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



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

#### **Overview**

- The MJO strengthened significantly over the first half of March, and is currently in phase 8 at very high amplitude.
- Dynamical model MJO index forecasts depict a weakening MJO signal propagating eastward into the Indian Ocean towards the end of March.
- There have been notable disruptions to synoptic features associated with the long-lived La Nina base state.

#### **200-hPa Velocity Potential Anomalies**



<u>Green shades</u>: Anomalous divergence (favorable for precipitation) <u>Brown shades</u>: Anomalous convergence (unfavorable for precipitation)



- A strong MJO signal is reemerging after a brief lull in signal strength at the end of February when there was a breakdown in an organized global tropical convective pattern.
- Enhanced(suppressed) convective envelope is currently over South America and Africa(Maritime Continent/Western Pacific) in a very amplified and well-structured pattern.

#### 200-hPa Wind Anomalies

Shading denotes the zonal wind anomaly. <u>Blue shades</u>: Anomalous easterlies. <u>Red shades</u>: Anomalous westerlies.



- Anomalous westerlies near and east of the Date Line have diminished almost entirely, replaced with anomalous easterlies instead. Only a small area of enhanced westerlies persists west of the Galapagos. Strong anomalous westerlies are also noted over much of the tropical Indian Ocean.
- Strong subtropical branch of jet stream is evident, stretching from the Date Line into the California coast and extending to the Great Lakes.

#### 850-hPa Wind Anomalies

Shading denotes the zonal wind anomaly. <u>Blue shades</u>: Anomalous easterlies. <u>Red shades</u>: Anomalous westerlies.



- Similar to what is seen at 200-hPa, the enhanced Pacific trade winds that have been a fixture for months on end have diminished almost entirely, replaced by widespread slacked trades.
- The subtropical jet feature seen at 200-hPa is accompanied by a large and potent cyclone at 850-hPa, setting up a very moist onshore flow into the West Coast of the U.S. A similar setup is seen at both levels over the North Atlantic as well.

### **Outgoing Longwave Radiation (OLR) Anomalies**

<u>Green shades</u>: Anomalous convection (wetness) <u>Brown shades</u>: Anomalous subsidence (dryness)



- The reemergence of the MJO signal is very clear in the OLR hovmoller after a period of destructive interference from Rossby waves and the lingering La Nina base state.
- CFS guidance indicates suppressed phase of current MJO pulse will be encountering more interference as it approaches the Date Line.

![](_page_6_Figure_1.jpeg)

- Oceanic downwelling Kelvin wave activity has led to a gradual erosion of the anomalously cold subsurface waters in the central and eastern equatorial Pacific.
- A warming trend is noted in all of the Niño indices since December, with the eastern and central Pacific (Niño 1+2 & 3) now indicating above-normal conditions.
- Dynamical models indicate a slackening of the recent low-level westerly wind burst with a slight return of anomalous easterlies, which could tap the brakes a little on the breakdown of the La Nina regime.

- Following eastward propagation of the MJO during early to mid-February, the signal weakened due to interference with Rossby waves.
- Since the beginning of March, the RMM-index depicts a rapidly strengthening MJO, currently over the Western Hemisphere.

![](_page_7_Figure_3.jpeg)

For more information on the RMM index and how to interpret its forecast please see: <a href="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</a>

#### **MJO Index: Forecast Evolution**

![](_page_8_Figure_1.jpeg)

- Dynamical model MJO index forecasts are in good agreement that the MJO propagates eastward during weeks 1&2, with a steadily decreasing signal strength.
- There is more uncertainty for week-3, with the GEFS and ECMWF extended runs suggesting continued eastward propagation of RMM signal. CFS and BOMM favor a slowdown of eastward movement, with diverging solutions as to signal strength.

#### **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.)

![](_page_9_Figure_2.jpeg)

 The GEFS RMM forecast based OLR anomaly outlook features a very amplified MJO initially, which gradually weakens as it creeps eastward over weeks 1&2. Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm<sup>-4</sup>) Period:03-Jul-2022 to 02-Jan-2023 The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

![](_page_9_Figure_5.jpeg)

#### **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.)

![](_page_10_Figure_2.jpeg)

MAR2023

Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm<sup>-2</sup>) Period:10-Sep-2022 to 12-Mar-2023 The unfilled contours are CA forecast reconstructed anomaly for 15 days

150W

16 24

120W

180

-8

120E

-24 - 16

-40 - 32

-48

150E

9ÔW

32 40

60W

3ÓW

• The constructed analog forecast depicts a quicker eastward propagation with little diminishment of the signal strength.

OLR prediction of MJO-related anomalies using CA model

reconstruction by RMM1 & RMM2 (12 Mar 2023)

#### **MJO: Tropical Composite Maps by RMM Phase**

850-hPa Velocity Potential and Wind Anomalies

![](_page_11_Figure_2.jpeg)

#### **Precipitation Anomalies**

![](_page_11_Figure_4.jpeg)

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.

![](_page_12_Figure_3.jpeg)

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.

![](_page_13_Figure_3.jpeg)