

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



**Update prepared by the Climate Prediction Center**  
Climate Prediction Center / NCEP  
30 November 2020

# Overview

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- The MJO is currently over the western Maritime Continent. Destructive interference with the low frequency state is causing difficulty in traditional MJO indices in characterizing its presence. Evaluation of individual circulation and convective variables supports a robust MJO over the Maritime Continent.
- Spread in model forecasts is substantial each of the next two weeks, due to competition of the active MJO and La Niña events, coupled with an atmospheric Kelvin wave approaching the MJO envelope and active equatorial Rossby waves over the Eastern Hemisphere. Various dynamical models, and ensemble members within these models, tend to emphasize these different modes to varied degrees leading to drastically different possible outcomes.
- Despite the uncertainty regarding the fate of the MJO, its presence is likely to increase tropical cyclone formation chances over the eastern Indian Ocean this week, with increased chances over the South China Sea, and extreme southeastern Indian Ocean during the following week.

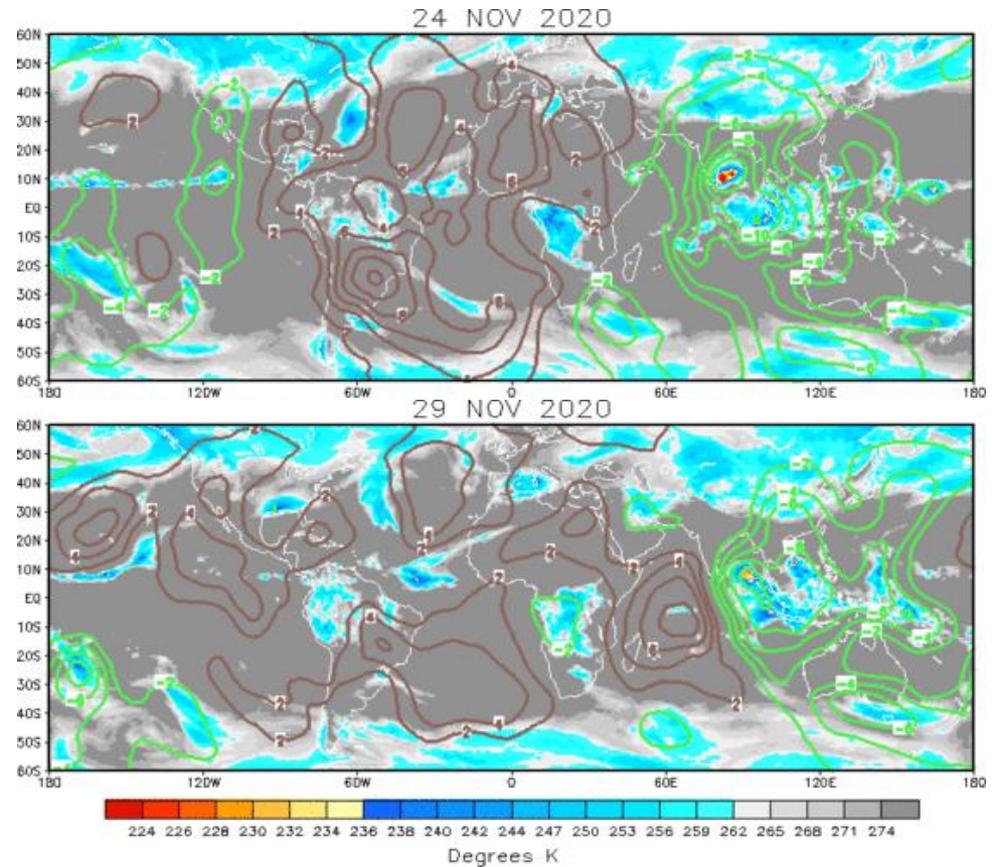
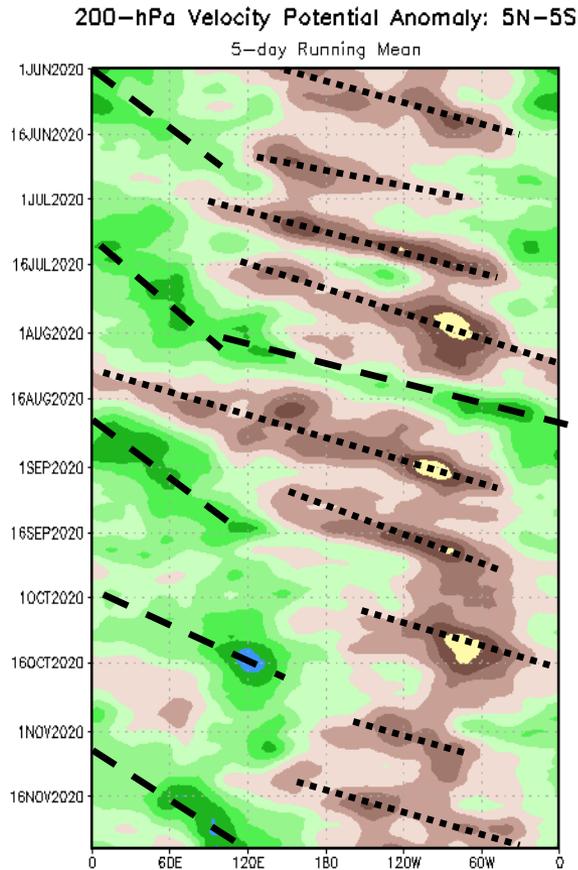
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:

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

# 200-hPa Velocity Potential Anomalies

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

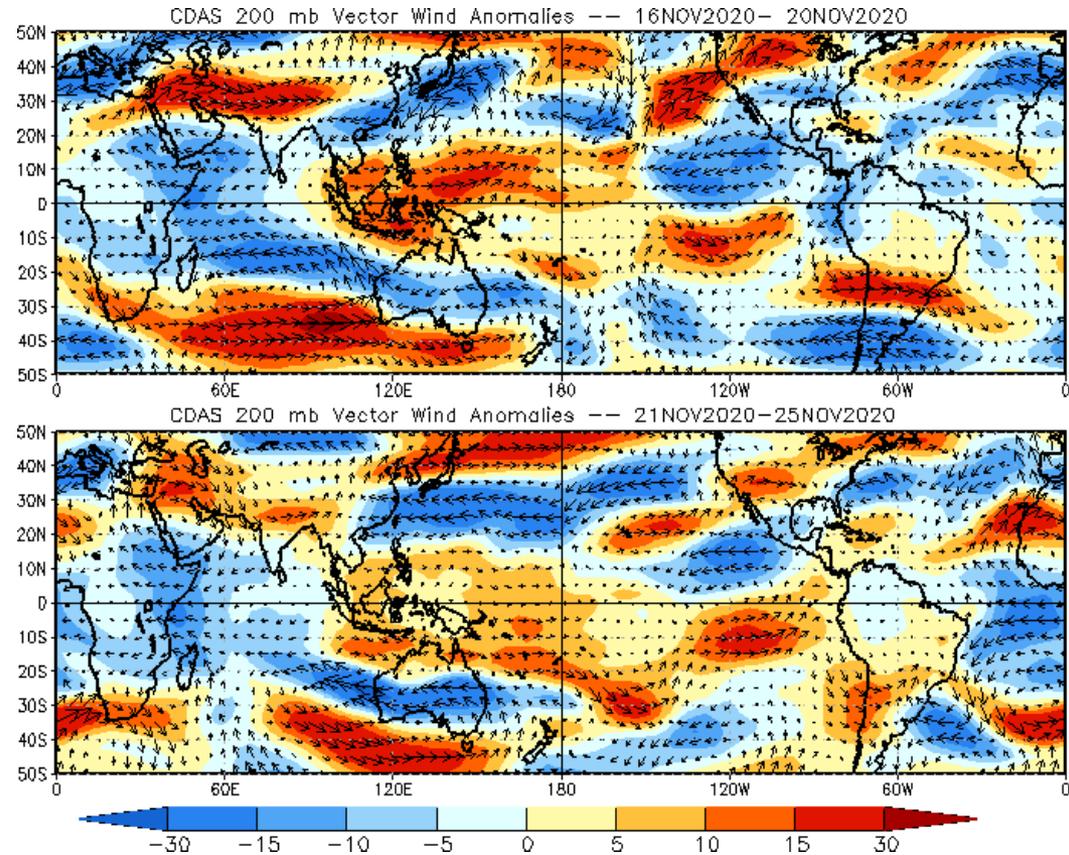
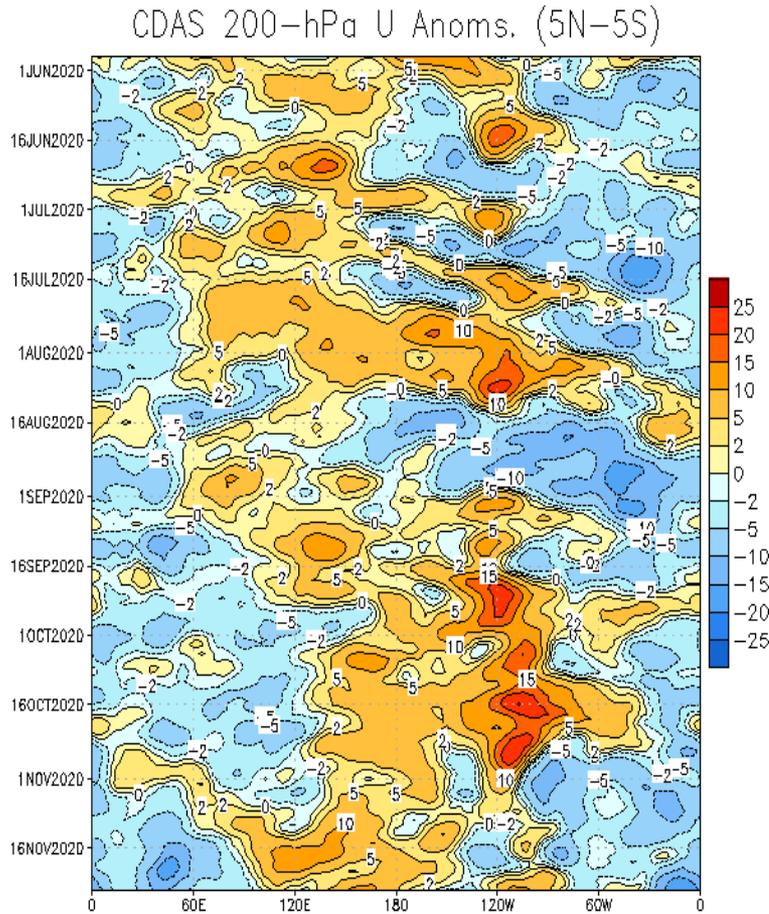
**Brown shades:** Anomalous convergence (unfavorable for precipitation).



- Following a period of destructive interference between the MJO and La Niña over the Western Hemisphere, the MJO has continued to show signs of strengthening since mid-November.
- A wave-1 pattern in the upper-level circulation has been prominent since mid-November, and showed eastward propagation characteristic of an active MJO.

# 200-hPa Wind Anomalies

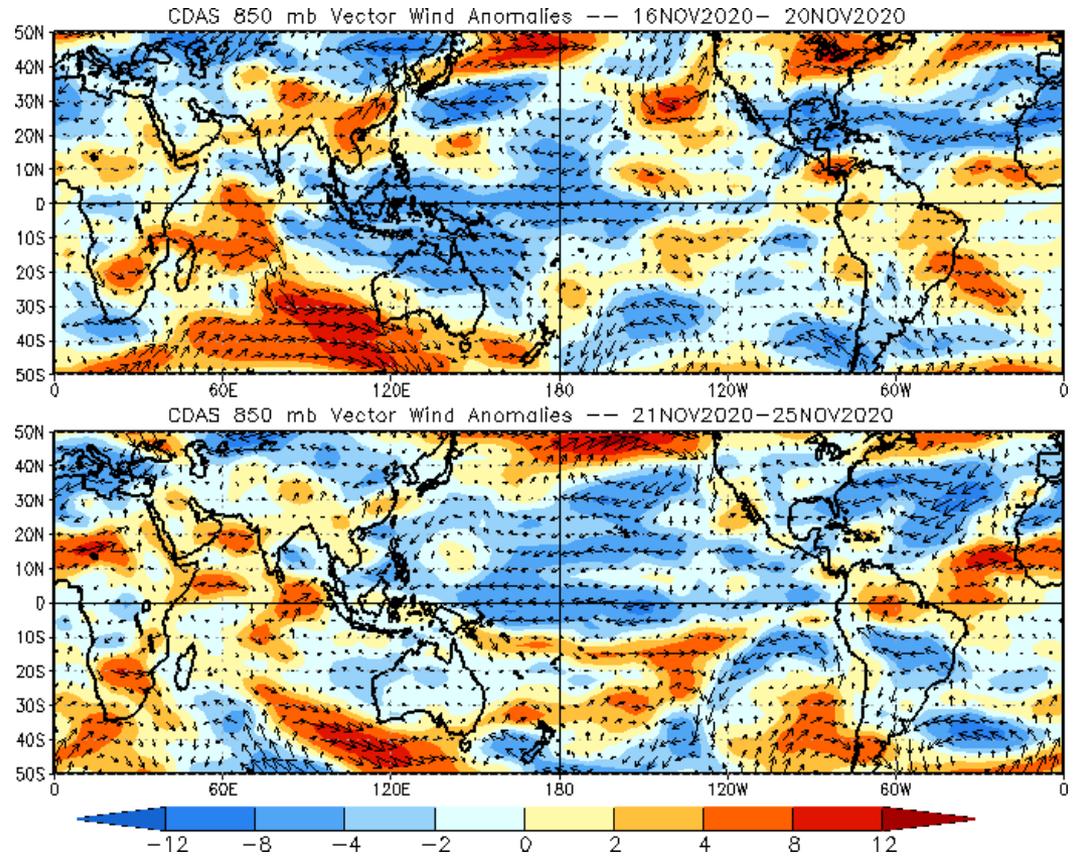
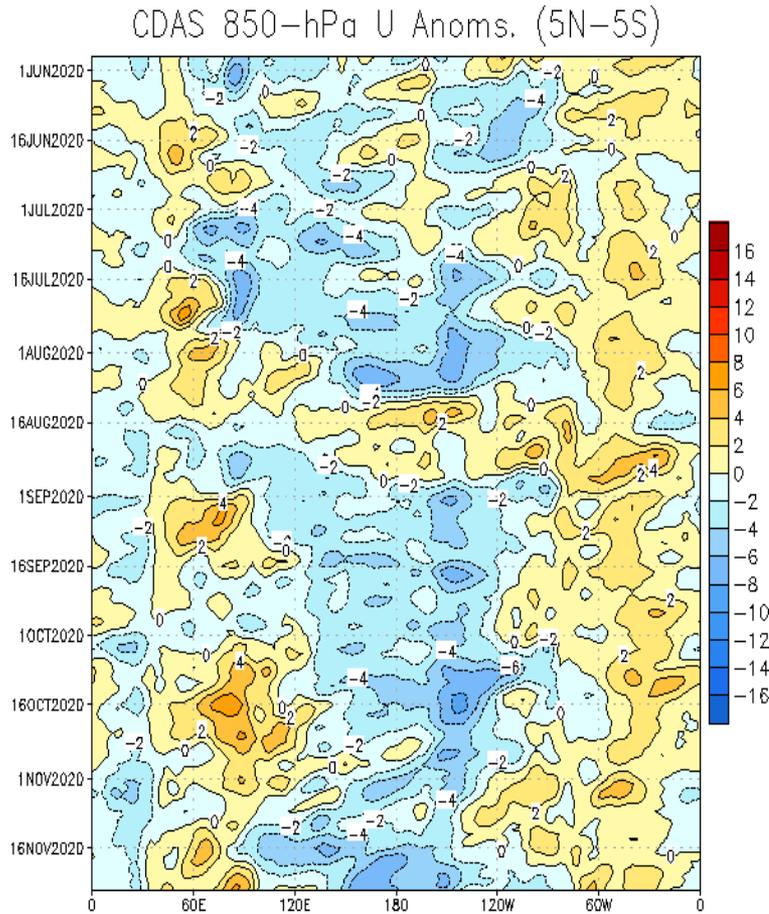
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Anomalous easterlies (westerlies) have strengthened aloft over the western Indian Ocean (Maritime Continent and West Pacific) helping to create a favorable environment for Eastern Hemisphere tropical cyclone formation.
- Anomalous ridges (troughs) in the subtropics over the Middle East and Southern Africa (West Pacific and Australia) are helping to reinforce this tropical circulation dipole.

# 850-hPa Wind Anomalies

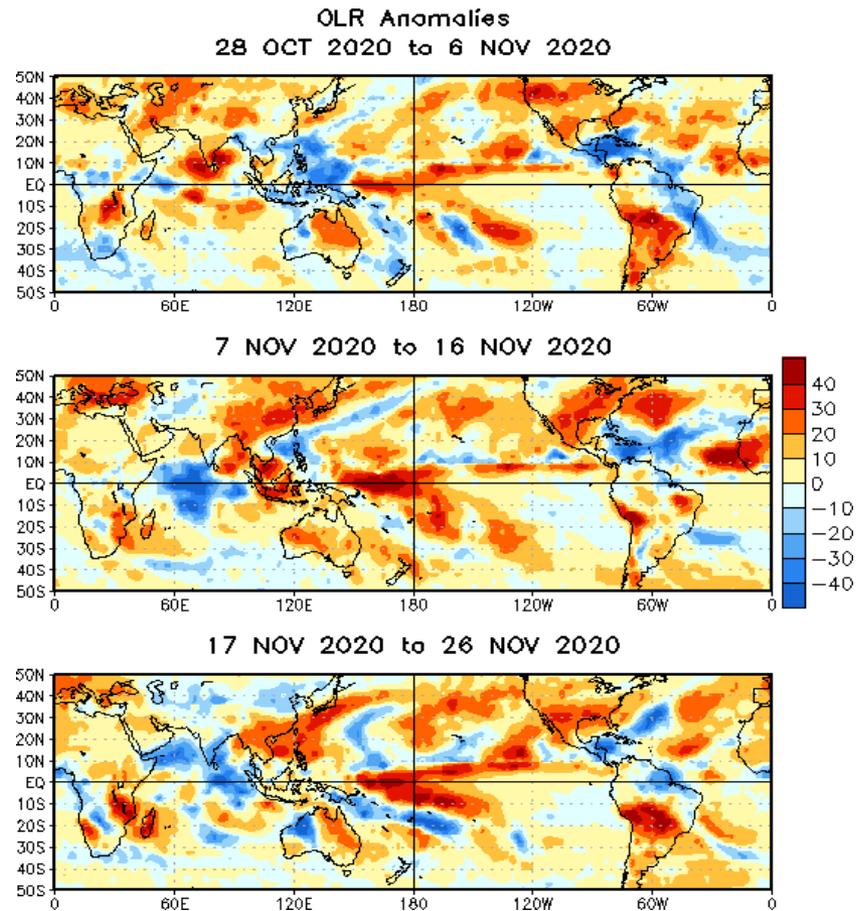
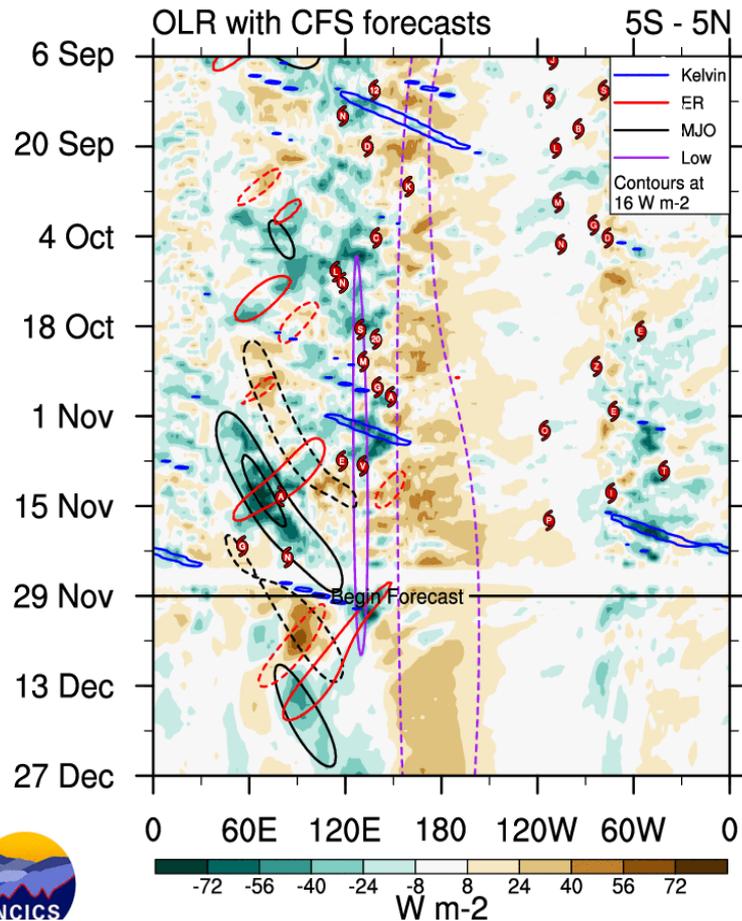
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Low-level anomalous westerlies have continued to push east over the Indian Ocean since mid-November, tied to the MJO's progression.
- Enhanced trades persist across the equatorial Pacific, tied to the ongoing La Niña.
- Increased low-level convergence is apparent over the South Pacific since the 21<sup>st</sup> of November.

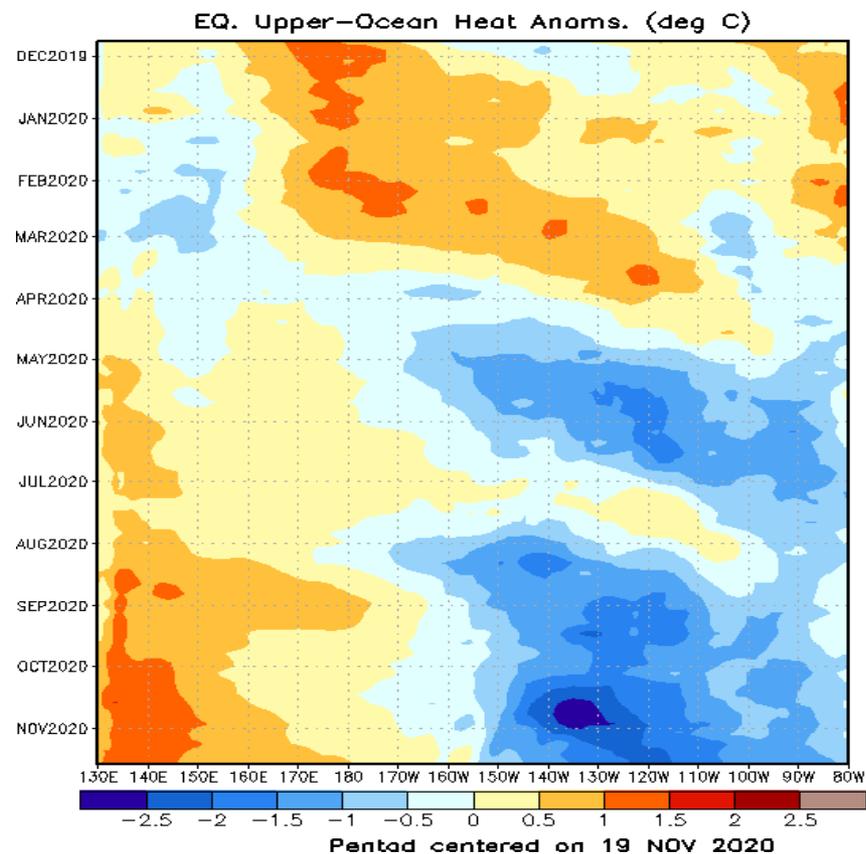
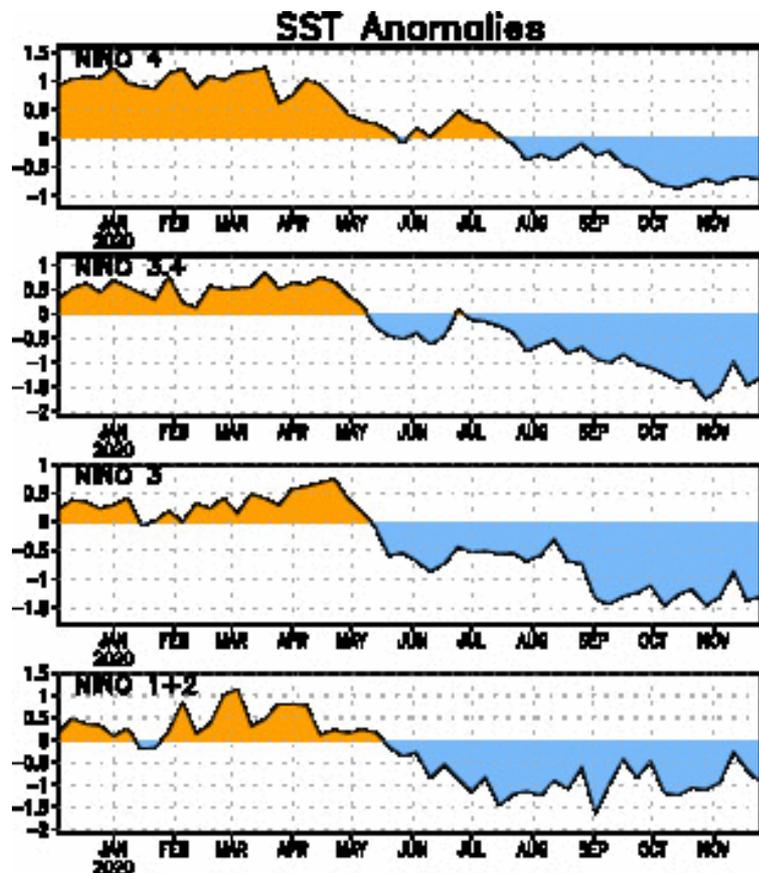
# Outgoing Longwave Radiation (OLR) Anomalies

**Blue shades: Anomalous convection (wetness).** **Red shades: Anomalous subsidence (dryness).**



- Enhanced convection continued to drift eastward over the Indian Ocean in association with the MJO's progression. A Kelvin wave is also analyzed near 120°E, catching up to the active MJO envelope.
- The “horseshoe” of suppressed convection over the Tropical Pacific continues to persist, characteristic of the ongoing La Niña.
- Convection has picked up over the South Pacific since mid-November, tied to the MJO approaching the Maritime Continent.

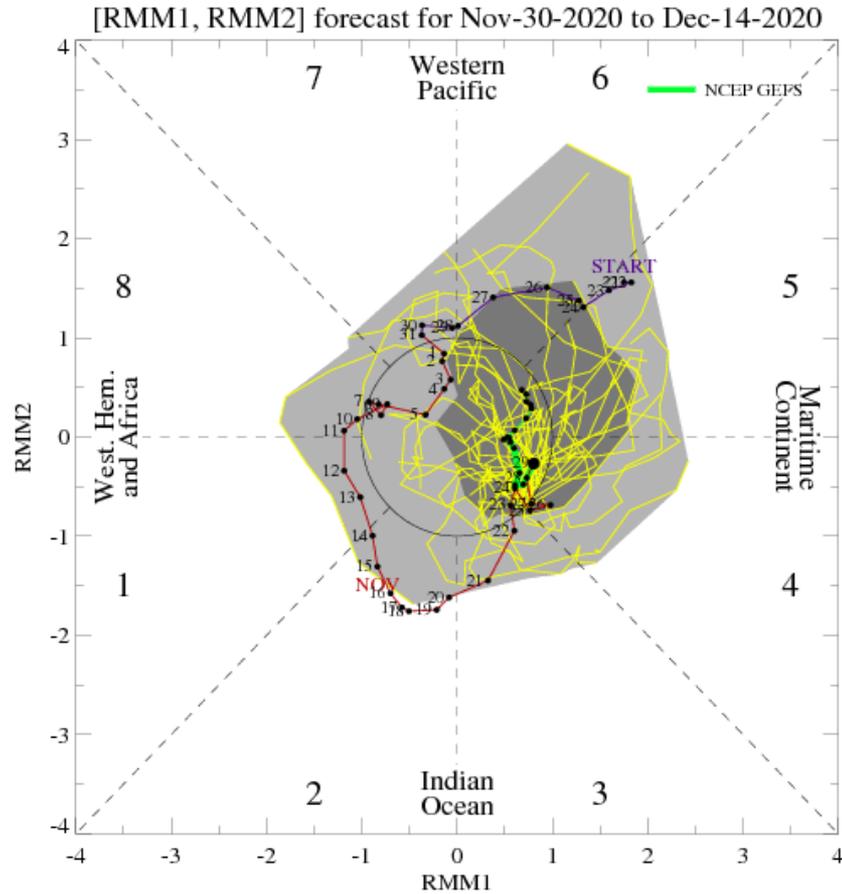
# SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



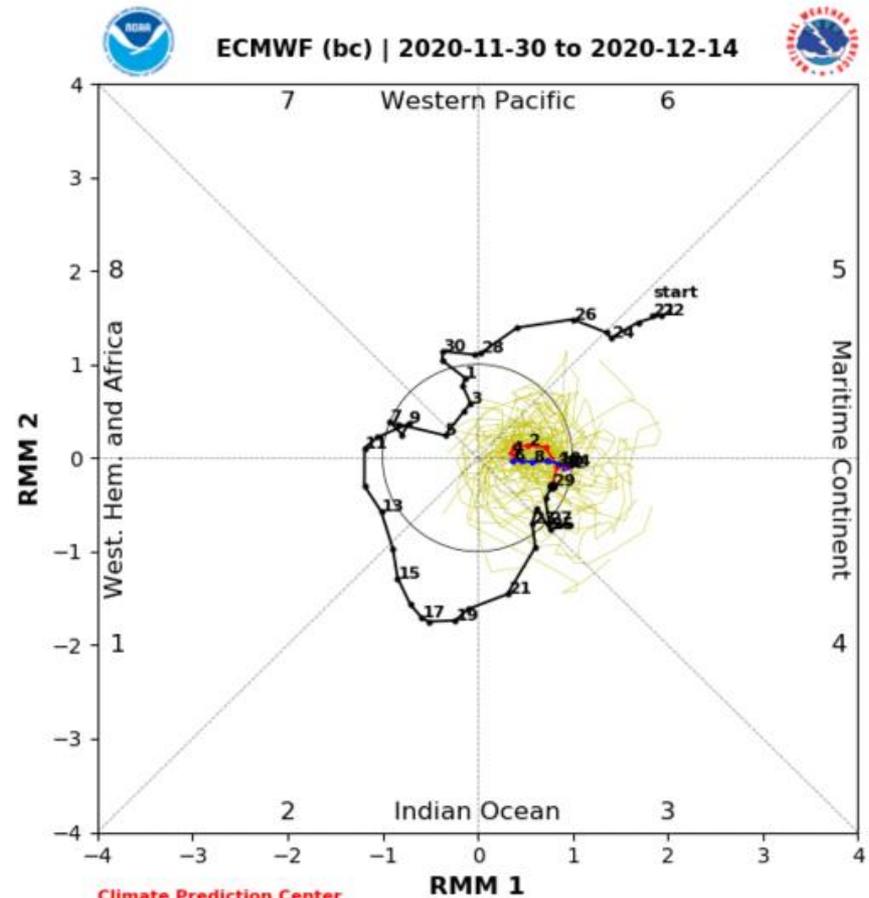
- Following destructive interference with the base state by a downwelling Kelvin wave during July, the subsequent upwelling phase has pushed the Pacific into La Niña conditions.
- Each of the ENSO regions has cooled slightly since a brief recovery in SSTs during early November.



# MJO Index: Forecast Evolution



**GEFS Forecast**



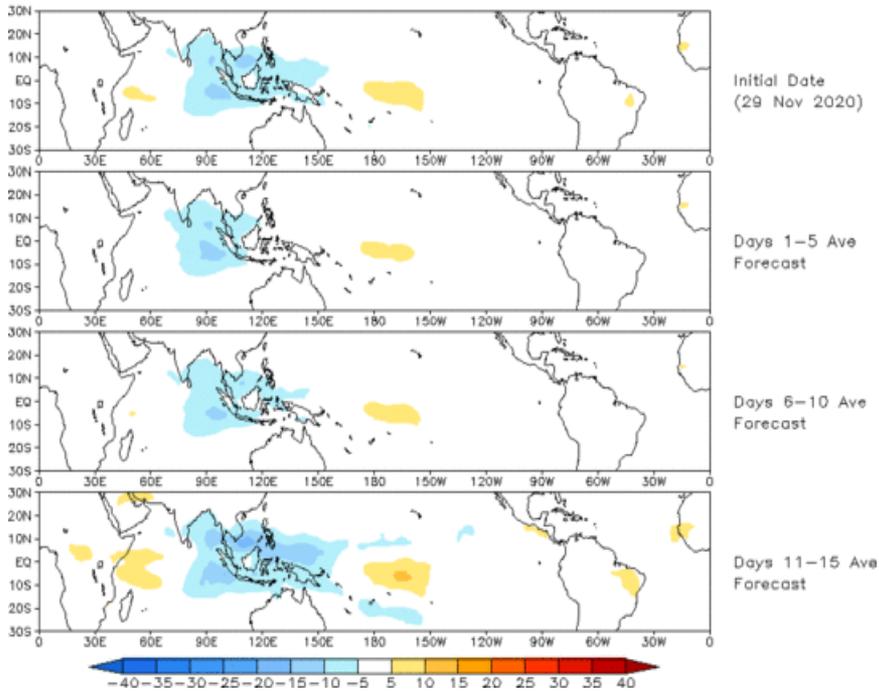
**ECMWF Forecast**

- The GEFS outlook the next two weeks features some initial westward progression, likely tied to Rossby wave activity, before approaching the West Pacific late in Week-2. Spread among ensemble members is large, particularly in RMM2 space.
- The ECMWF shows the RMM index largely stagnant over the Maritime Continent. This is likely again due to emphasis of Rossby wave activity, and to some extent interference with the background state.

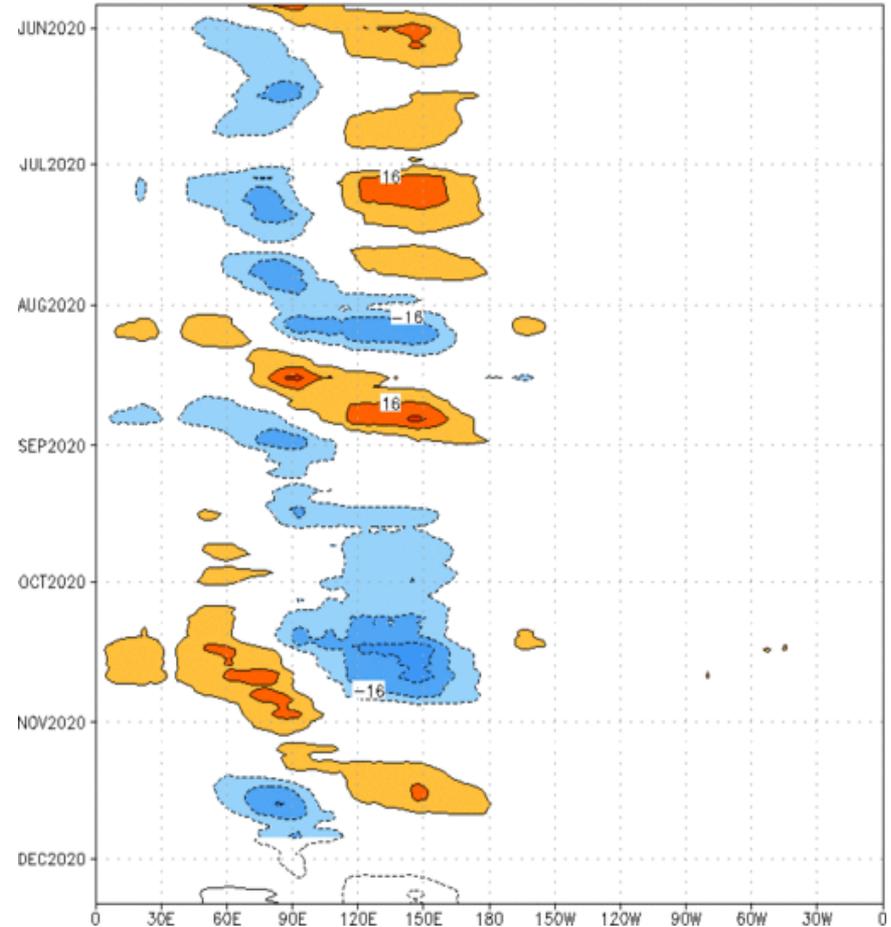
# MJO: GEFS Forecast Evolution

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: 29 Nov 2020  
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2  
OLR [ $7.5^{\circ}\text{S}, 7.5^{\circ}\text{N}$ ] ( $\text{cont: } 4\text{Wm}^{-2}$ ) Period: 27-May-2020 to 26-Nov-2020  
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

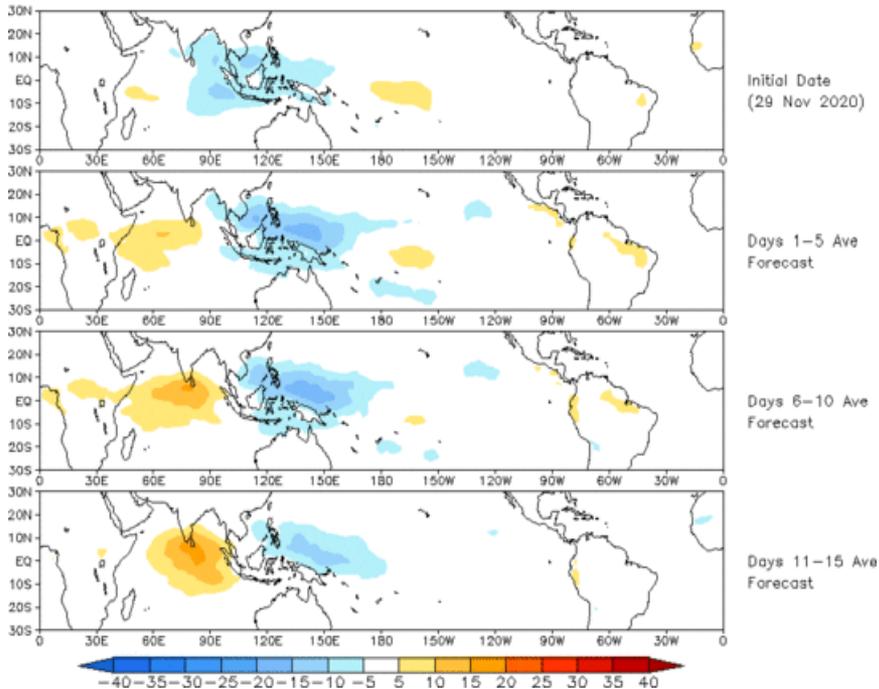


- The GEFS forecasts show gradual propagation of the MJO envelope, with some strengthening of the pattern by mid-December.
- A Kelvin wave signal appears to bleed into the original analysis, causing the uncharacteristic westward shift of enhanced convection during the initial forecast period.

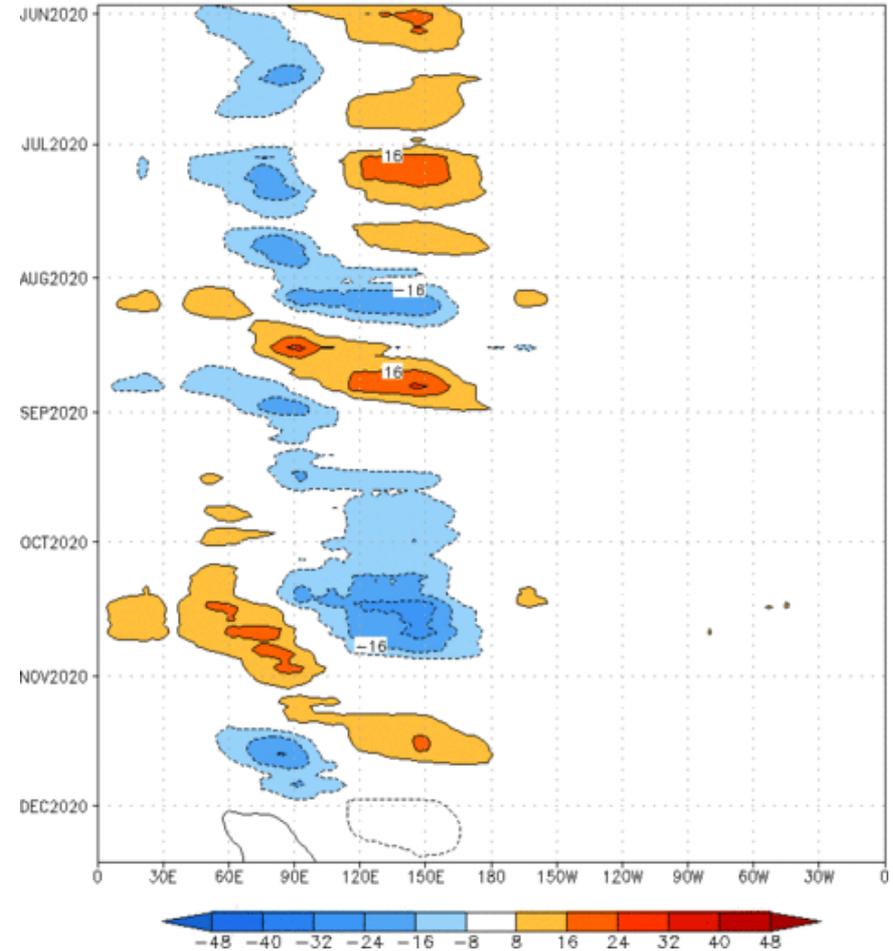
# MJO: Constructed Analog Forecast Evolution

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 (29 Nov 2020)



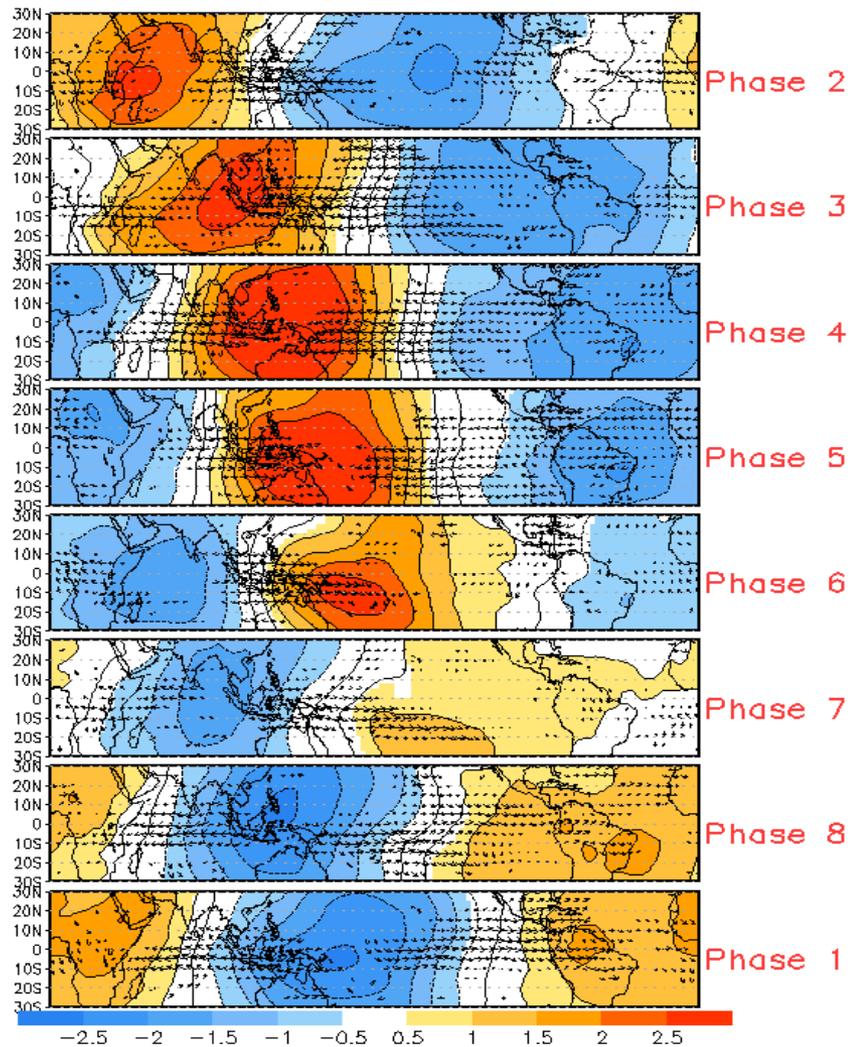
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm<sup>-2</sup>) Period:30-May-2020 to 29-Nov-2020  
The unfilled contours are CA forecast reconstructed anomaly for 15 days



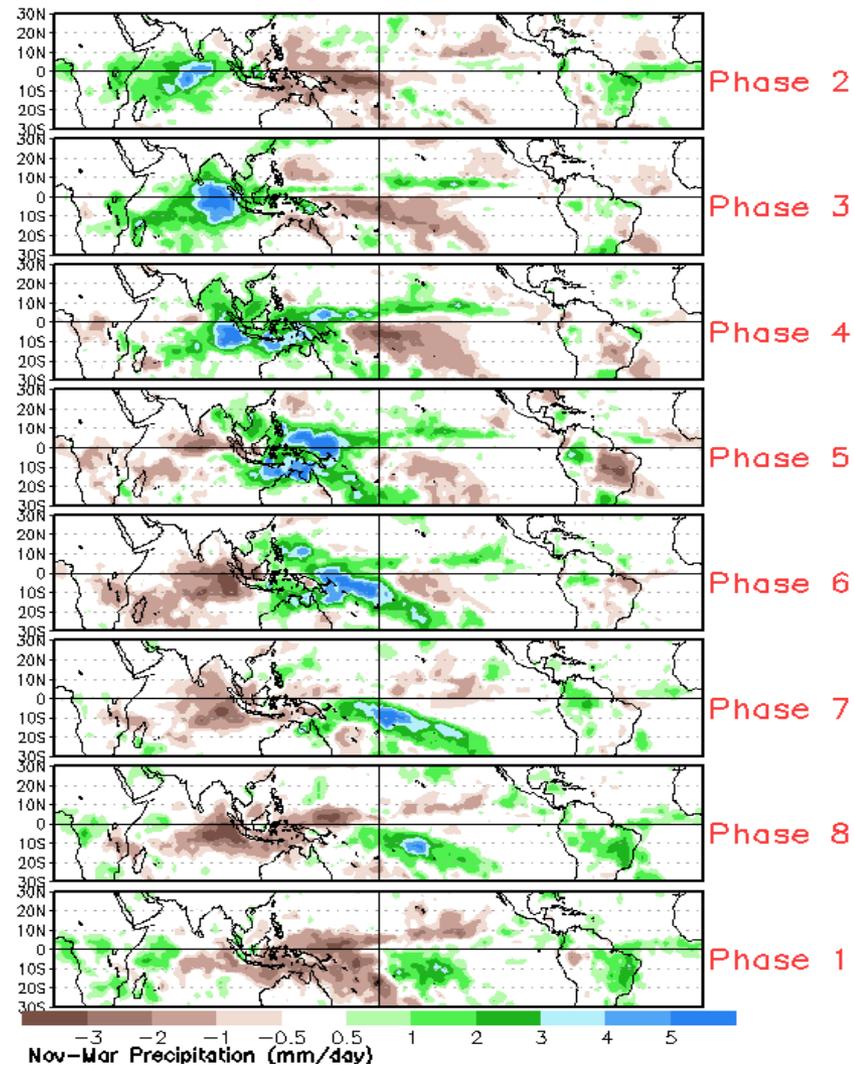
- The constructed analog outlook is more progressive than the GEFS, while showing the enhanced (suppressed) MJO signal decaying (building) over time.
- The aforementioned Kelvin wave not being filtered out in wavenumber/frequency space hints this may be a bit too progressive.

# MJO: Tropical Composite Maps by RMM Phase

## 850-hPa Velocity Potential and Wind Anomalies



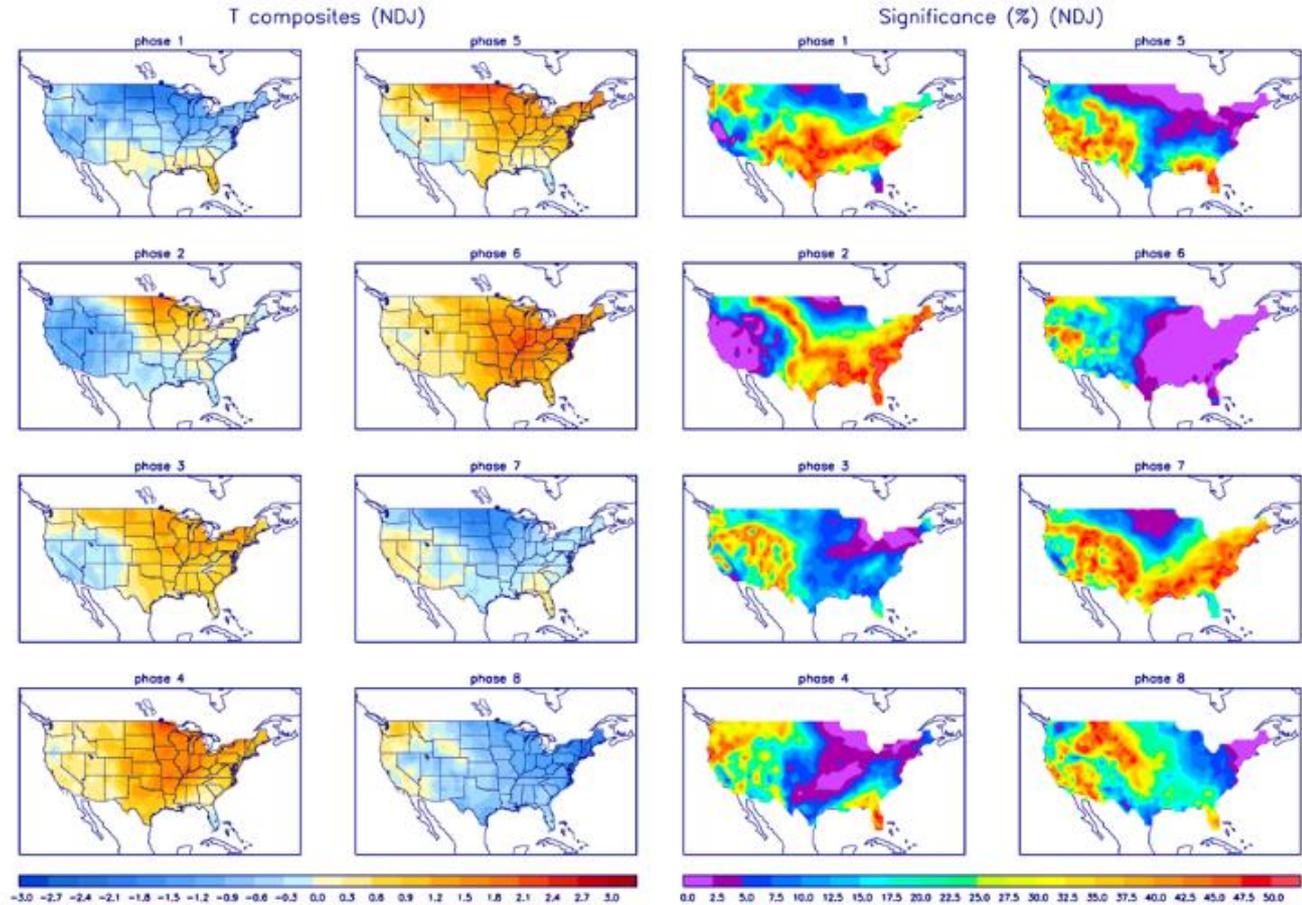
## Precipitation Anomalies



# 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 - Temperature

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.

