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



Update prepared by the Climate Prediction Center NWS / NCEP / CPC 20 March 2023

Overview

- Strong MJO activity remains present in the latest observations. The RMM index shows the enhanced phase having propagated eastward over the Western Hemisphere during the last week, and is currently nearing the Indian Ocean.
- RMM forecasts continue to favor a much weakened MJO as it crosses the Indian Ocean, however this is at odds with upper-level velocity potential guidance which indicate a more coherent MJO that eventually enters the Maritime Continent during the next several weeks.
- Conditions are expected to become increasingly favorable (unfavorable) for tropical cyclone (TC) development in the Indian Ocean (South Pacific) later in March and heading to April.
- Although MJO teleconnections can become more tenuous during boreal spring, the extratropical response associated with Maritime Continent events can lead to increasing midlevel heights and above-normal temperatures over parts of the eastern CONUS later in April. A residual atmospheric signature tied to an outgoing La Nina is also expected to play a role in the downstream response as well.

A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at: <u>http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php</u>

200-hPa Velocity Potential Anomalies



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



- Strong MJO activity remains evident, consisting of a well-defined wave-1 pattern through the middle of March.
- While the leading edge of the enhanced upper-level divergence envelope has slightly shifted eastward over the Indian Ocean, more suppressed conditions have overspread the eastern Pacific and the Americas during the past week.

200-hPa Wind Anomalies

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



- During the past month, the strong MJO markedly upended the low frequency circulation, producing anomalous easterlies over the central and eastern equatorial Pacific with enhanced westerlies over the Indian Ocean.
- An enhanced subtropical jet remains evident over the Northern Hemisphere.
- Anomalous easterlies have strengthened off the west coast of South America.

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



- Following the passage of the MJO over the Western Hemisphere, anomalous lower-level easterlies have returned over the central equatorial Pacific suggestive of a residual atmospheric response tied to an outgoing La Nina.
- Anomalous easterlies continued to shift eastward into the Maritime Continent.
- The enhanced subtropical jet is accompanied by moist onshore flow persisting over the western CONUS, which has shifted southward compared to earlier in March.

Outgoing Longwave Radiation (OLR) Anomalies

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



- Along the equator, enhanced convection shifted eastward beyond the Prime Meridian and into the Indian Ocean.
- Consistent with the lower-level wind response with the residual effects of La Nina, suppressed convection returned along and east of the Date Line and is forecast to persist into mid-April.



- Negative subsurface heat content anomalies have transitioned to near- to above-normal throughout much of the equatorial Pacific.
- Another downwelling Kelvin wave episode appears to be pushing warmer waters eastward beyond the Date Line.
- At the surface, 3 of the 4 Nino regions are registering above-normal, with a continued warming trend indicated throughout the equatorial Pacific supportive of the transition to ENSO-neutral conditions.

• The RMM index indicates a robust MJO event through mid-March, but has weakened in amplitude over the western Hemisphere more recently.



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

MJO Index: Forecast Evolution



- Dynamical model MJO index forecasts are in good agreement that the MJO continues to propagate eastward over the Indian Ocean but greatly decreases in amplitude by late week-1.
- Although the RMM forecasts favor a less coherent MJO, upper-level velocity potential anomaly forecasts show the MJO maintaining an organized structure, while propagating into the Maritime Continent during the outlook period.

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.)



 The GEFS RMM forecast based OLR anomaly outlook features enhanced convection shifting eastward across the Indian Ocean. Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm*) Period:03-Jul-2022 to 02-Jan-2023 The unfilled contours are GEFS forecast reconstructed anomaly for 15 days



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 (19 Mar 2023)

 The constructed analog forecast depicts an MJO event that maintains much of its structure during the next two weeks, consistent with upper-level velocity potential predictions. OCT2022 NOV202 DEC2022 JAN2023 FEB2023 MAR2023 APR2023 150W 0 30E 120E 150E 180 120W 9ÓW 60W -40 -32-24-1632 40 -8 24

Reconstructed anomaly field associated with the MJO using RMM1 & RMM2

OLR [7.5°S,7.5°N] (cint:4Wm⁻³) Period:17-Sep-2022 to 19-Mar-2023 The unfilled contours are CA forecast reconstructed anomaly for 15 days

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



Precipitation Anomalies



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.



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.

