

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



Update prepared by the Climate Prediction Center  
NWS / NCEP / CPC  
13 February 2023

# Overview

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- Following a period where the MJO was slow to propagate eastward from the Indian Ocean, the RMM index indicates a coherent and fast moving intraseasonal signal over the Maritime Continent during the past week.
- Dynamical models favor continued eastward propagation of the MJO across the western Pacific where it looks to destructively interfere with the background La Niña state. As it approaches the western Hemisphere, there is large ensemble spread in regards to the strength and evolution of the MJO, contributing to uncertainty in the outlook.
- The suppressed (enhanced) phase of the MJO is favored to decrease (increase) chances for tropical cyclone development over the Indian Ocean (western Pacific) later in February.
- The extratropical response associated with western Hemisphere MJO events during boreal winter typically favors warmer (colder) than normal conditions developing across the western (eastern) U.S., however this is at odds with the latest dynamical model guidance which maintains more of a La Niña pattern heading into March.

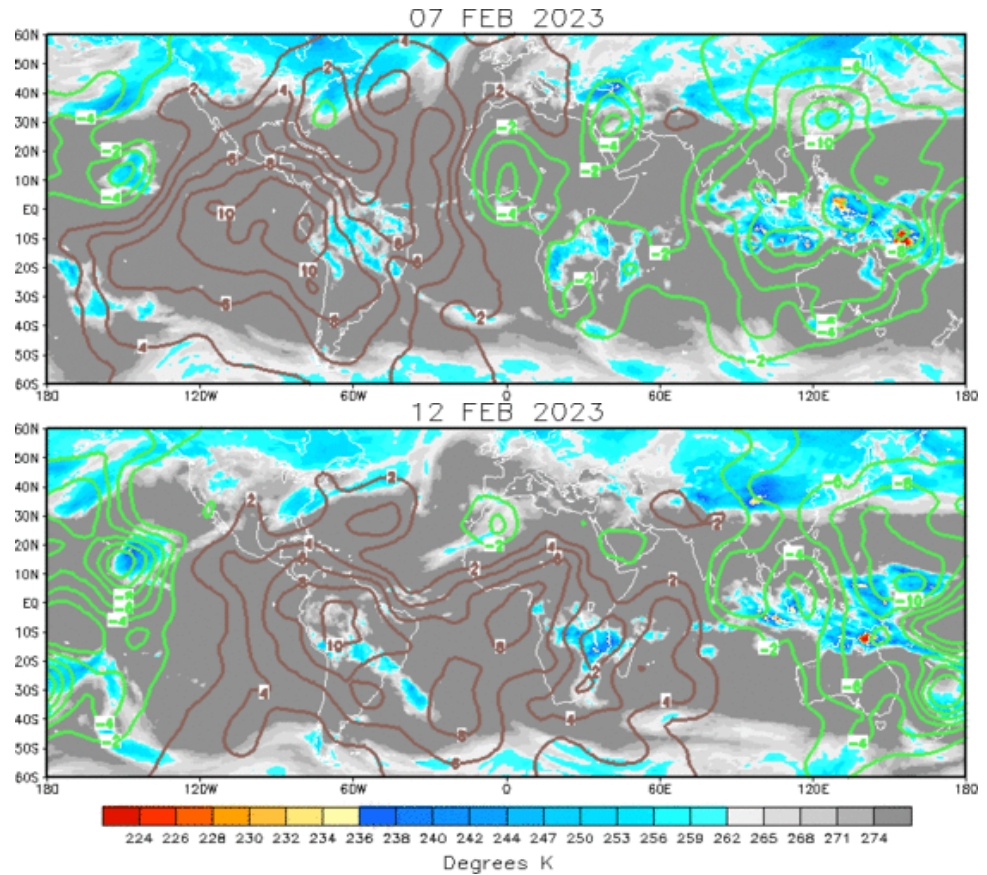
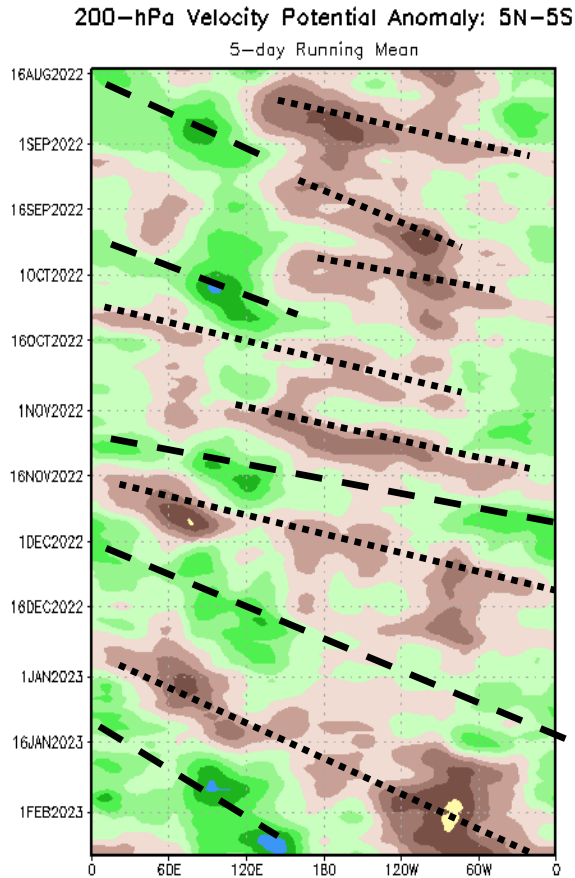
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:

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

# 200-hPa Velocity Potential Anomalies

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

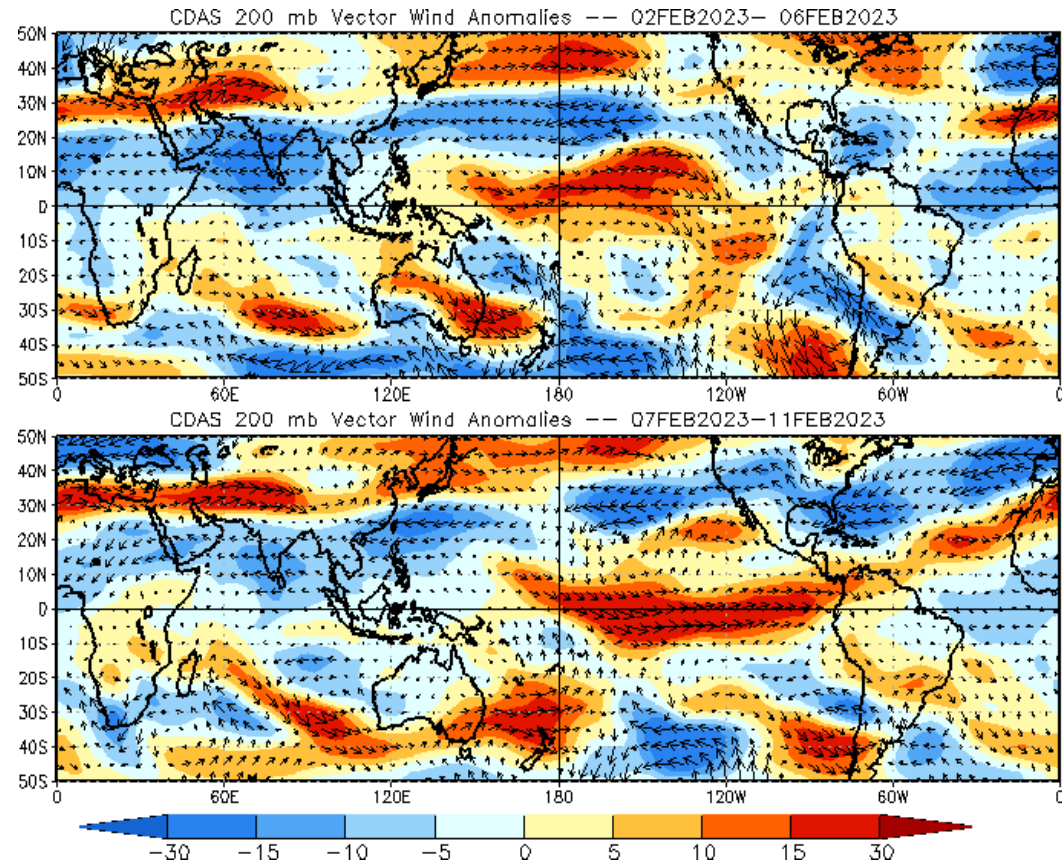
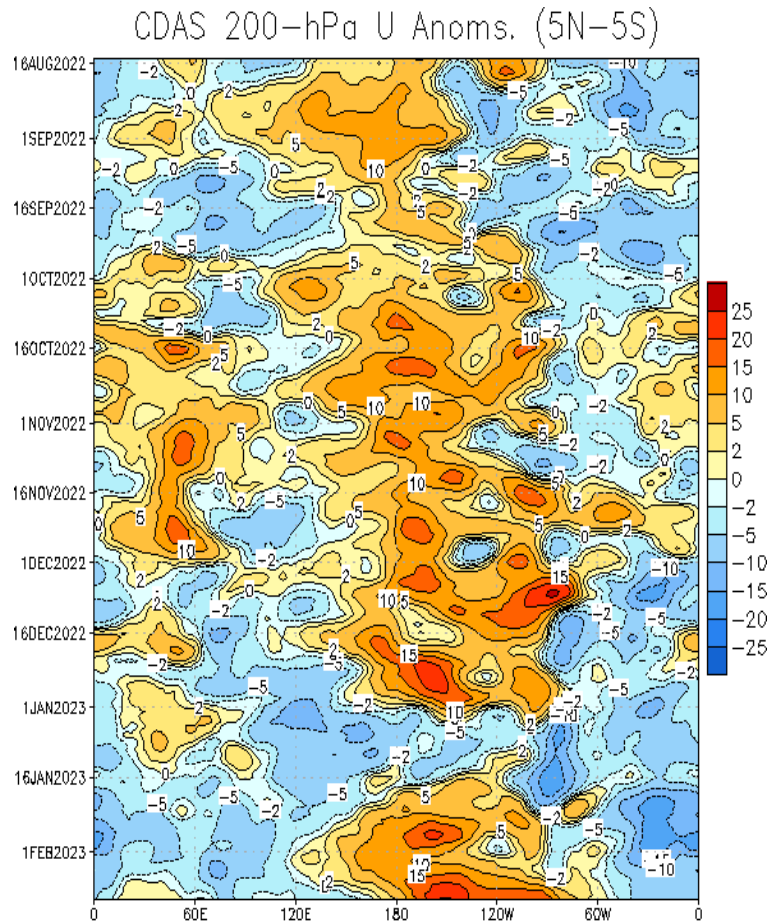
**Brown shades: Anomalous convergence (unfavorable for precipitation)**



- Eastward propagating MJO activity is clearly evident in the upper-level velocity potential fields, with robust anomalies emerging east of 120E and over the Americas.
- Anomalous divergence (convergence) aloft has crossed the Date Line (Prime Meridian), with more enhanced convection expanding into the West Pacific during the last week.

# 200-hPa Wind Anomalies

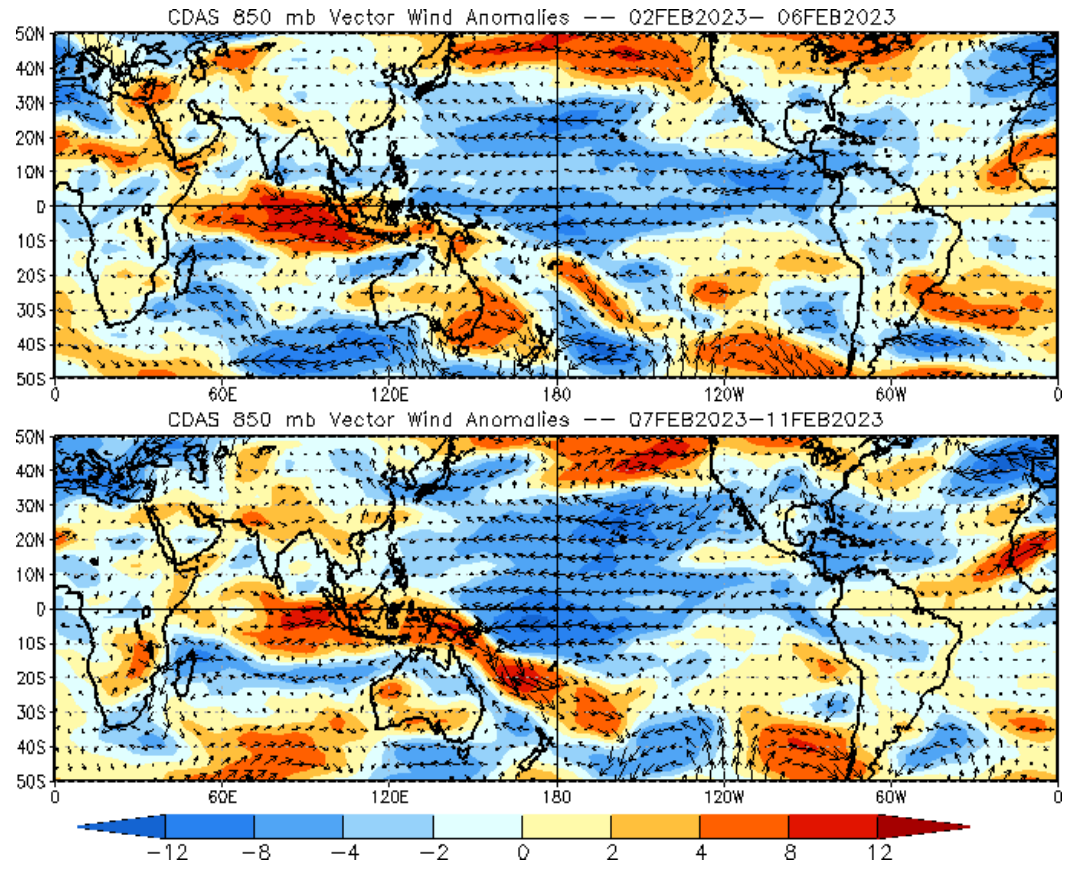
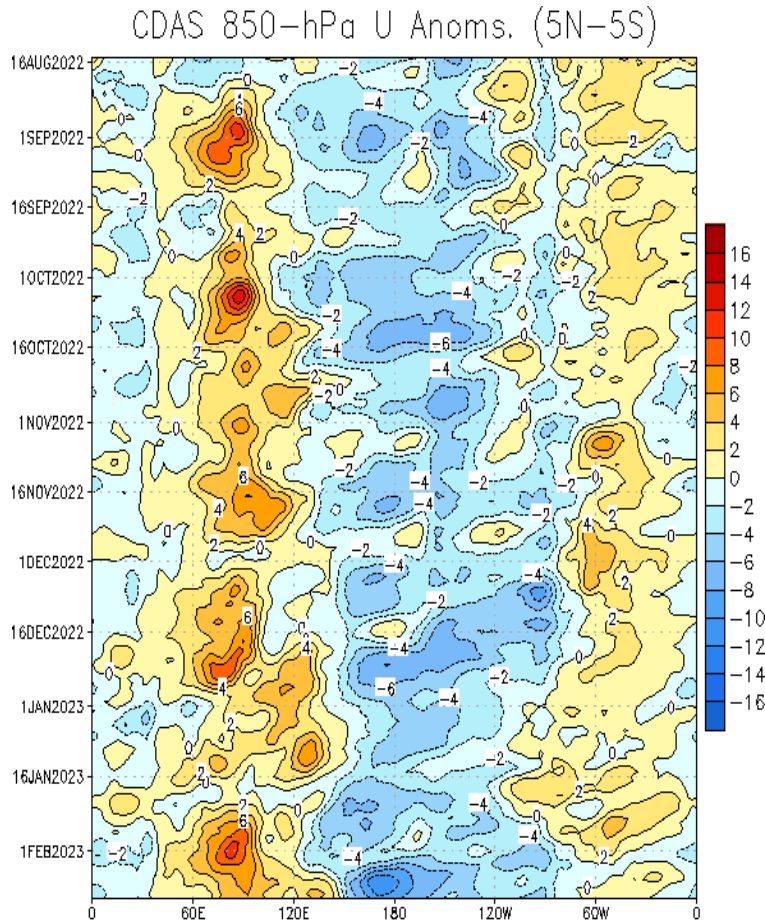
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Constructive interference between La Niña and the MJO resulted in a strengthening of westerlies aloft over the equatorial Pacific, with more anomalous westerlies being observed between 120W and 60W.
- Anomalous easterlies persist over the Indian Ocean (mostly north of the equator likely due to TC activity), and have expanded eastward into the Maritime Continent.
- A pair of anomalous anti-cyclonic circulation centers have continued over the North Pacific and the eastern U.S since the beginning of February.

# 850-hPa Wind Anomalies

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

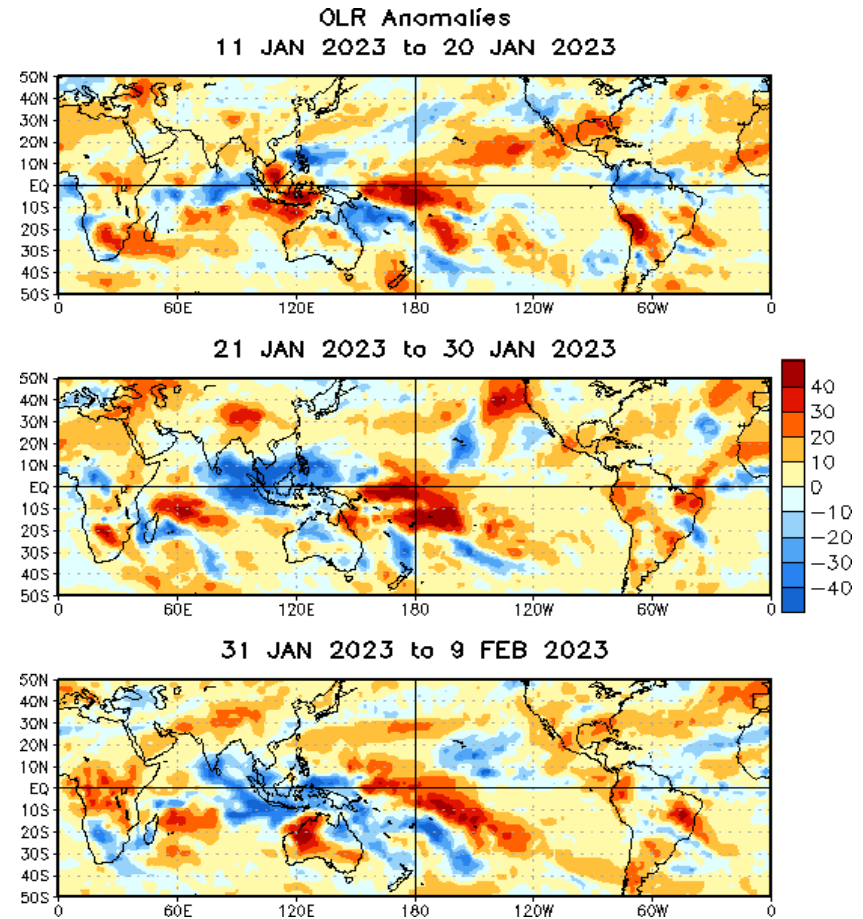
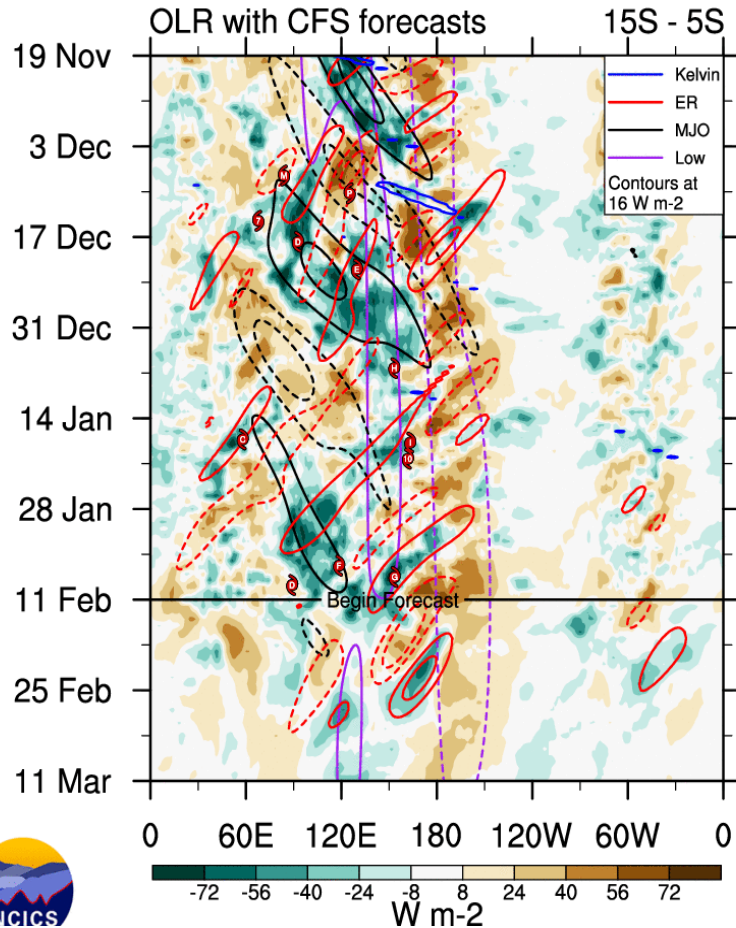


- The strongest low-level westerly anomalies have shifted eastward across the equatorial Indian Ocean and into the Maritime Continent consistent with an eastward propagating MJO.
- These anomalous westerlies have encountered a substantially enhanced trade wind regime across the central equatorial Pacific, resulting in strong lower-level convergence and enhanced convection near 150E. Lower-level zonal wind forecasts (not shown) favor a rapid relaxation of the enhanced trades during the next week.

# Outgoing Longwave Radiation (OLR) Anomalies

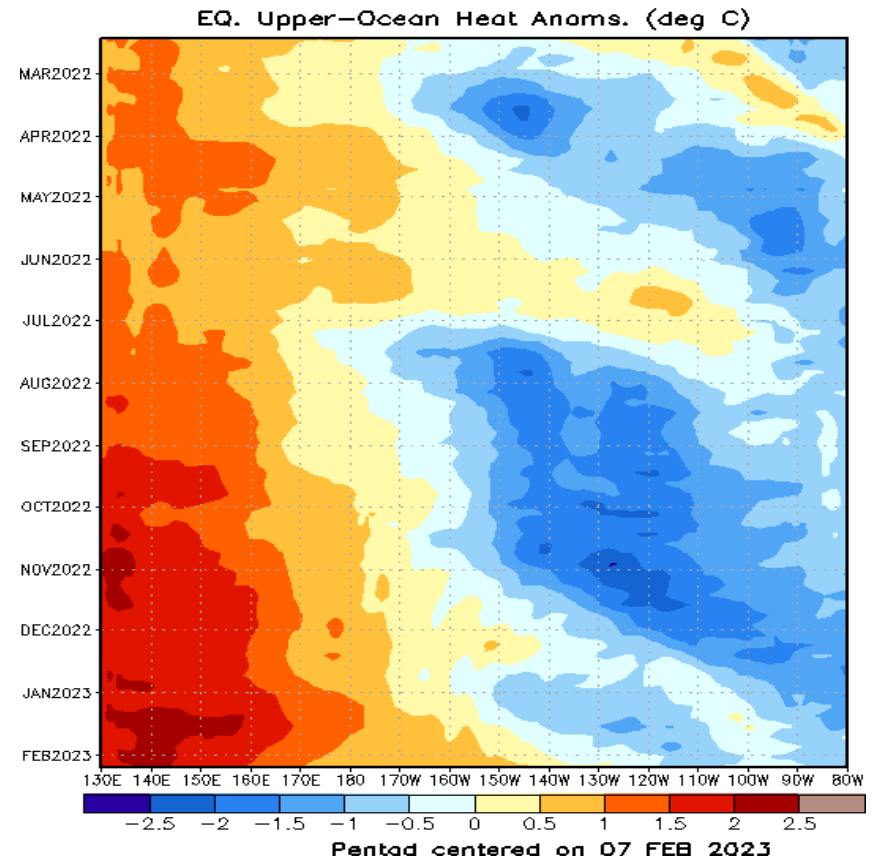
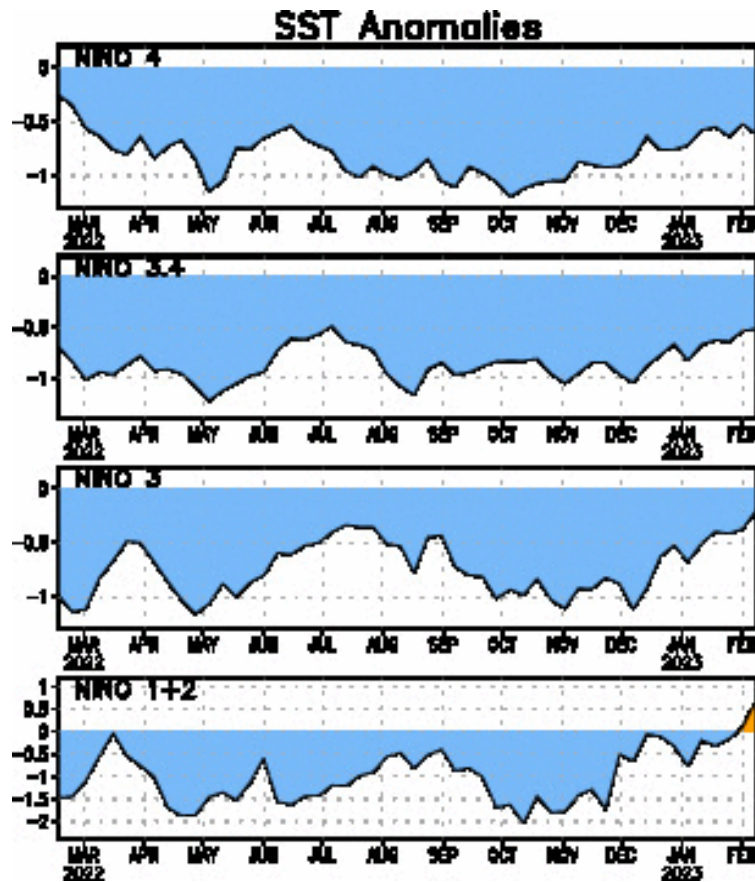
**Green shades: Anomalous convection (wetness)**

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



- Both MJO and Rossby wave activity are evident in the objective filtering of OLR fields, and have likely contributed to a number of tropical cyclones in the southern Hemisphere during the past few weeks.
- Tied to La Nina, suppressed convection remains entrenched across the central equatorial Pacific, though these anomalies have weakened west of the Date Line compared to late January.

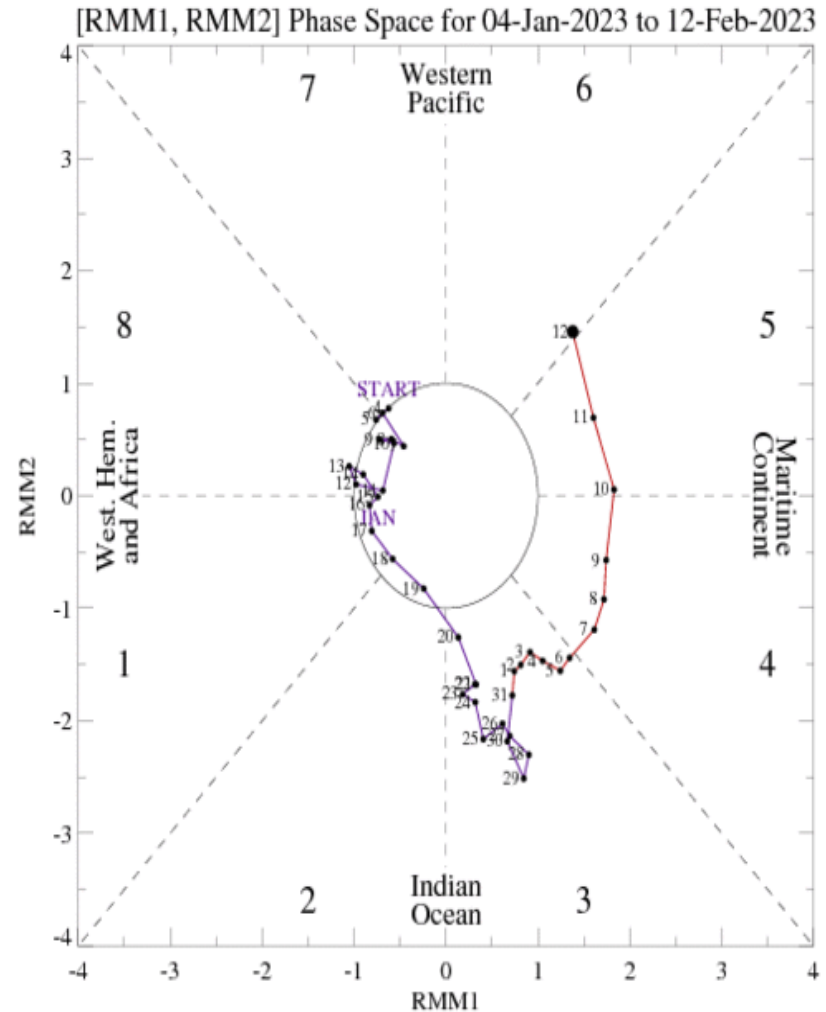
# SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Oceanic downwelling Kelvin wave activity has led to a gradual erosion of the anomalously cold subsurface waters in the equatorial Pacific. A sharp uptick in lower-level westerlies favored in models (near 130E) may initiate a another Kelvin wave to reinforce much of the subsurface warming further eastward.
- A warming trend is noted in all of the Niño indices since December, with the eastern Pacific (Niño 1-2) now indicating above-normal conditions.

# MJO Index: Recent Evolution

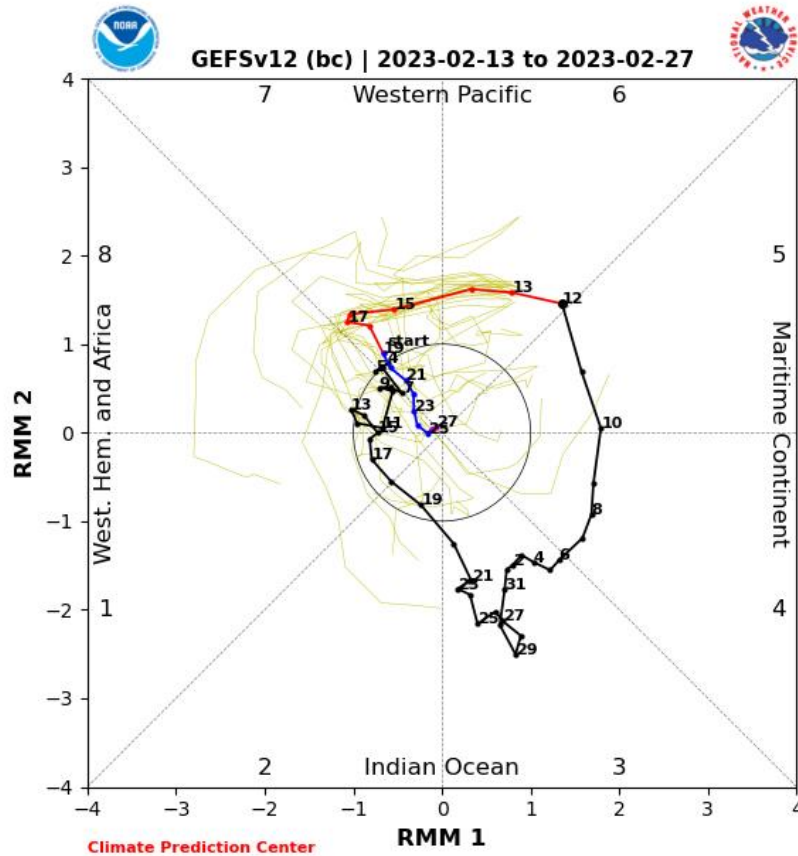
- The RMM index indicates the MJO signal has been slow to propagate eastward during February, but has since shown an acceleration over the Maritime Continent where it has recently entered the western Pacific (phase 6).
- There are questions as to how well the RMM index has been representing the actual location of the MJO, which may be biased westward due to competing modes of tropical variability. This may be manifesting itself as a fast phase speed in RMM space.



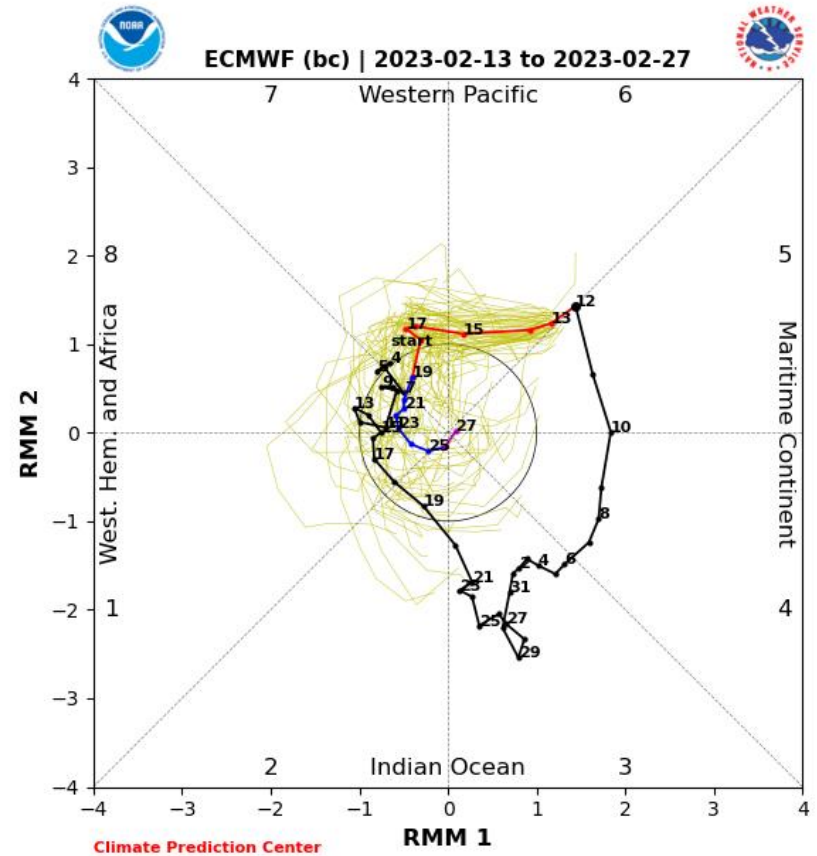
For more information on the RMM index and how to interpret its forecast please see:  
[https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC\\_MJOinformation.pdf](https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf)



# MJO Index: Forecast Evolution



**GEFS Forecast**



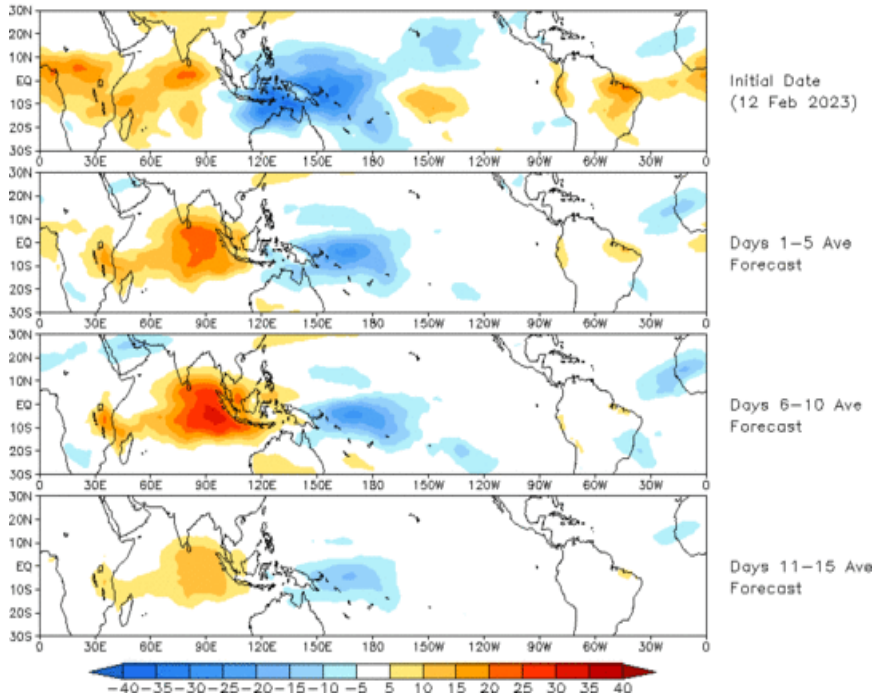
**ECMWF Forecast**

- GEFS and ECMWF RMM forecasts are in good agreement with the MJO signal quickly propagating eastward across the western Pacific at a moderate amplitude during week-1.
- By week-2, ensemble means favor a much weakened signal though there is considerable ensemble spread during this time, where several members indicate a more coherent MJO over the western Hemisphere heading into March.

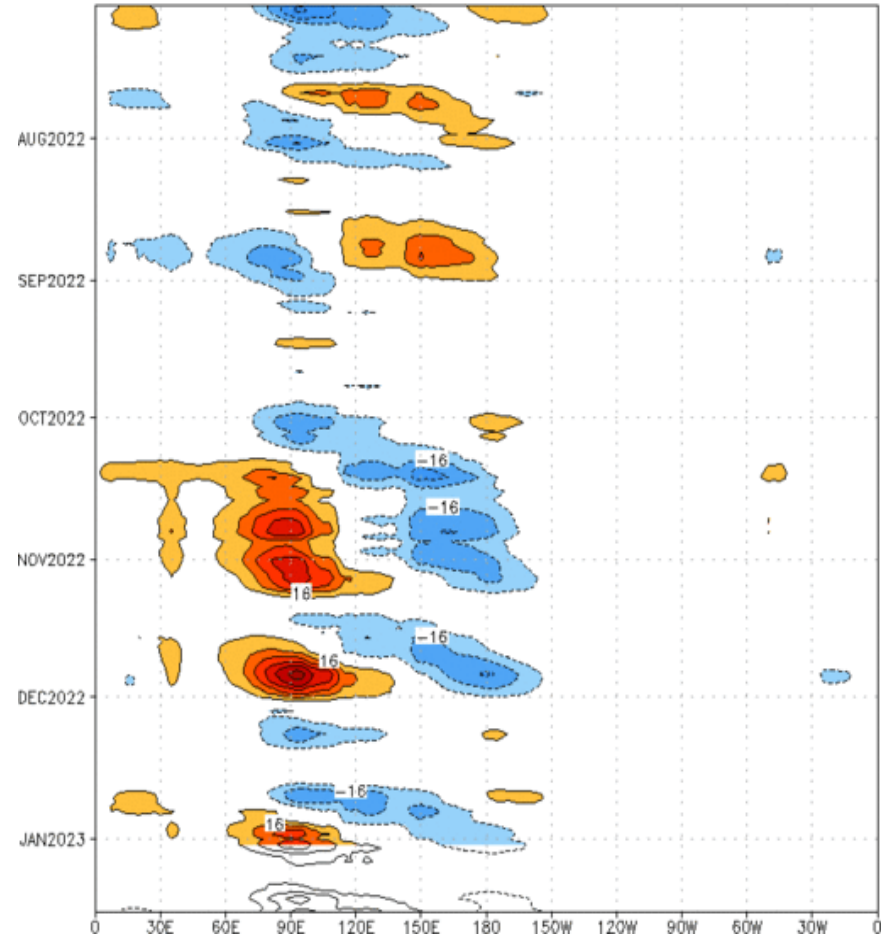
# MJO: GEFS Forecast Evolution

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: 12 Feb 2023  
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2  
OLR [7.5°S,7.5°N] (cint:4Wm<sup>-2</sup>) Period:03-Jul-2022 to 02-Jan-2023  
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

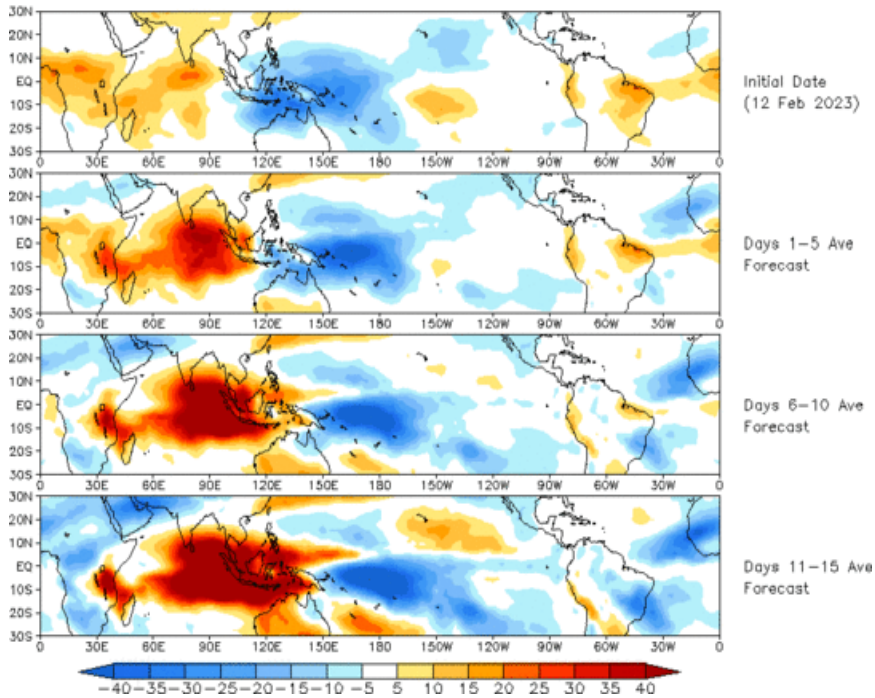


- The GEFS indicates a convective dipole shifting eastward during week-1, but stalls and weakens slightly over the Indian Ocean and western Pacific during week-2.

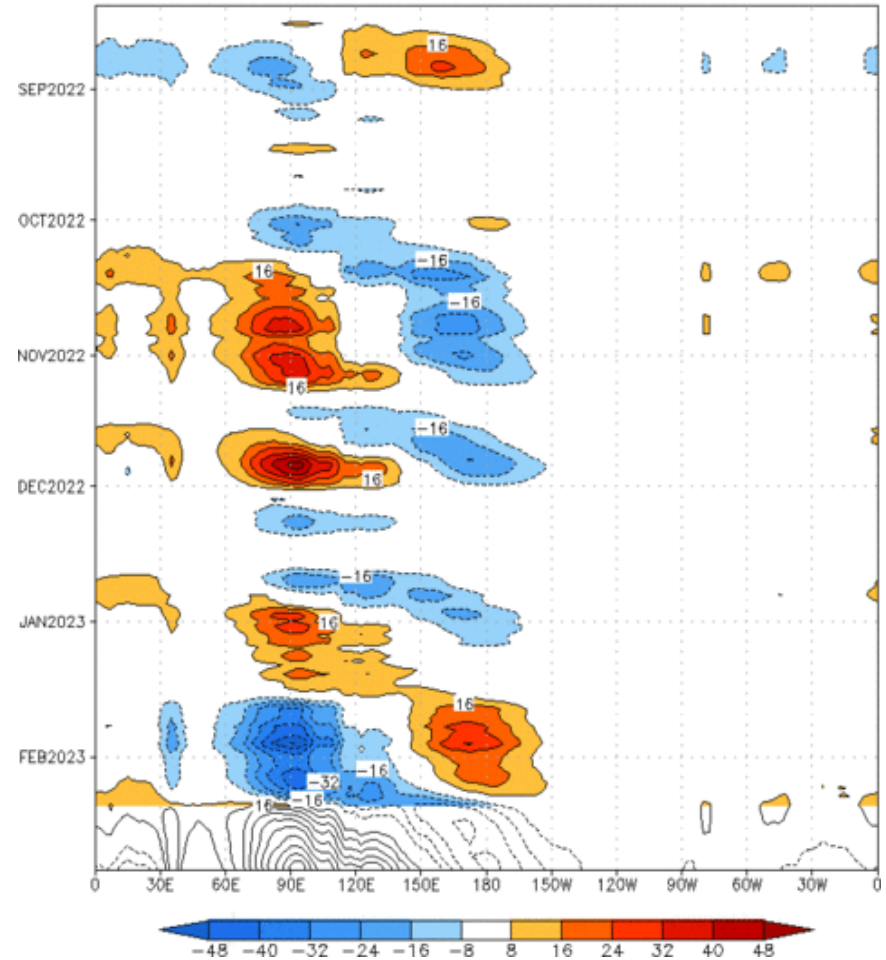
# MJO: Constructed Analog Forecast Evolution

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 (12 Feb 2023)



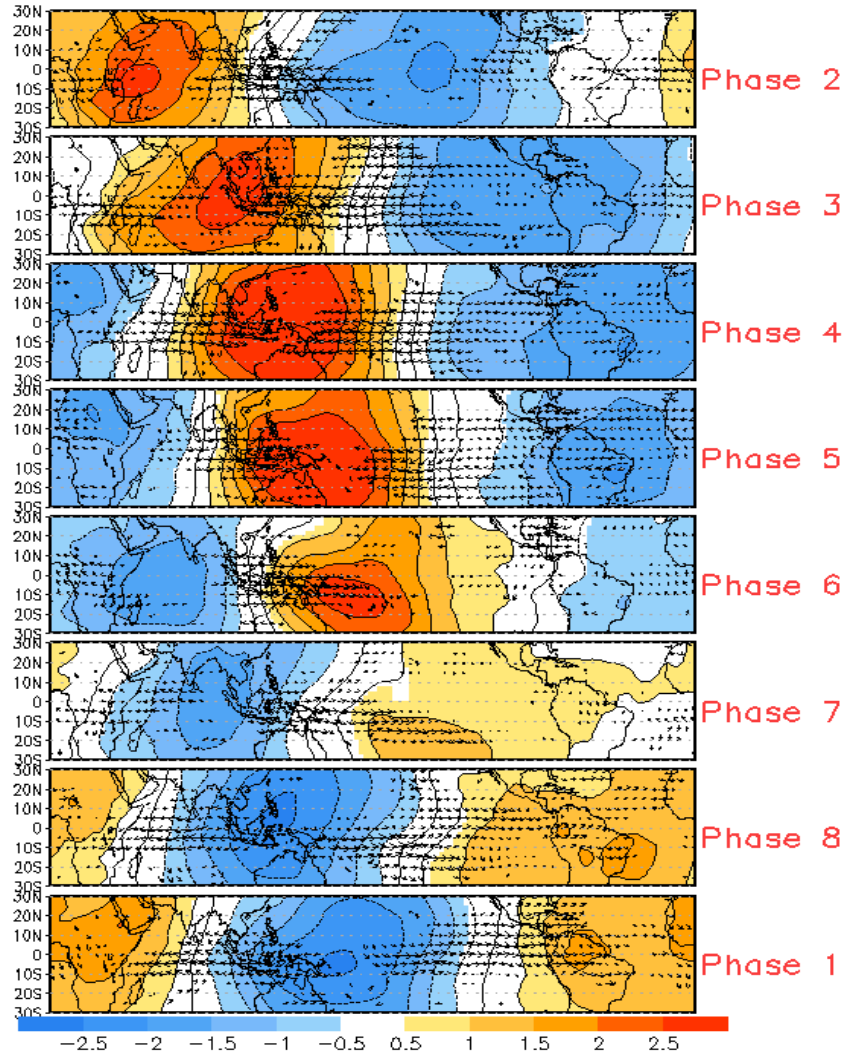
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm<sup>-2</sup>) Period:13-Aug-2022 to 12-Feb-2023  
The unfilled contours are CA forecast reconstructed anomaly for 15 days



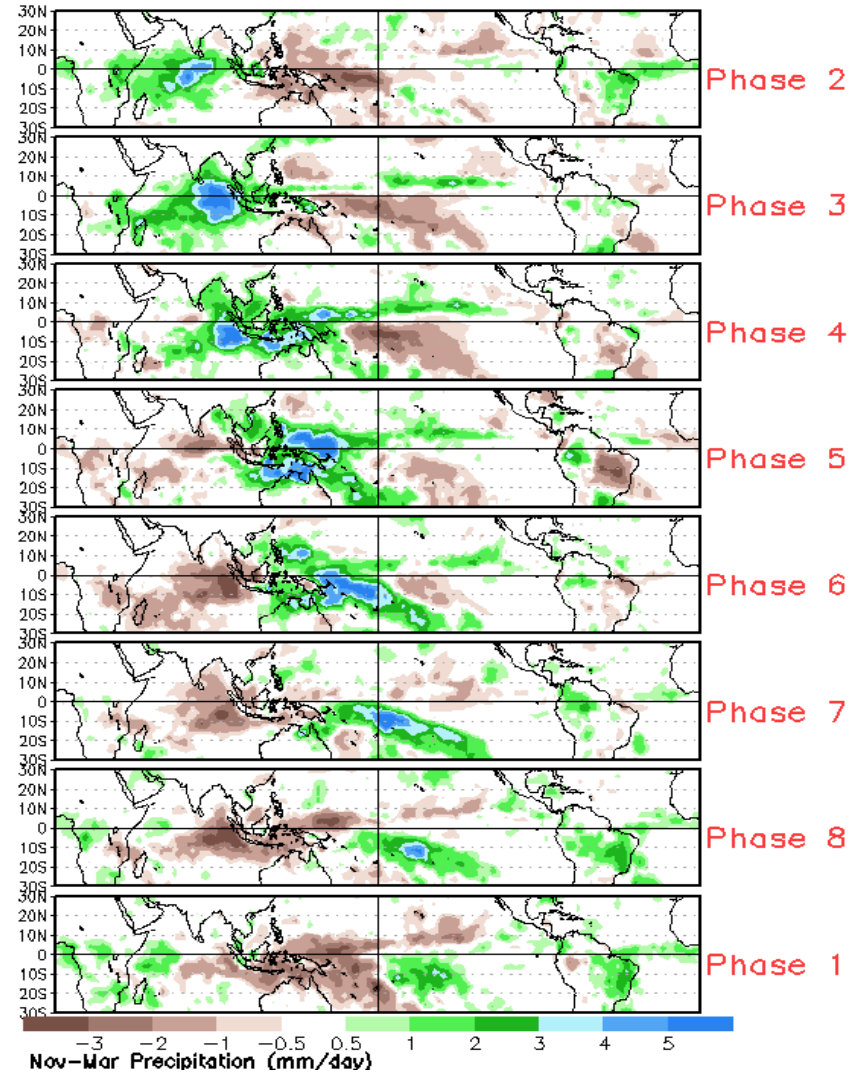
- The constructed analog forecast is more progressive than the GEFS, and features more enhanced convection over the western Hemisphere and returning over parts of Africa later in week-2.

# MJO: Tropical Composite Maps by RMM Phase

## 850-hPa Velocity Potential and Wind Anomalies



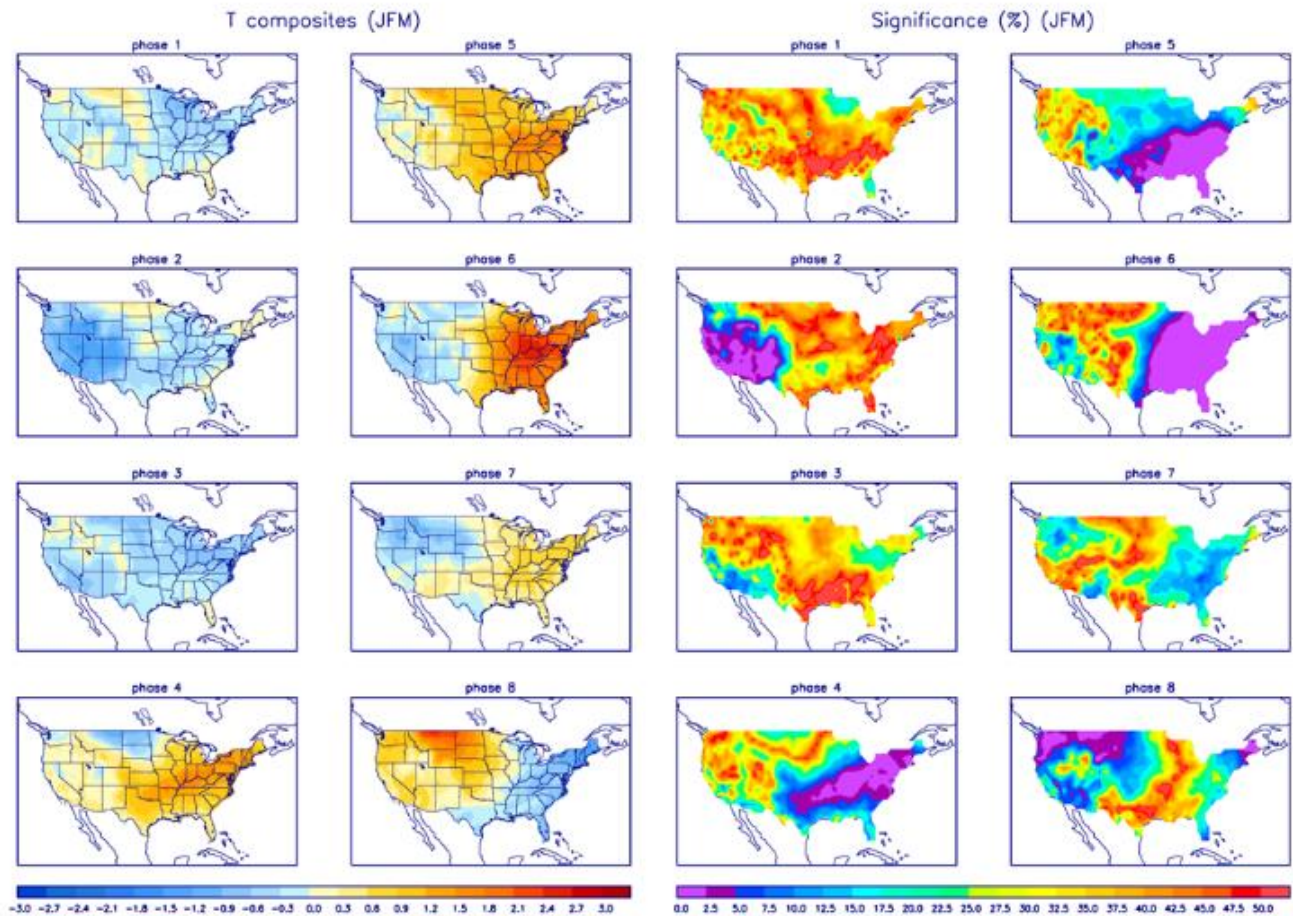
## Precipitation Anomalies



# 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.

