

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



**Update prepared by the Climate Prediction Center**  
Climate Prediction Center / NCEP  
21 February 2022

# Overview

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- The RMM index indicates the MJO remains in phase 3 over the Indian Ocean where it has been slow to propagate eastward over the past week.
- Dynamical model RMM forecasts generally favor a more canonical eastward propagation of the MJO into the Maritime Continent during the next week, with differences in regards to its amplitude and phase speed heading into early March.
- The enhanced phase of the MJO, as well as predicted Kelvin wave activity, is expected to contribute to tropical cyclone formation over the southern Indian Ocean and western Pacific during the next two weeks.
- Constructive interference with the low frequency base state remains likely during the outlook period, with an anticipated extratropical response typical of La Niña downstream over the mid-latitudes.

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

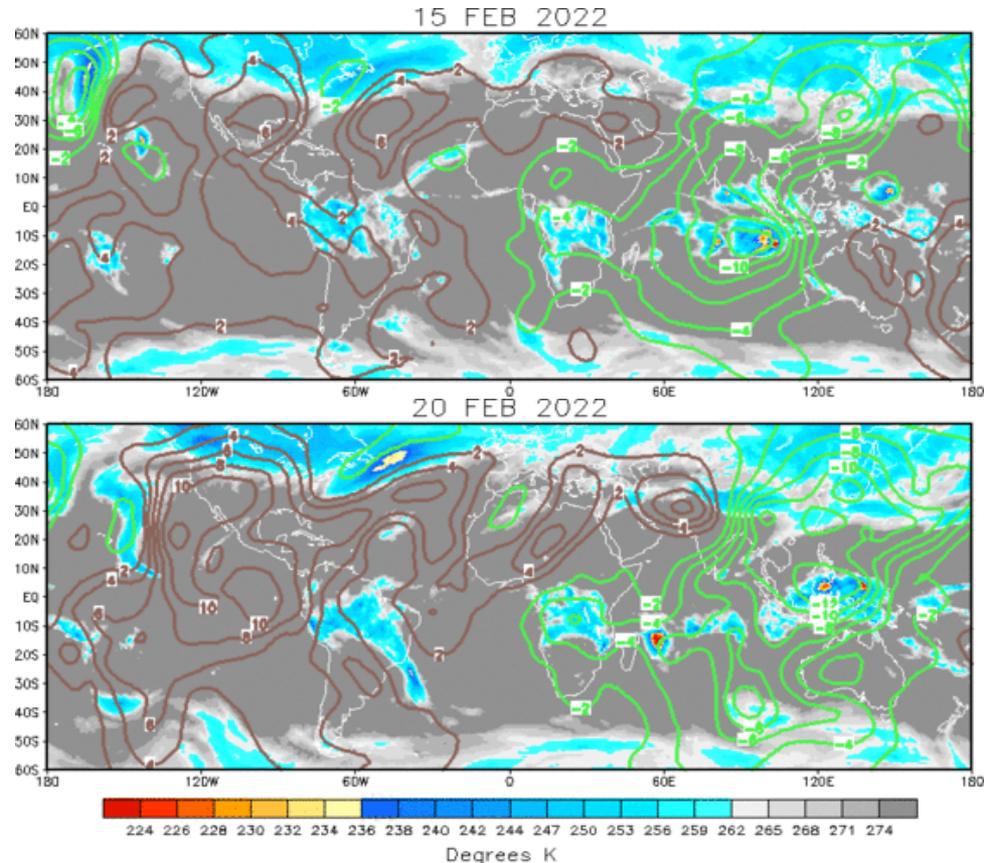
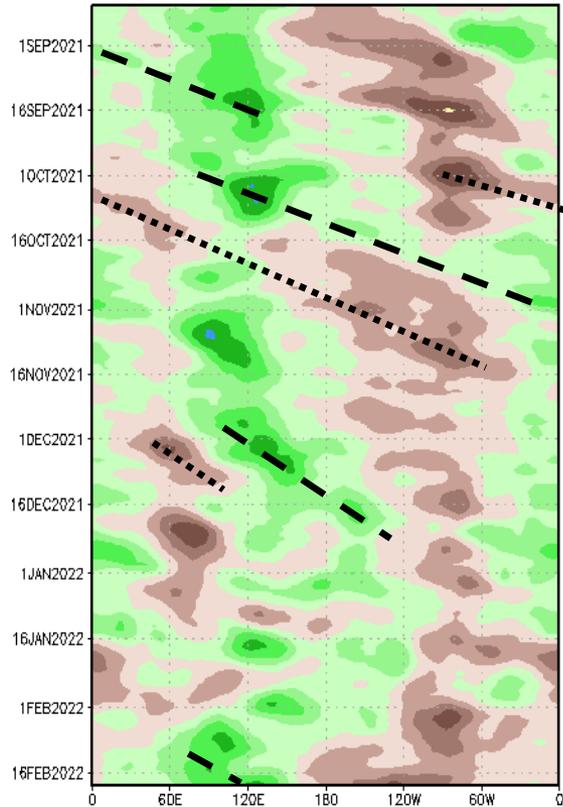
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

# 200-hPa Velocity Potential Anomalies

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

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

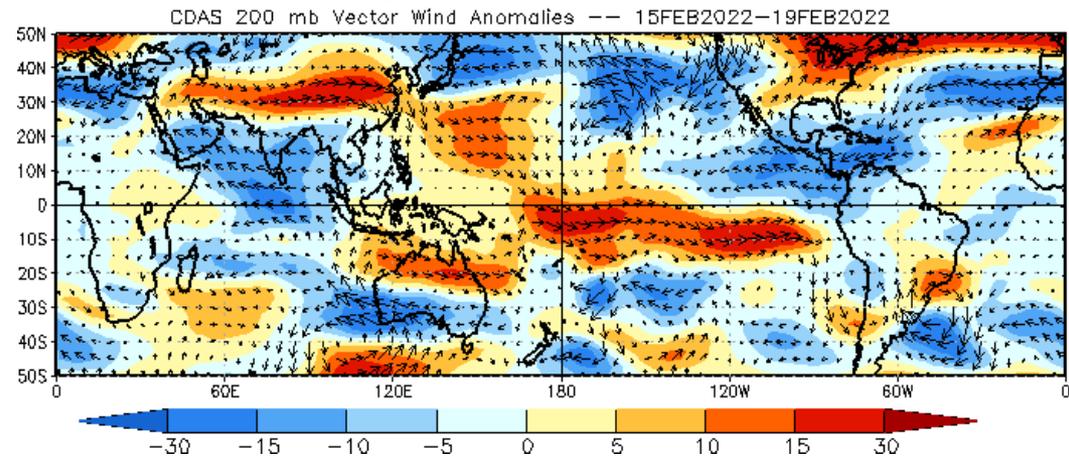
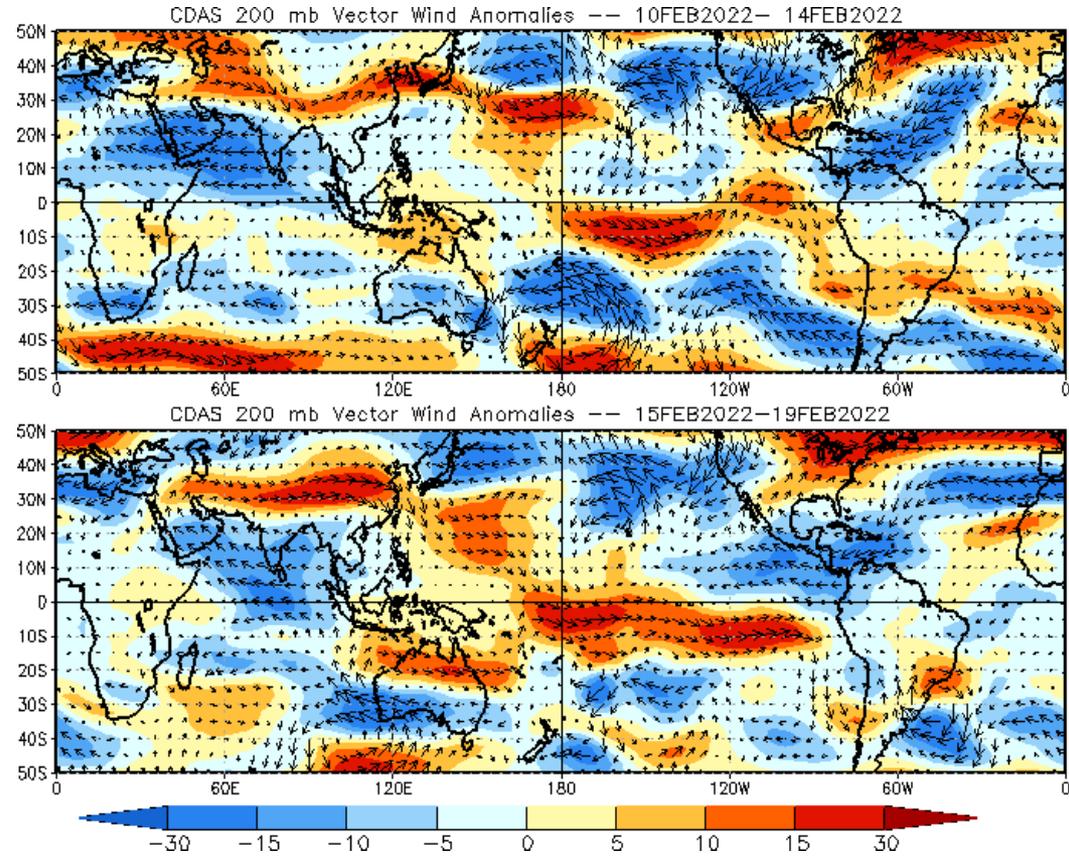
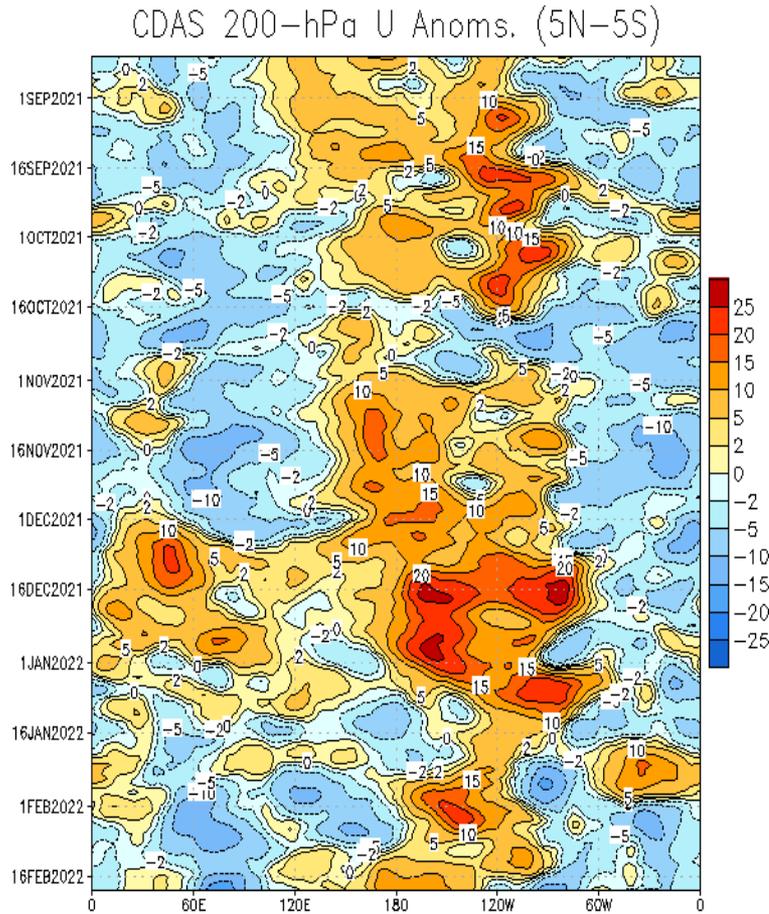
200-hPa Velocity Potential Anomaly: 5N-5S  
5-day Running Mean



- Following a period of competing influences of Kelvin and equatorial Rossby wave activity in January, the velocity potential pattern has become more coherent due to an reemerging MJO over the Indian Ocean since early February.
- During the past week, the enhanced phase of the MJO has been slow to propagate with enhanced (suppressed) conditions continuing to prevail over the eastern (western) Hemisphere.

# 200-hPa Wind Anomalies

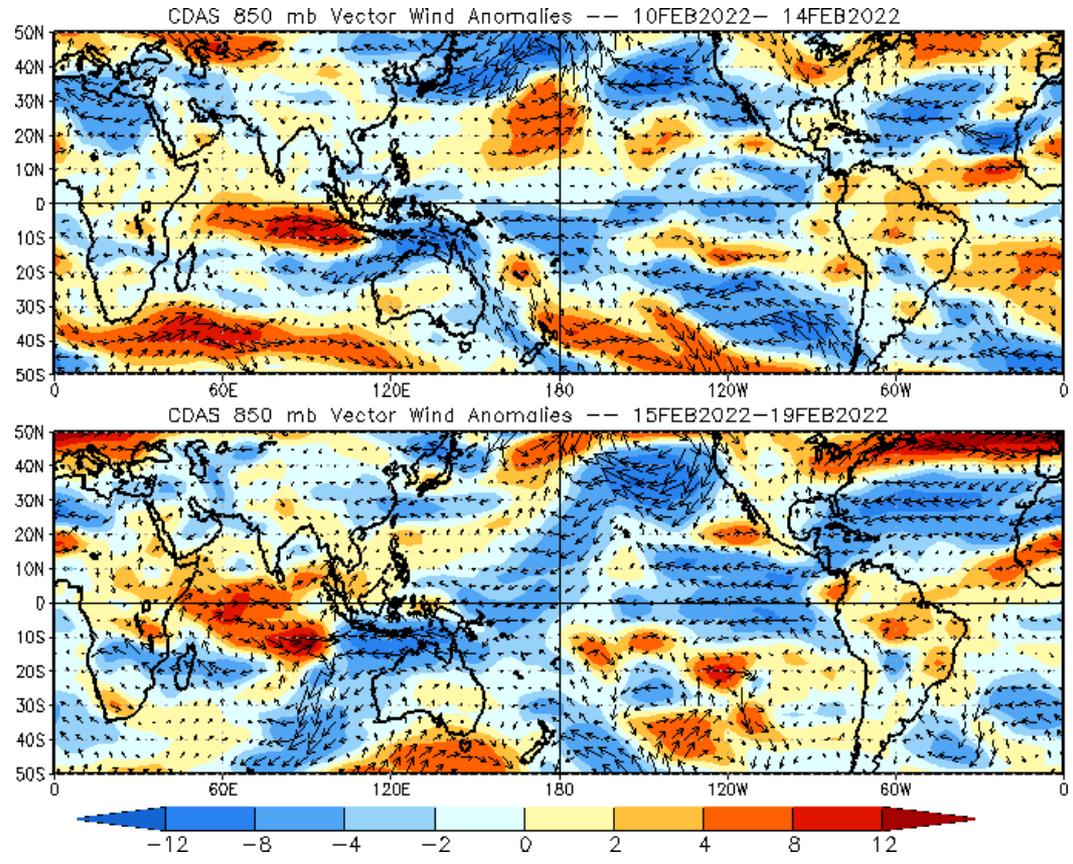
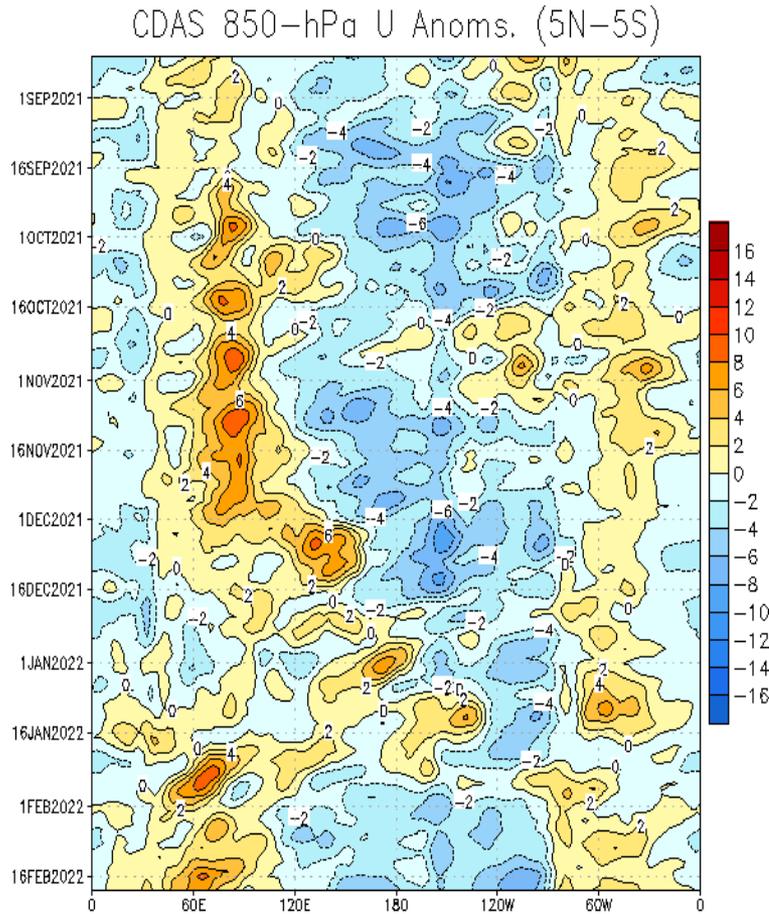
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Anomalous upper-level easterlies have strengthened across the equatorial Indian Ocean, with an anomalous anticyclonic circulation aloft reflective of tropical cyclone (TC) activity, observed south of the equator.
- Consistent with an enhanced Walker Circulation associated with La Niña, anomalous upper level westerlies persist over much of the equatorial Pacific. Much of these anomalous westerlies aloft have expanded westward beyond the Date Line during mid-February.

# 850-hPa Wind Anomalies

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

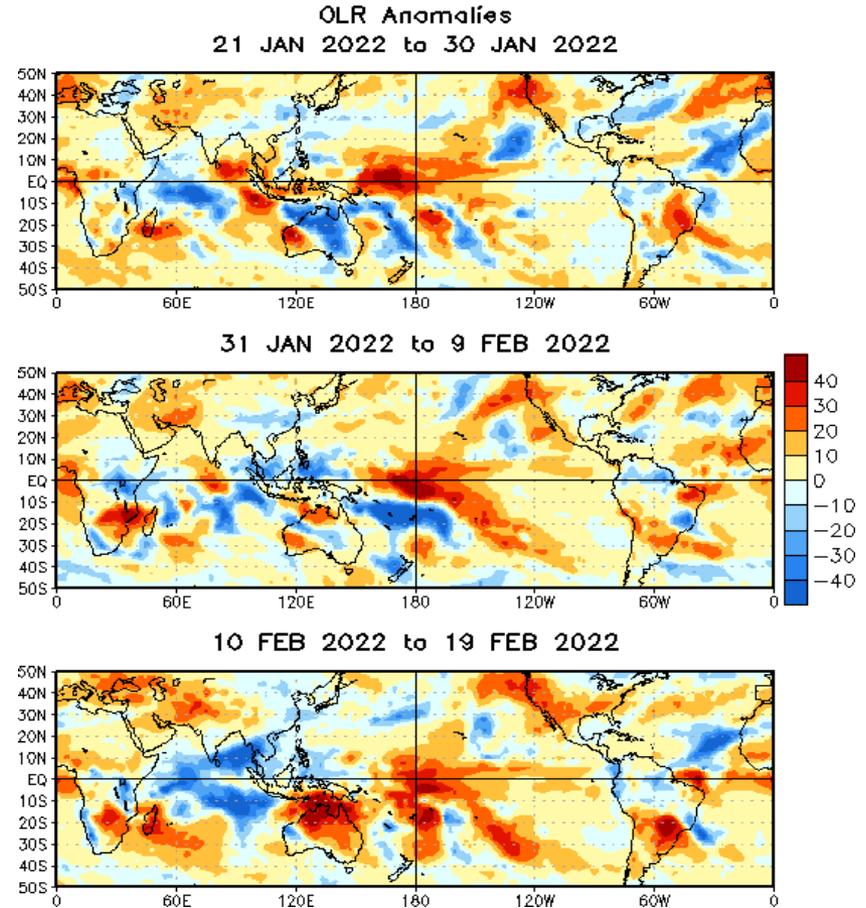
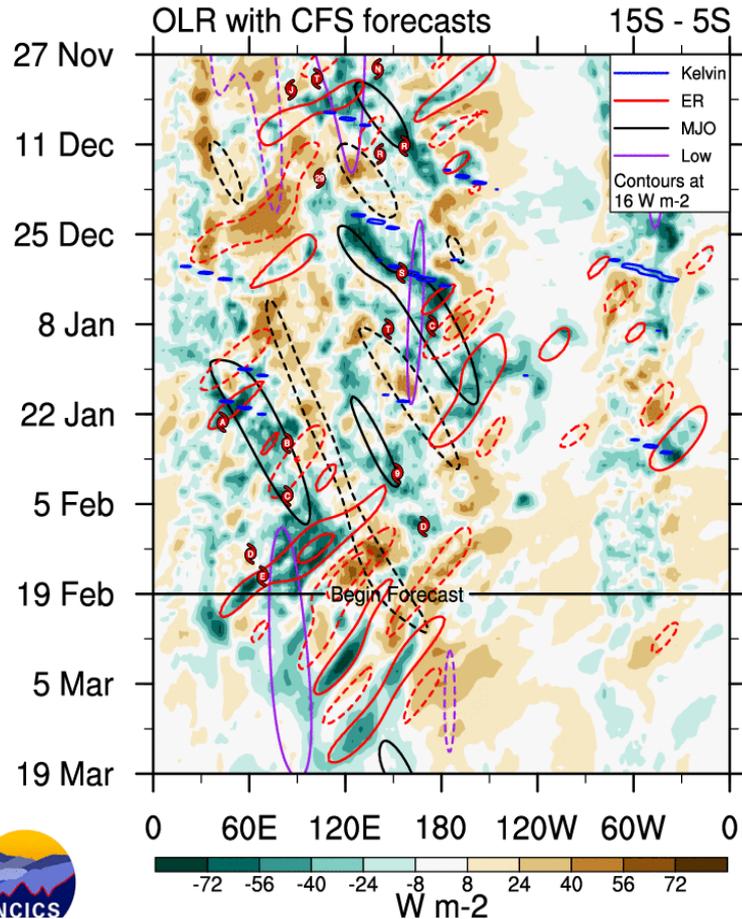


- Enhanced lower-level convergence is evident over the eastern Indian Ocean, as anomalous westerlies over the western Indian Ocean have strengthened along and north of the equator.
- Enhanced trades remain over the equatorial Pacific, consistent with the canonical La Niña atmospheric response.

# Outgoing Longwave Radiation (OLR) Anomalies

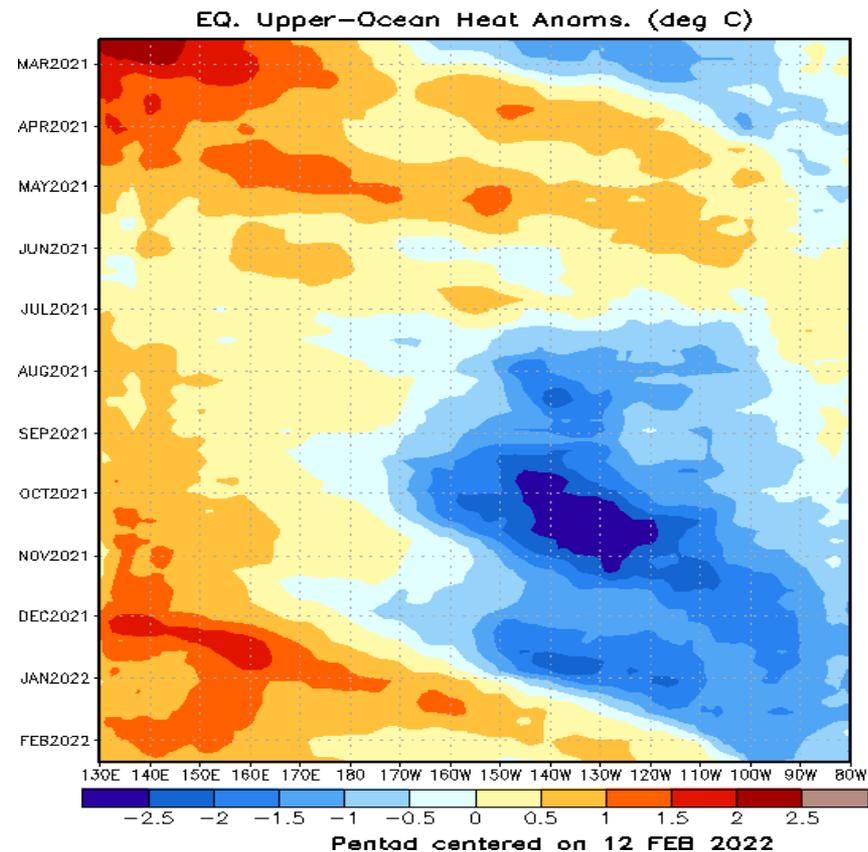
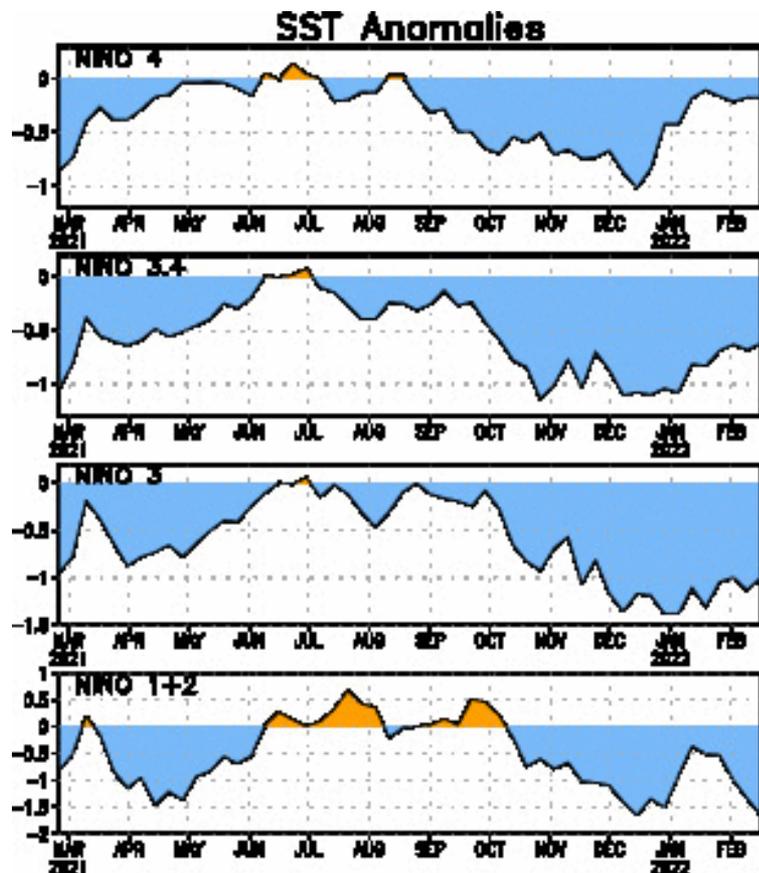
**Green shades: Anomalous convection (wetness)**

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



- Recent trends in the zonal wind pattern have resulted in a larger spatial distribution of enhanced convection throughout much of the Indian Ocean during mid-February.
- Suppressed convection continues near and to the west of the Date Line indicative of the low frequency La Niña footprint.

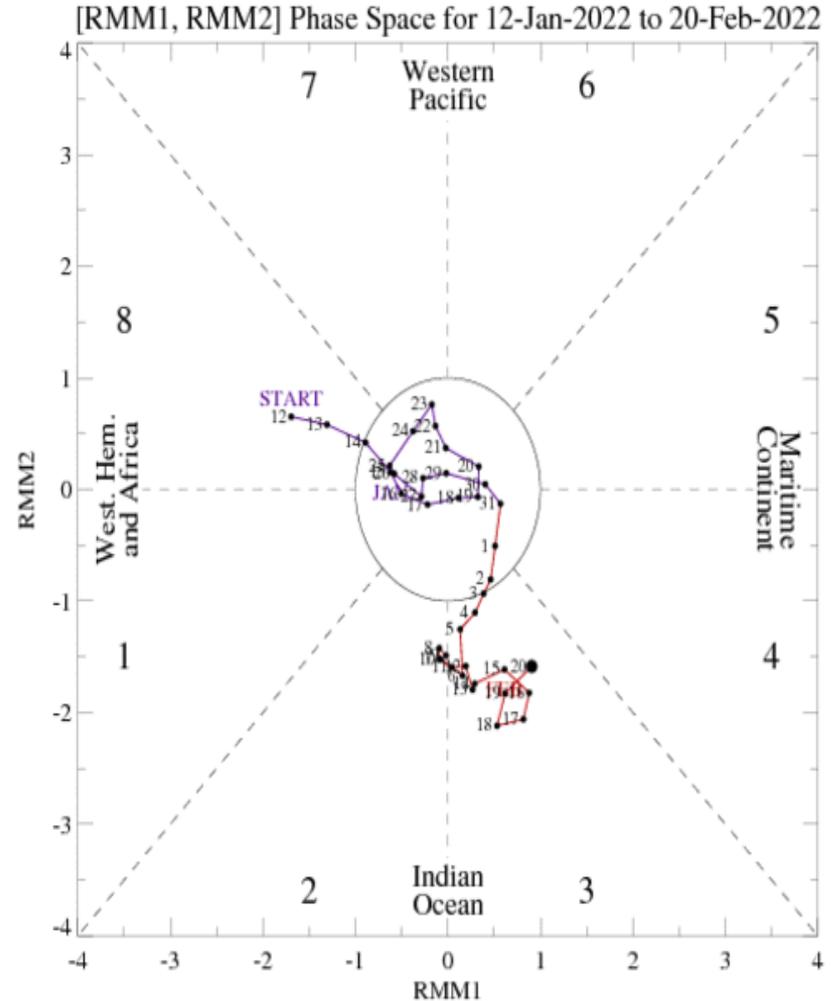
# SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Positive oceanic heat content anomalies continue to expand eastward through the equatorial Pacific in response to a downwelling Kelvin Wave and a subsequent increase in the thermocline.
- While a moderation of SSTs is evident over the Niño 4 region tied to this downwelling Kelvin Wave, stronger negative SST departures continue in the eastern Niño regions. This suggests anomalously cold waters have become more shallow across the central and eastern equatorial Pacific.

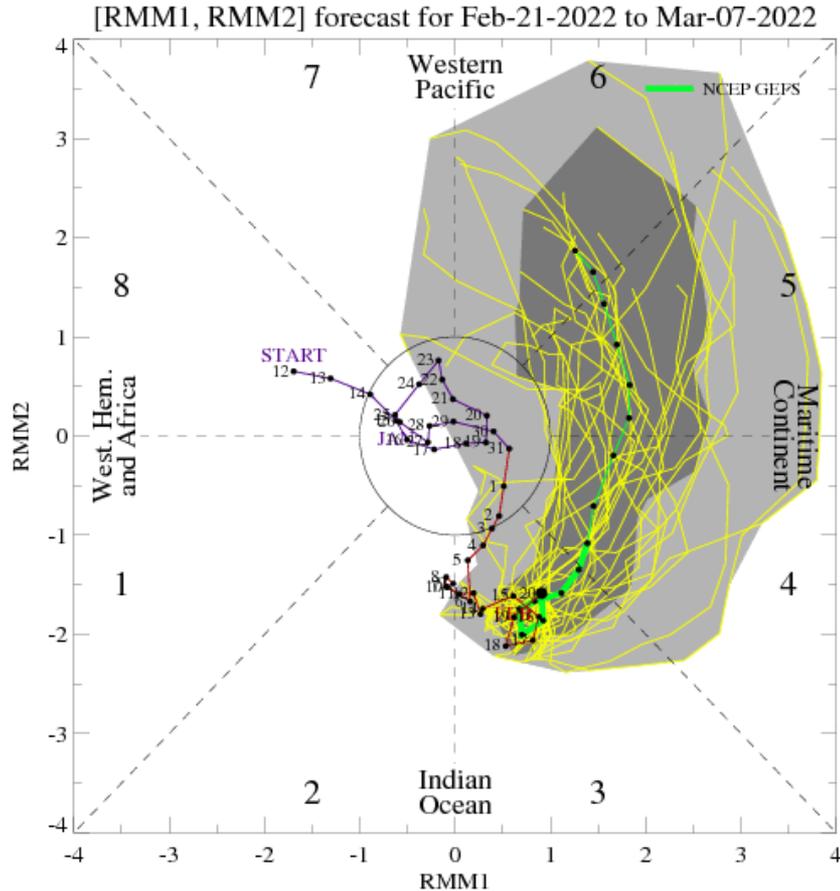
# MJO Index: Recent Evolution

- The RMM index indicates the intraseasonal signal gained amplitude over phase 3 during early February, but has since been slow to continuously propagate eastward across the eastern Indian Ocean.
- This sluggish behavior in RMM space is likely tied to tropical cyclones and Rossby waves observed in the basin during the past couple of weeks.

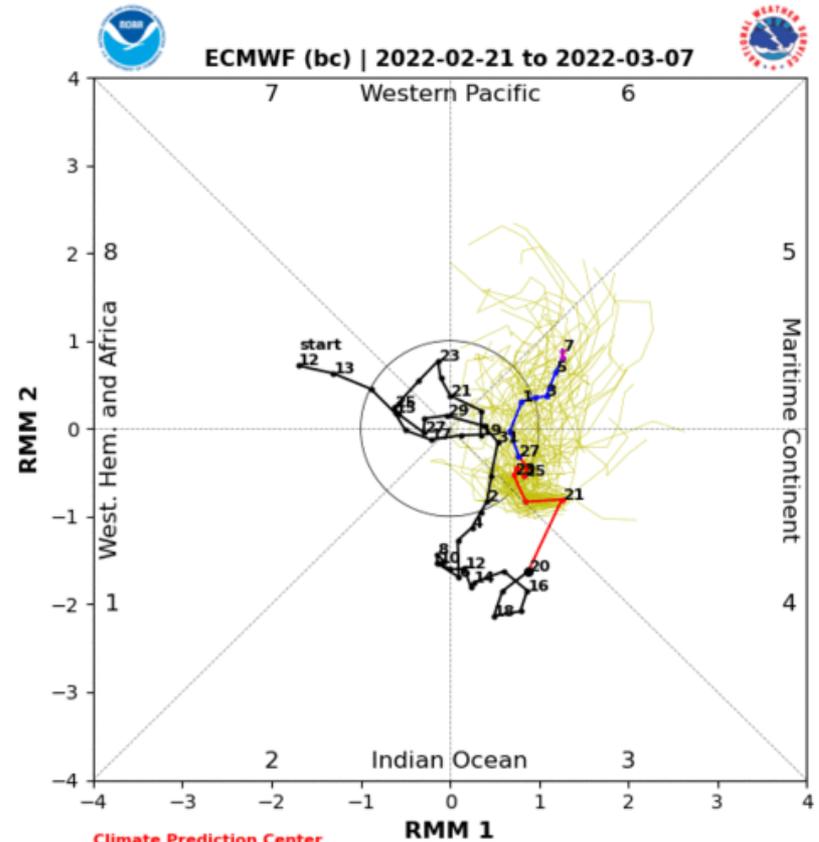


For more information on the RMM index and how to interpret its forecast please see:  
[https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC\\_MJOinformation.pdf](https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf)

# MJO Index: Forecast Evolution



**GEFS Forecast**



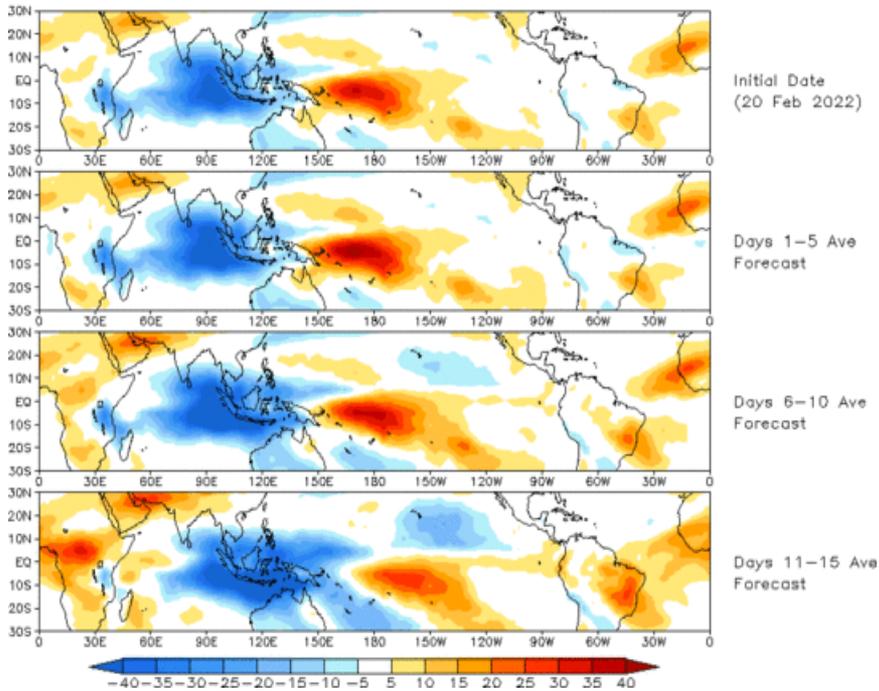
**ECMWF Forecast**

- There is good agreement in the dynamical models depicting eastward propagation of the MJO over the Maritime Continent, with differences in regards to its amplitude over the next two weeks.
- The GEFS remains the most robust with the intraseasonal signal as it constructively interferes with ongoing La Nina. However, its predicted phase speed (i.e. 3-4 days per phase) appears to fall more in line with the Kelvin wave side of the wavenumber-frequency spectrum during early March.

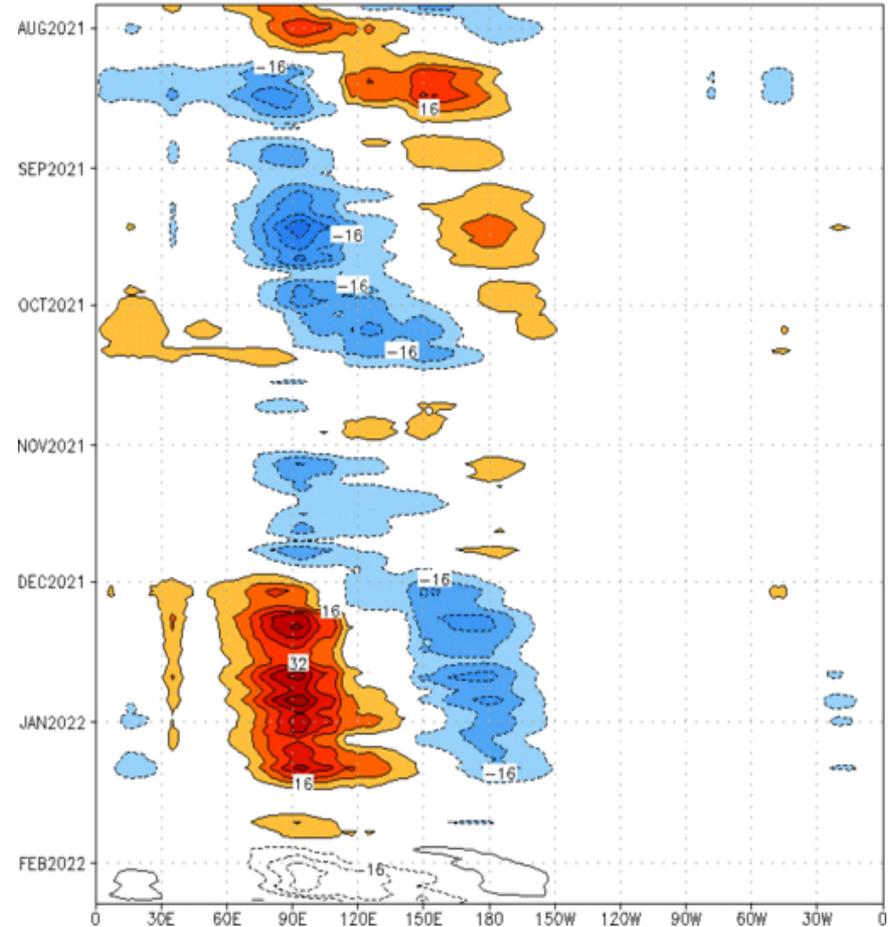
# MJO: GEFS Forecast Evolution

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: 20 Feb 2022  
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2  
OLR [ $7.5^{\circ}\text{S}, 7.5^{\circ}\text{N}$ ] (cont:  $4\text{Wm}^{-2}$ ) Period: 27-Jul-2021 to 26-Jan-2022  
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

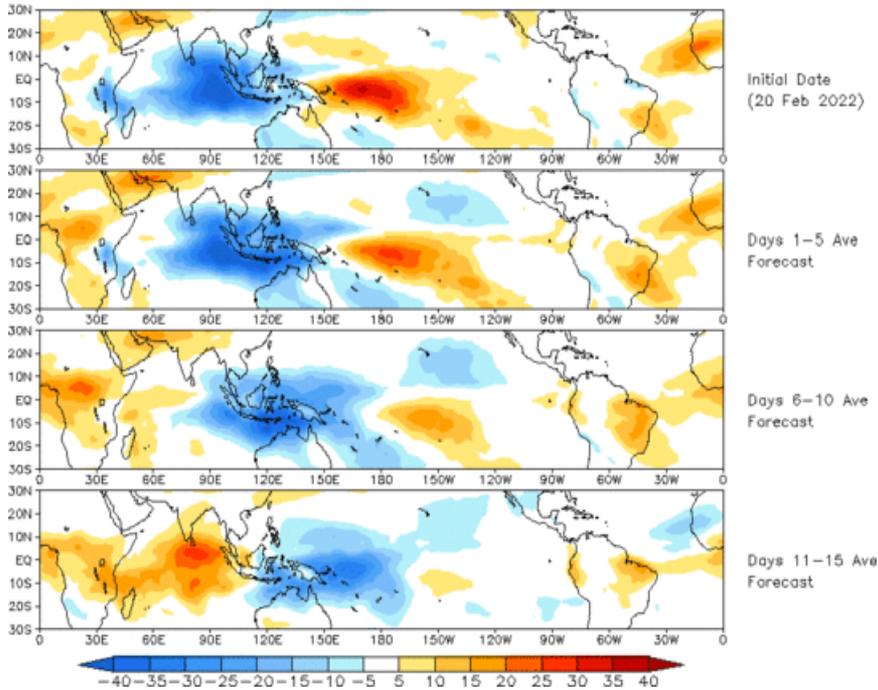


- The GEFS RMM-based OLR field depicts a strong convective dipole shifting eastward, with suppressed convection reemerging over Africa and the western Indian Ocean during week-2.

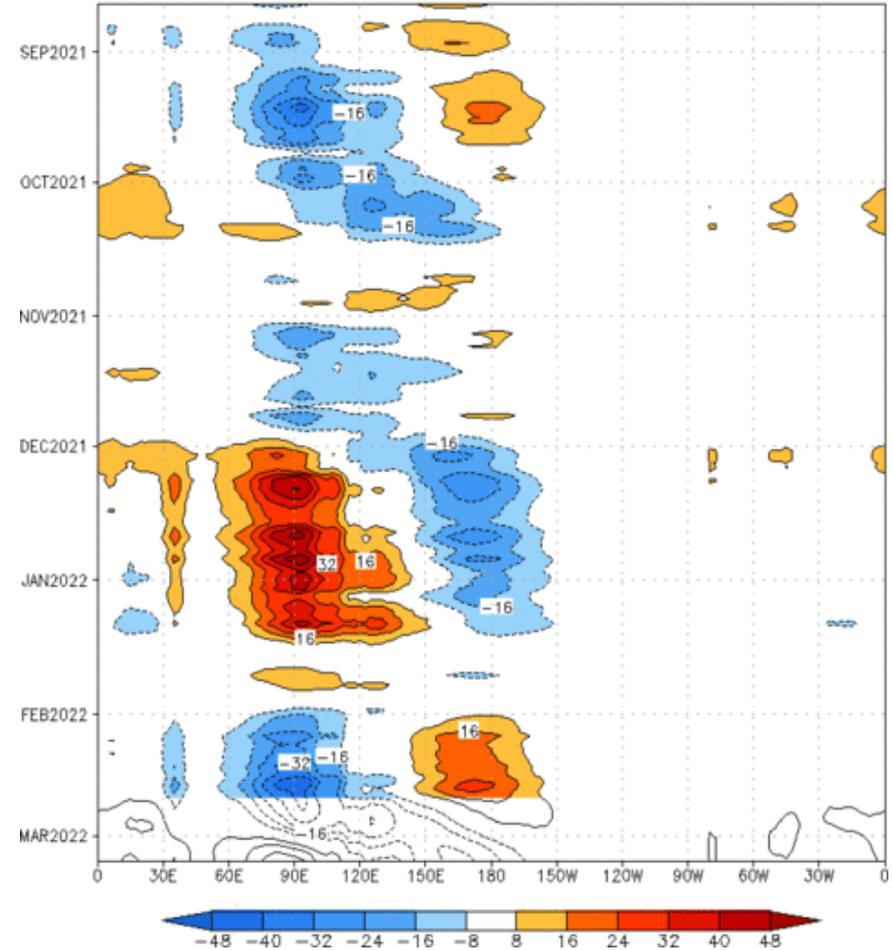
# MJO: Constructed Analog Forecast Evolution

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.)

OLR prediction of MJO-related anomalies using CA model reconstruction by RMM1 & RMM2 (20 Feb 2022)



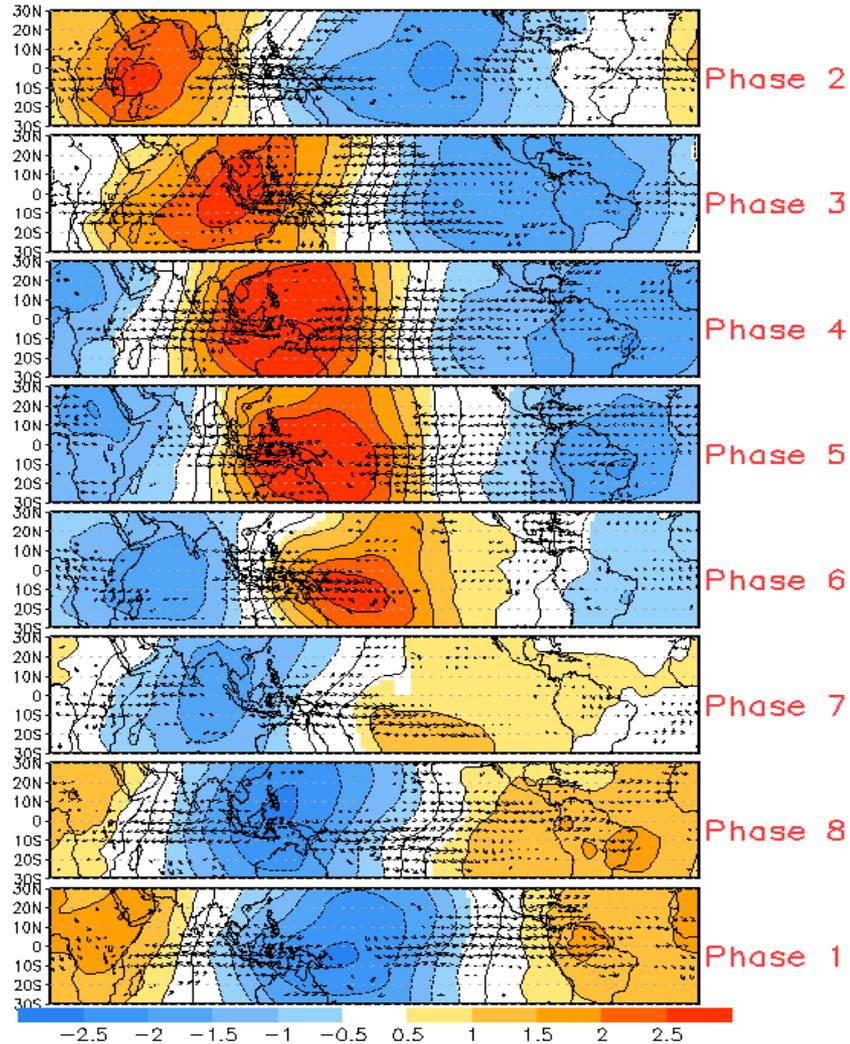
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm<sup>-2</sup>) Period:21-Aug-2021 to 20-Feb-2022  
The unfilled contours are CA forecast reconstructed anomaly for 15 days



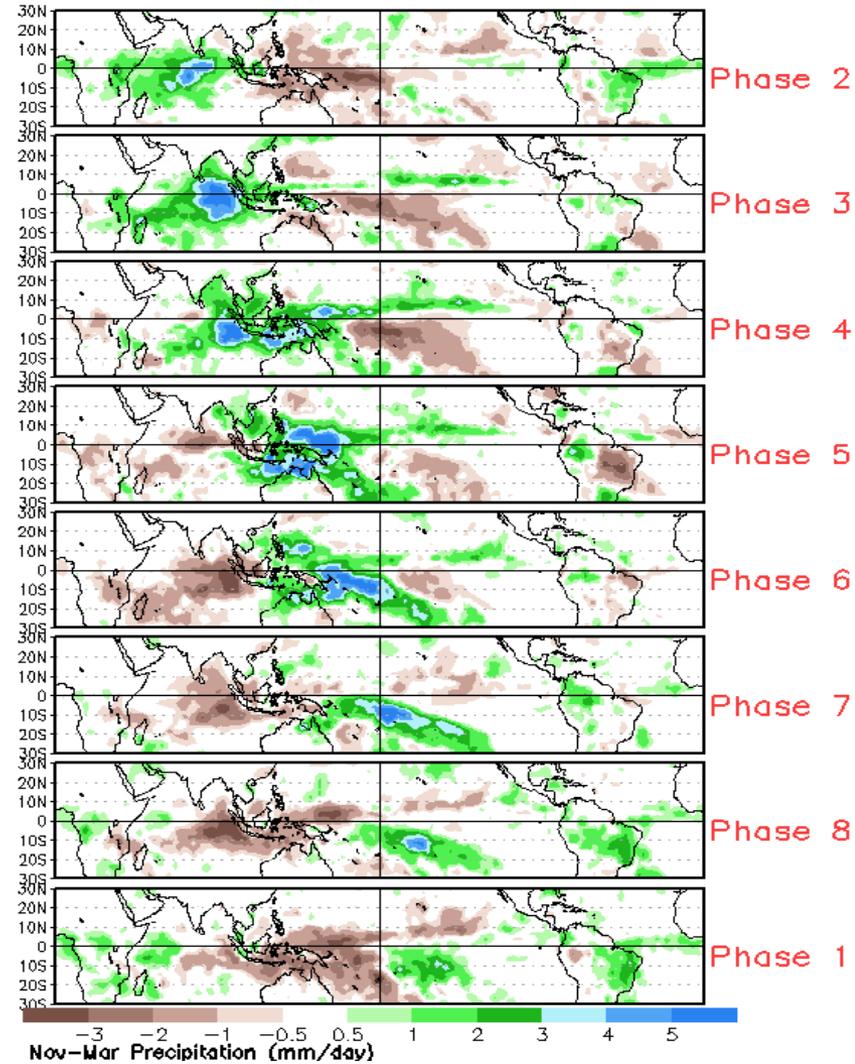
- The constructed analog forecast favors a more progressive evolution compared to the GEFs, with more enhanced (suppressed) convection over the western and central Pacific (Africa and western Indian Ocean).

# MJO: Tropical Composite Maps by RMM Phase

## 850-hPa Velocity Potential and Wind Anomalies



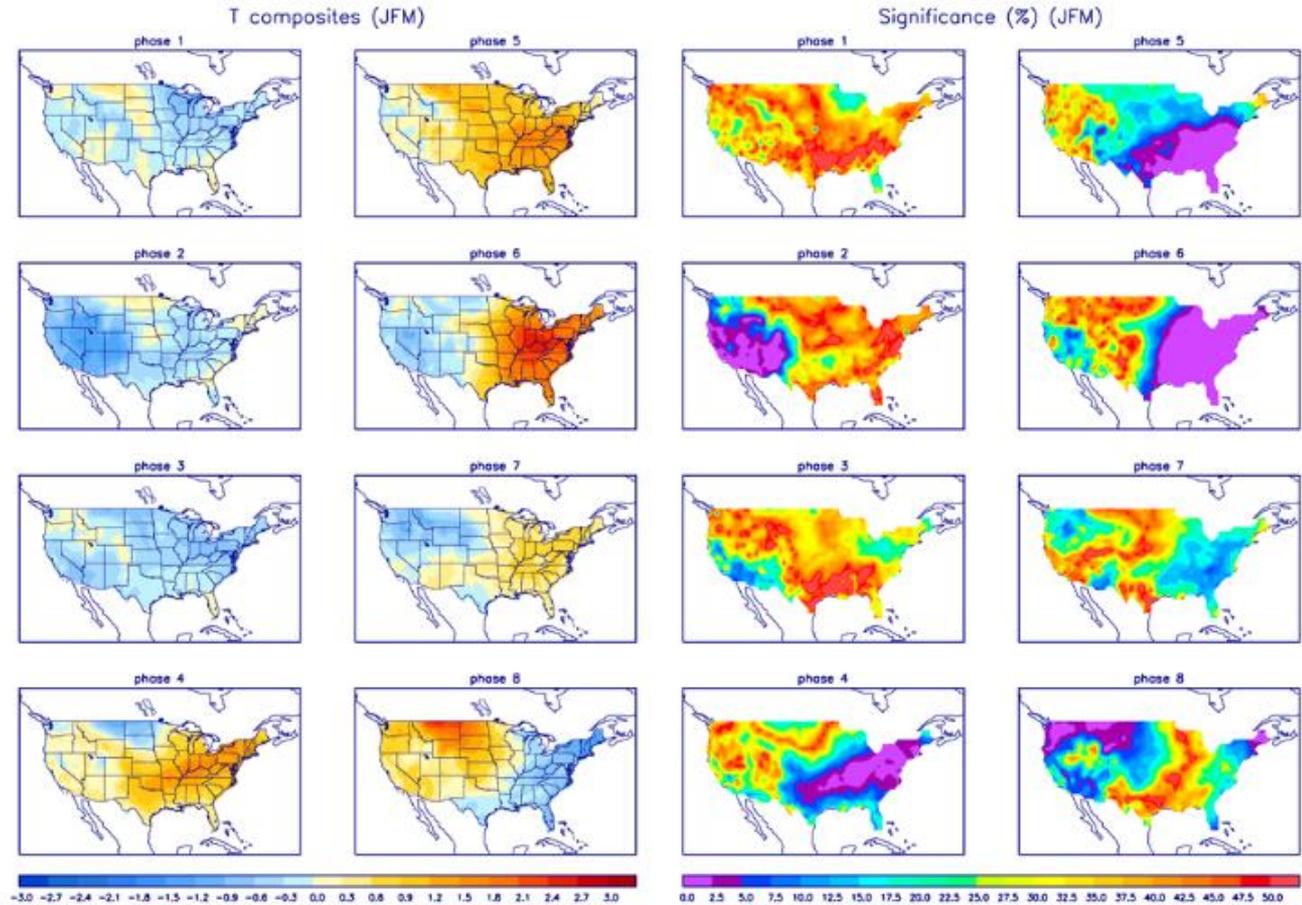
## Precipitation Anomalies



# 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.



# 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.

