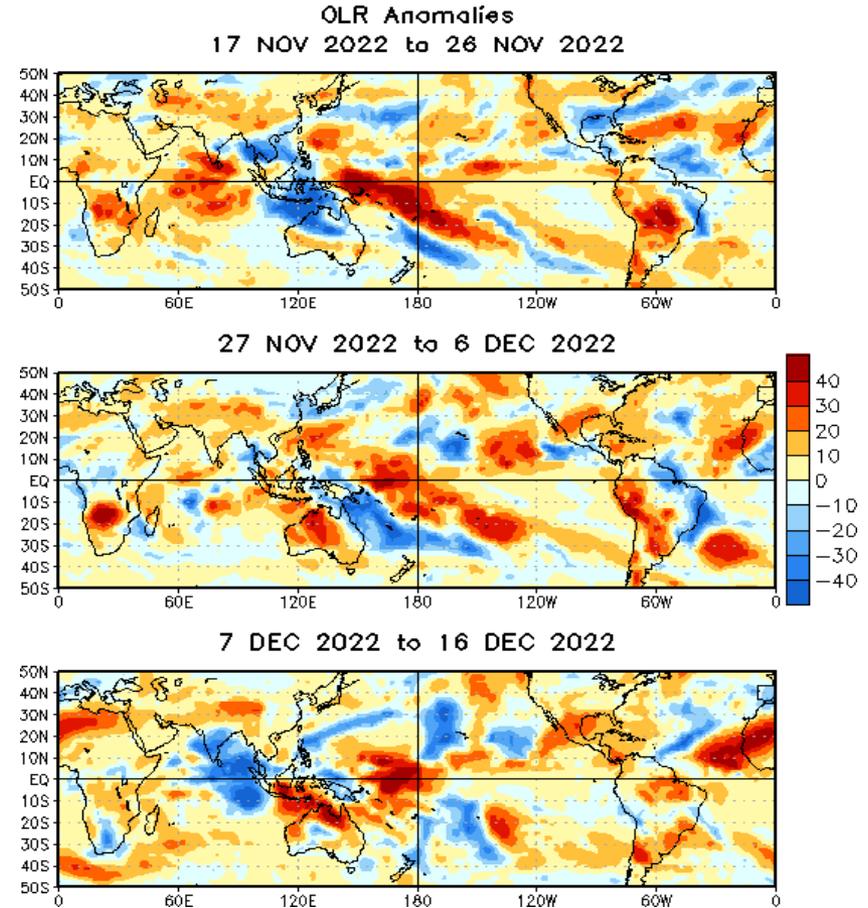
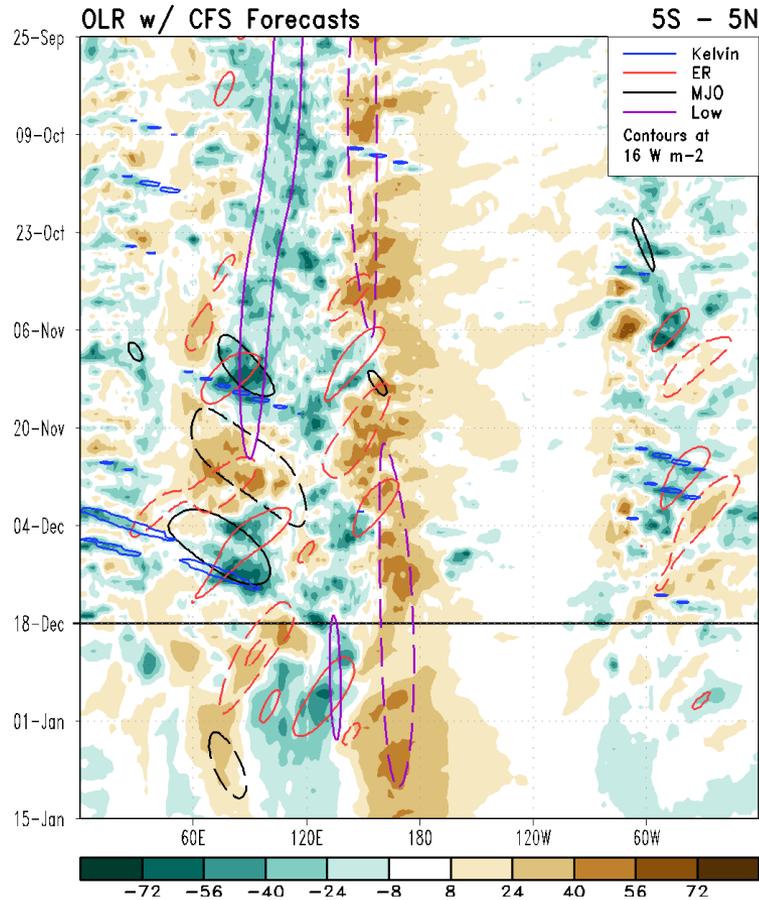


- Strong anomalous westerlies persist over the Indian Ocean, aiding in the enhancement of convection and contributed to the development to a pair of tropical cyclones during the last week.
- The enhanced trade wind regime is disrupted near the Date Line mainly south of the equator, likely tied to Rossby wave activity recently.

# Outgoing Longwave Radiation (OLR) Anomalies

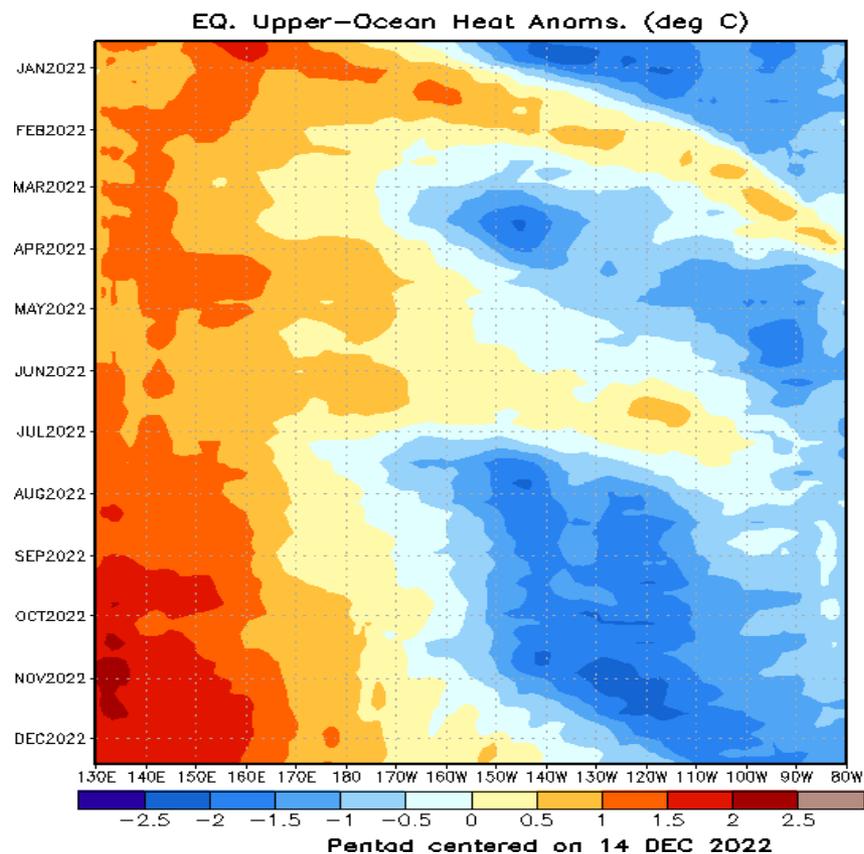
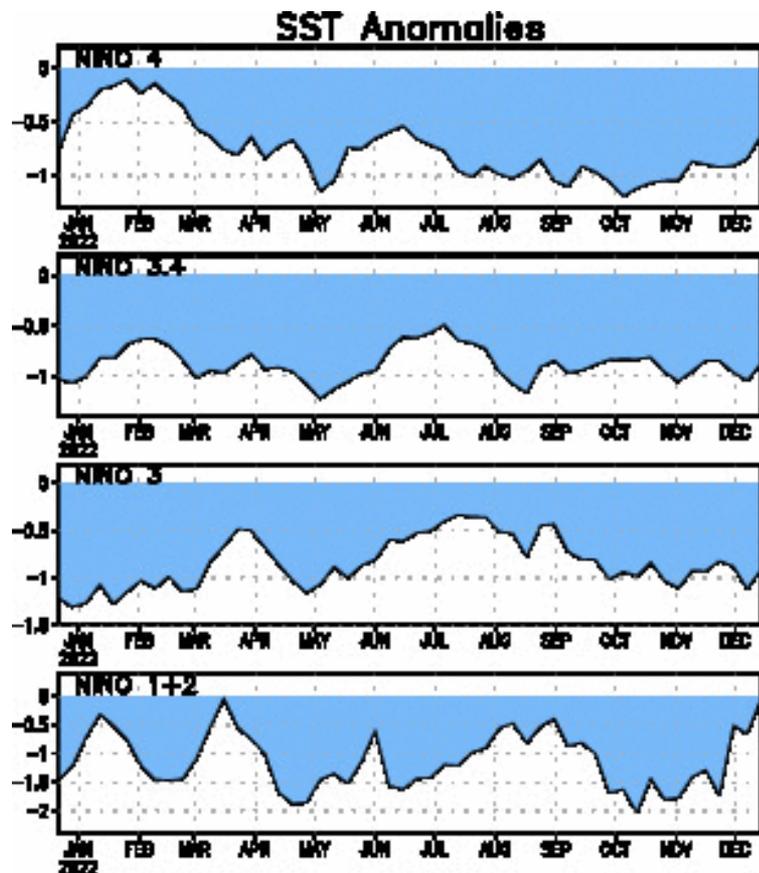
**Green shades: Anomalous convection (wetness)**

**Brown shades: Anomalous subsidence (dryness)**



- The low frequency ENSO base state remains the most dominant feature in the OLR field.
- Enhanced convection became more pronounced over the eastern Indian Ocean
- OLR forecasts reveal a more stationary convective pattern consistent with La Nina, however time-longitude forecast plots focused south of the equator (not pictured) show more of an eastward shift of the enhanced convective signal into western Pacific.

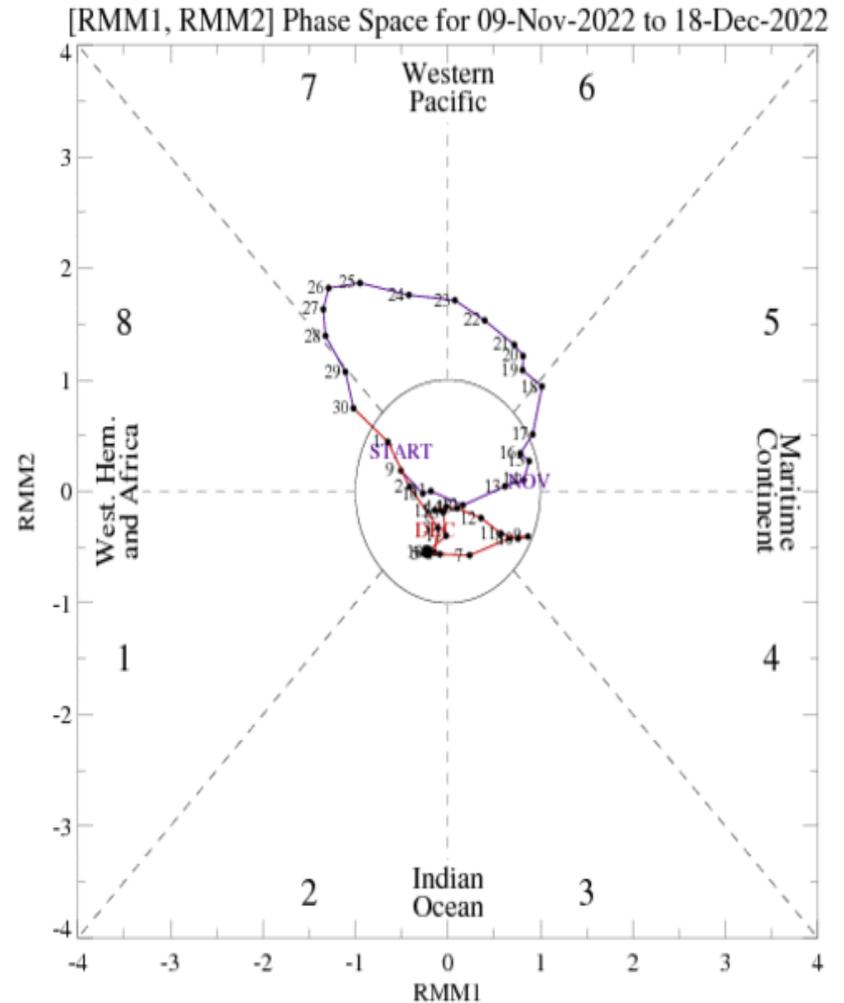
# SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Negative upper-ocean heat anomalies have continued to become more zonally narrow during the boreal autumn, with more subsurface warming expanding further eastward near 140W during mid-December.
- SSTs remain well below average across all Niño basins, except the eastern Pacific (Niño 1+2) where a sharp warming trend is indicated since late November.

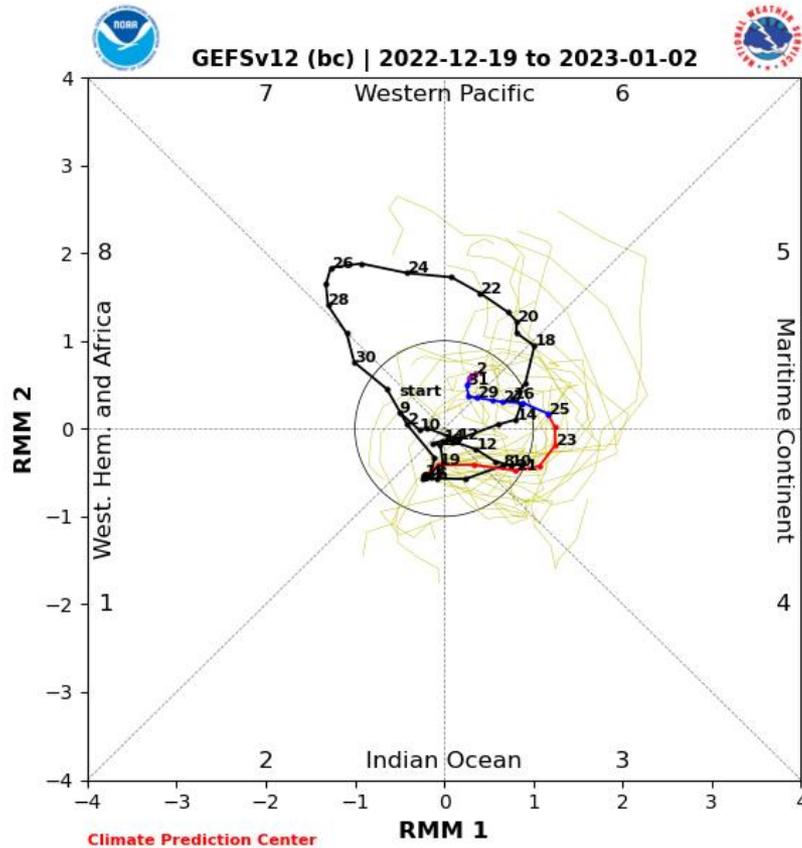
# MJO Index: Recent Evolution

- Contrasting the observed upper-level velocity potential anomaly fields, the RMM index shows more of westward shift of the intraseasonal signal while maintaining a low amplitude during the past week.

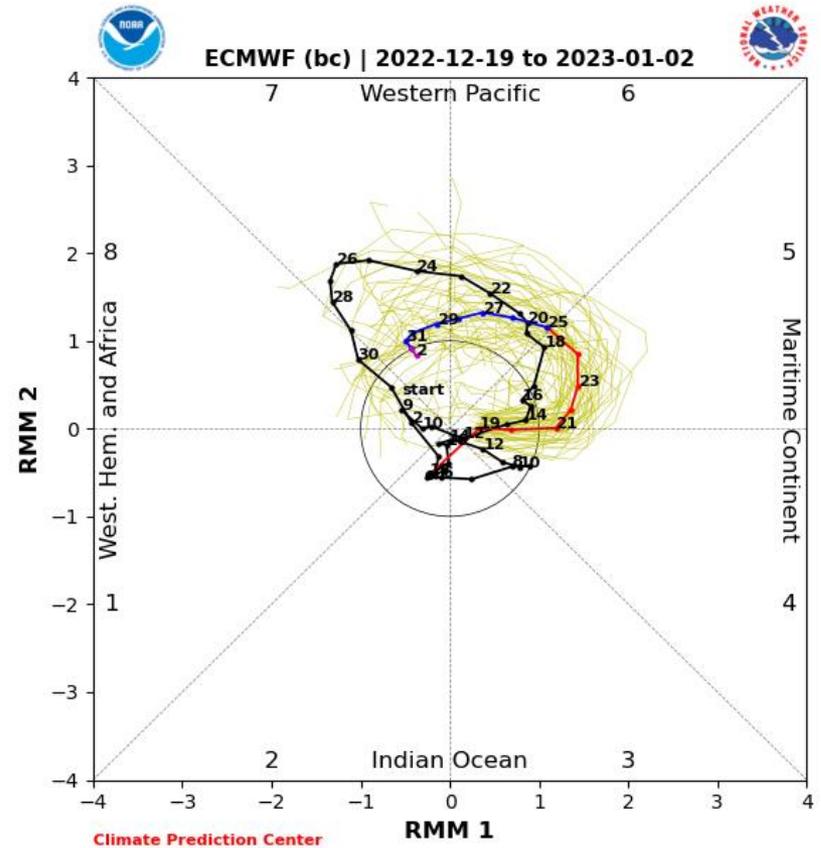


For more information on the RMM index and how to interpret its forecast please see:  
[https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC\\_MJOinformation.pdf](https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf)

# MJO Index: Forecast Evolution



**GEFS Forecast**



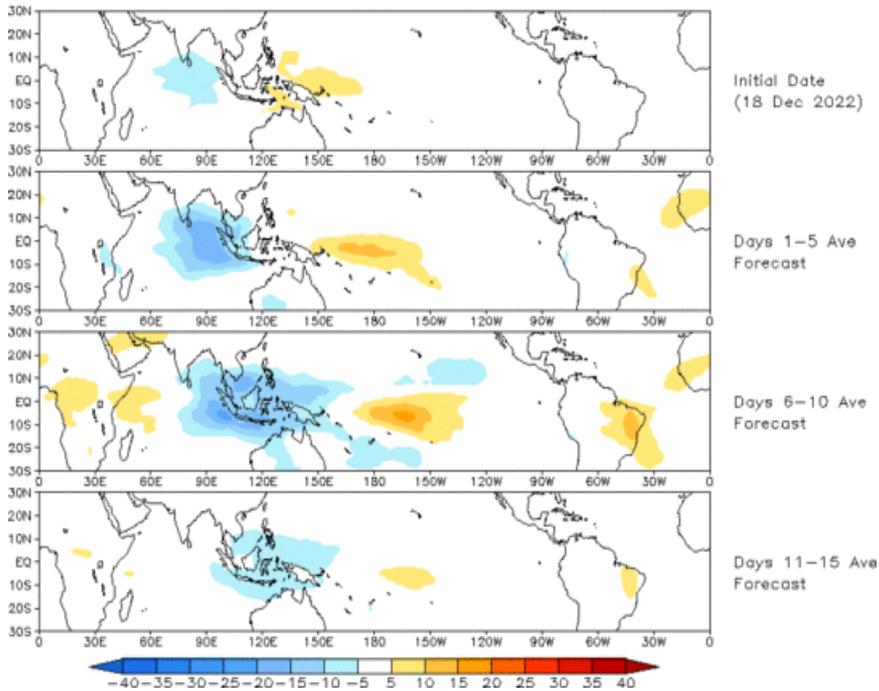
**ECMWF Forecast**

- Both the GEFS and ECMWF RMM forecasts favor the resumption of an eastward propagating MJO signal over the Maritime Continent and western Pacific during the next two weeks, though a slower evolution and lower amplification is evident in the GEFS.

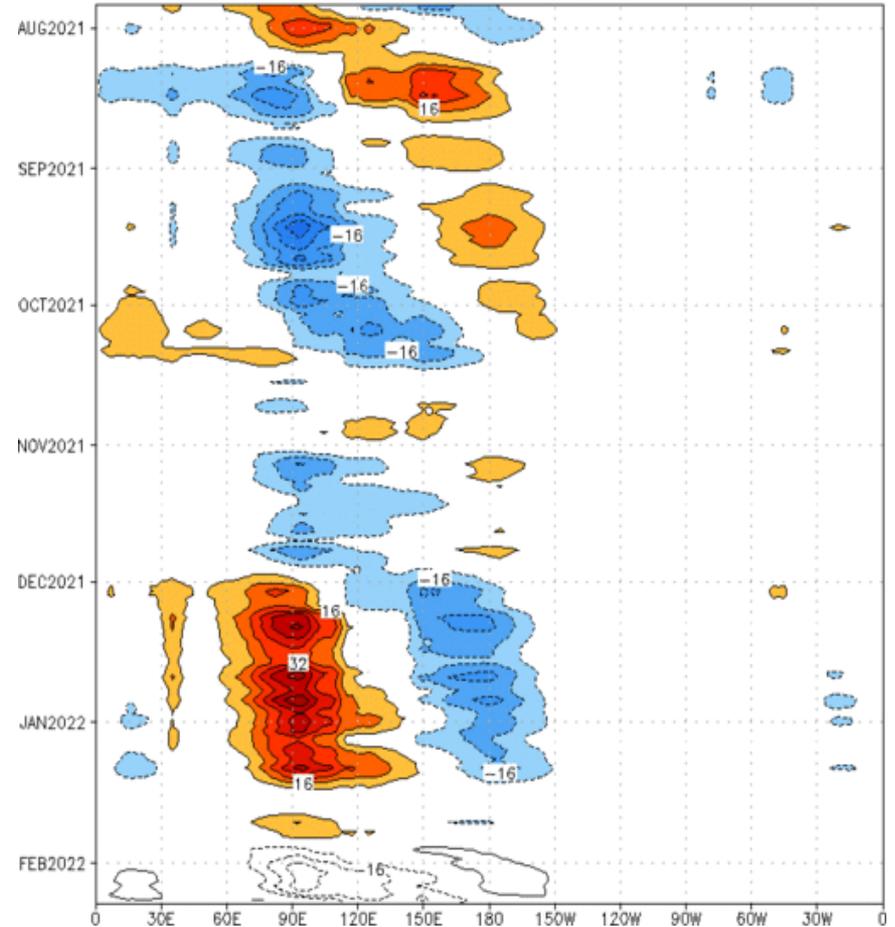
# MJO: GEFS Forecast Evolution

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.)

Prediction of MJO-related anomalies using GEFS operational forecast  
Initial date: 18 Dec 2022  
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2  
OLR [7.5°S,7.5°N] (cont:4Wm<sup>-2</sup>) Period:27-Jul-2021 to 26-Jan-2022  
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

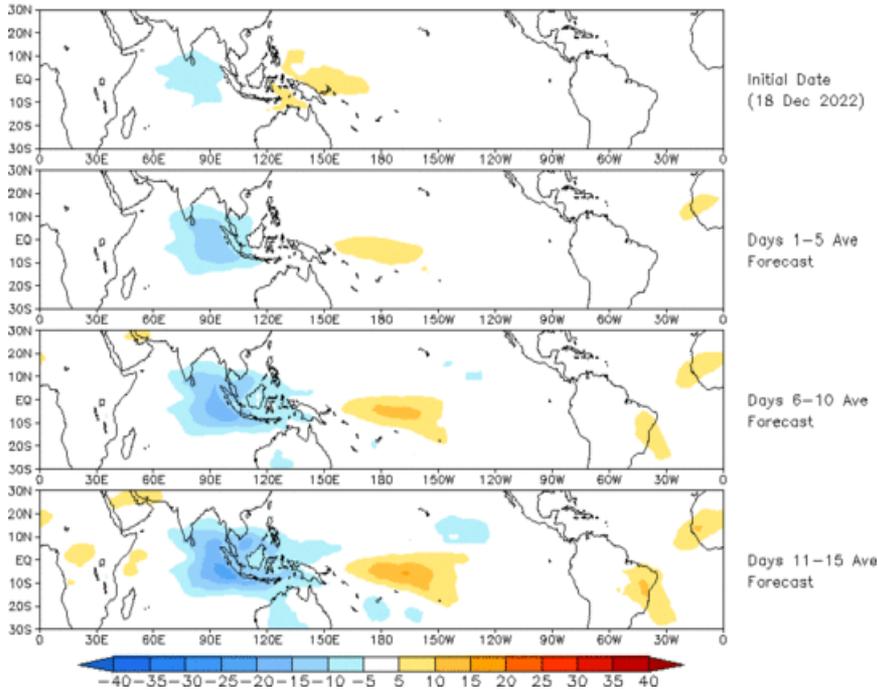


- The GEFS-based OLR anomaly fields depict enhanced convection strengthening over the Maritime Continent, with more suppressed conditions developing over the Africa and central Pacific. However, this convective pattern breaks down later in the period.

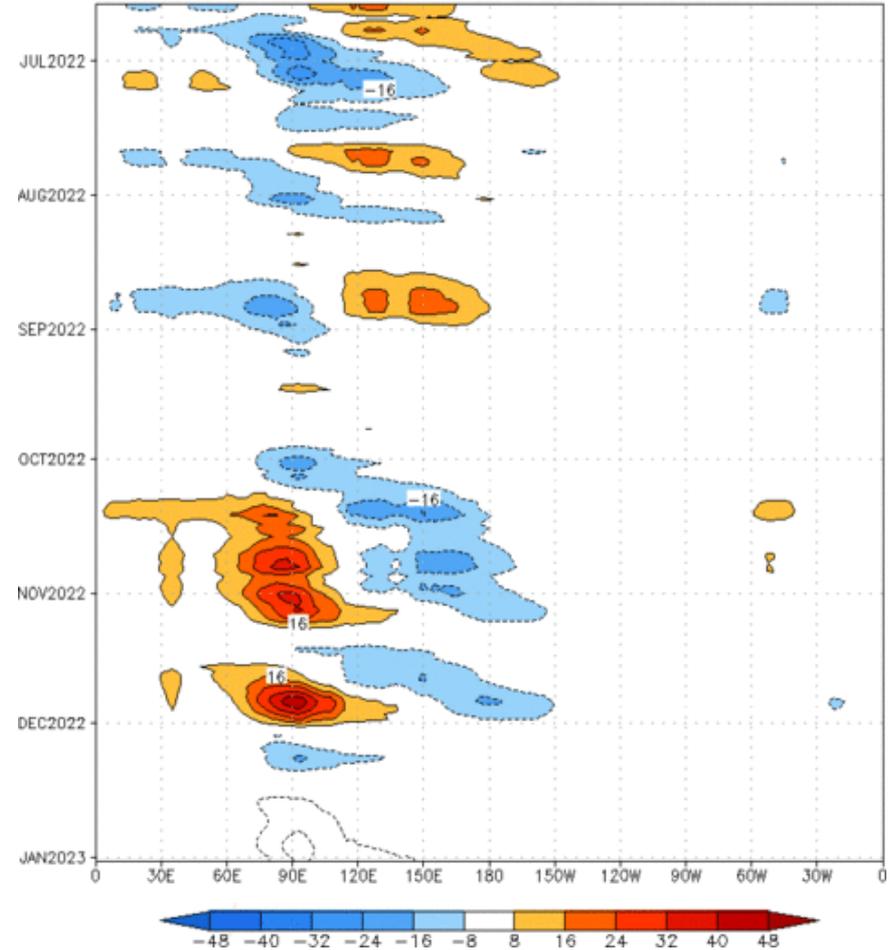
# MJO: Constructed Analog Forecast Evolution

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.)

OLR prediction of MJO-related anomalies using CA model reconstruction by RMM1 & RMM2 (18 Dec 2022)



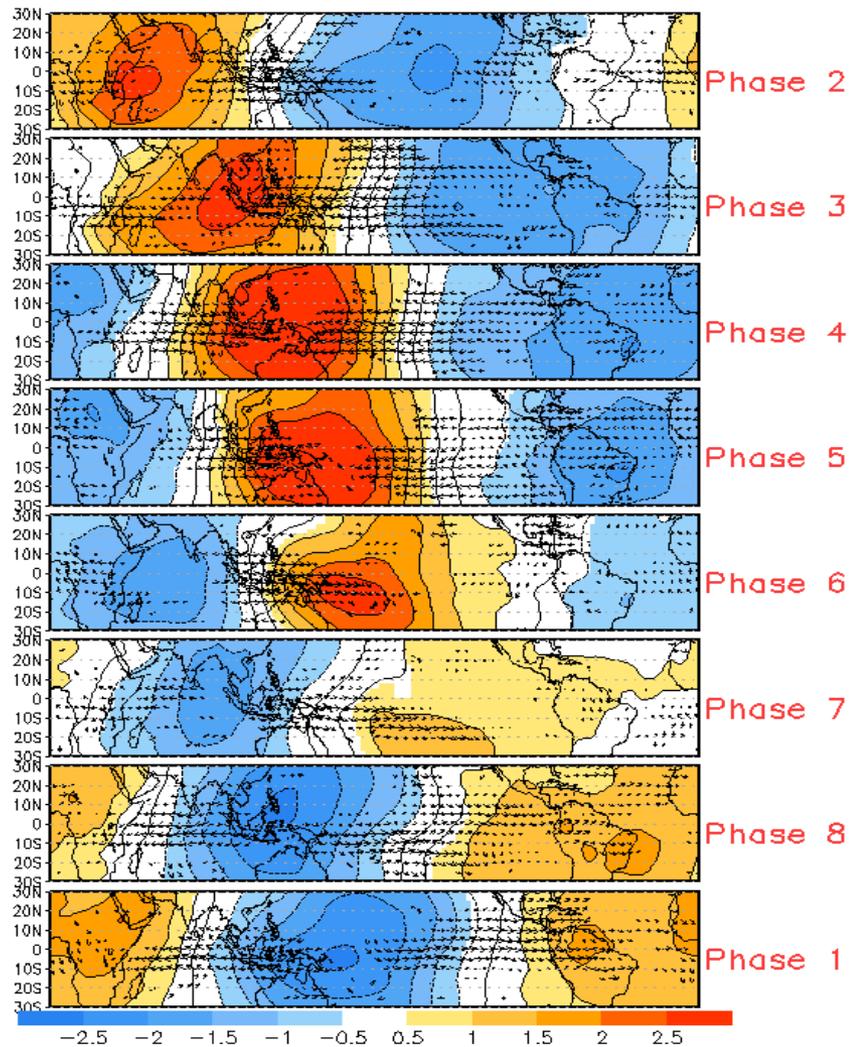
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm<sup>-2</sup>) Period:18-Jun-2022 to 18-Dec-2022  
The unfilled contours are CA forecast reconstructed anomaly for 15 days



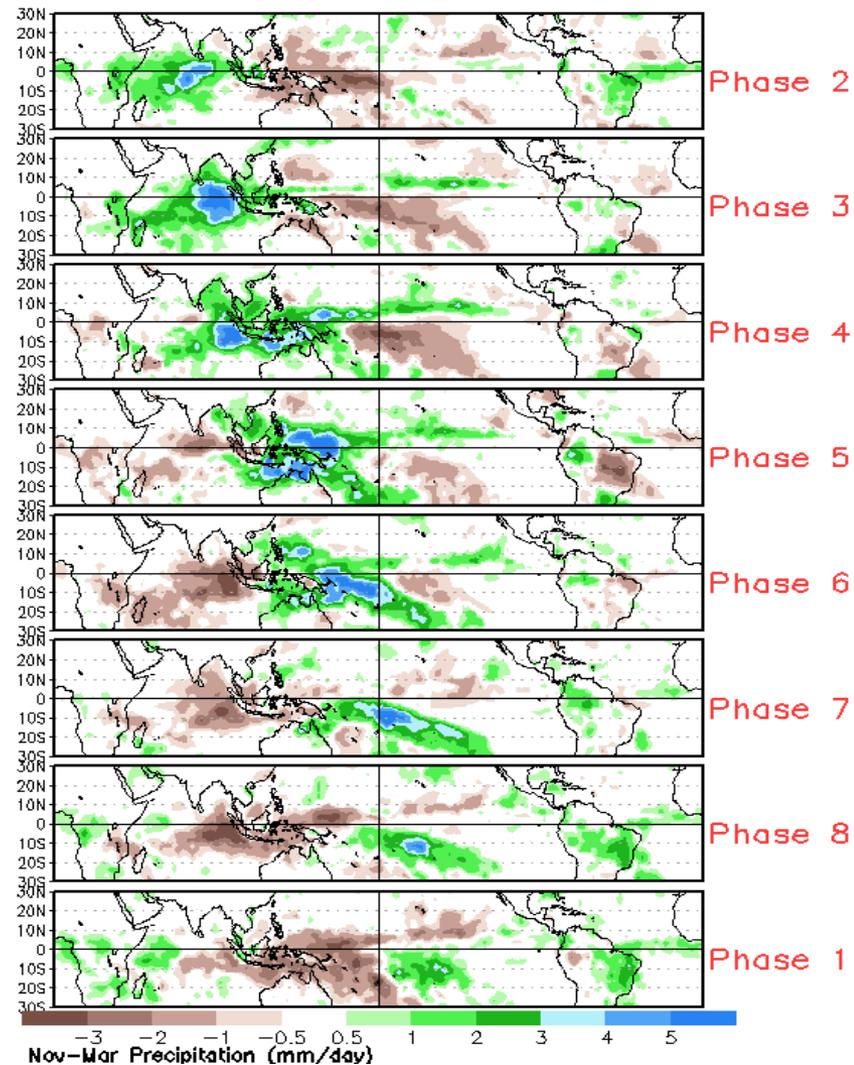
- The constructed analog forecast of RMM-based OLR depicts a gradually strengthening convective pattern, but remains more stationary throughout the period compared to the GEFS.

# MJO: Tropical Composite Maps by RMM Phase

## 850-hPa Velocity Potential and Wind Anomalies



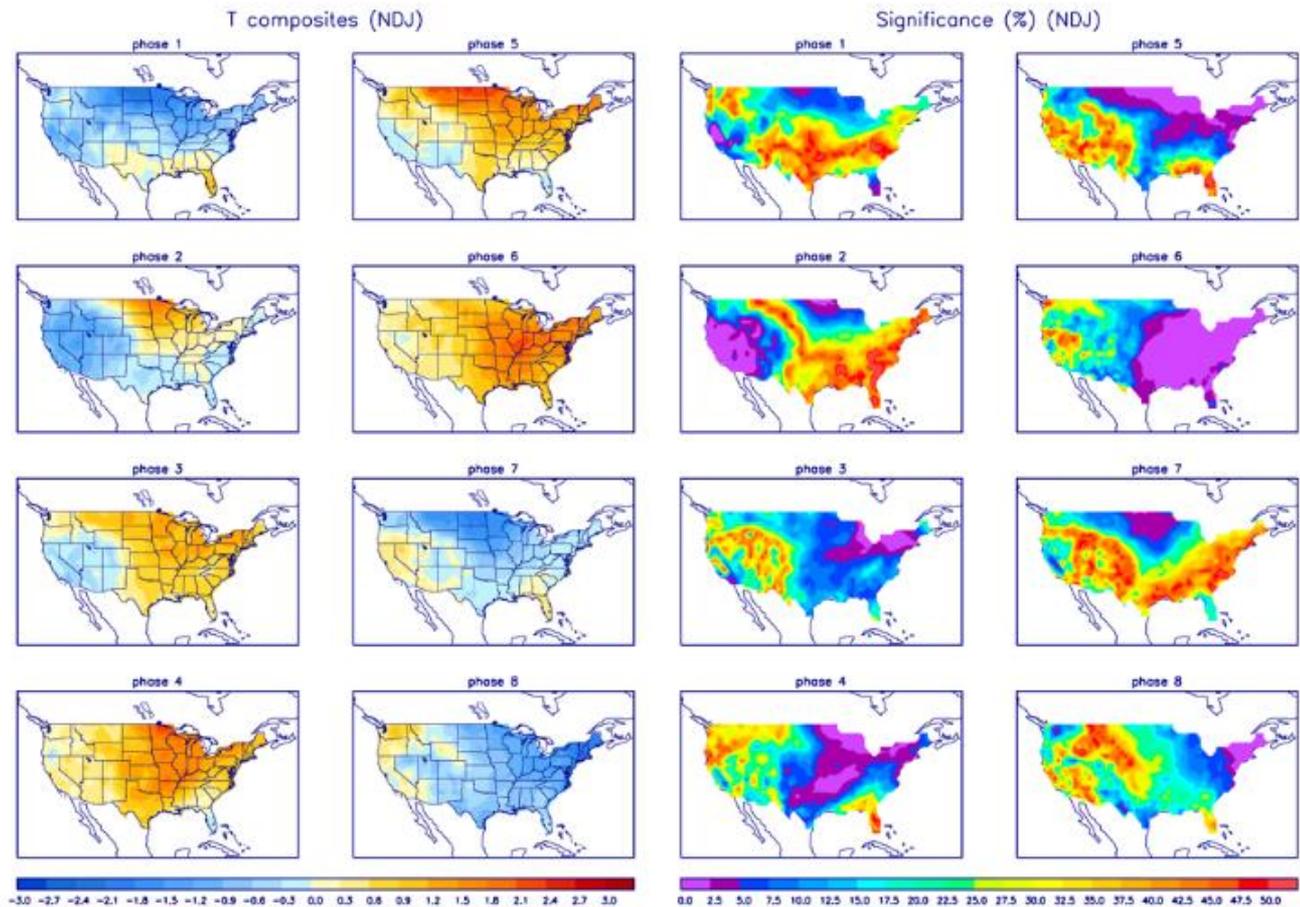
## Precipitation Anomalies



# 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.



# 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.

