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



Update prepared by the Climate Prediction Center NWS / NCEP / CPC 22 May 2023

Overview

- The MJO remains active, with recent observations showing the enhanced convective phase now over the Pacific.
- The MJO signal has become less coherent over the past week, with a slowing of the propagation phase speed. This is due in part to interference from Rossby wave activity, including the formation of large and low-latitude Typhoon Mawar.
- Typhoon Mawar may bring significant wind, flood, and surge hazards to Guam and the Mariana Islands.
- Dynamical model MJO index forecasts are mixed, with the ECMWF continuing to show a fairly progressive pattern, while the GEFS slows the propagation considerably.
- The GEFS may be responding to feedback from Typhoon Mawar, as well as a more stationary circulation pattern over the Pacific in response to warming SSTs.
- The MJO may provide an opportunity for early season tropical cyclone formation across the East Pacific basin, though strong vertical shear will act as a substantial inhibiting factor over the next week or two.

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)



- Robust MJO activity has been observed over the past several months. The enhanced convective phase of the intraseasonal signal is currently over the Pacific.
- Other modes are currently destructively interfering with the MJO signal. The large circulation and outflow associated with low-latitude Typhoon Mawar is evident west of the Date Line.

200-hPa Wind Anomalies

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



- Although MJO activity is still evident in the upper-level zonal wind field, with easterlies (westerlies) over the Maritime Continent (Western Hemisphere), the pattern has become increasingly incoherent.
- An amplified pattern and tropical cyclone activity over the southern Indian Ocean has promoted increased easterly anomalies along the Equator north of Madagascar, and westerlies over the eastern Indian Ocean.

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



- MJO activity remains apparent in the low-level wind field, with westerly anomalies now increasing west of the Date Line. Some of this increase is due to influences from low-latitude Typhoon Mawar.
- Anomalous cyclonic circulation over the south-central Indian Ocean was associated with tropical cyclone Fabien.

Outgoing Longwave Radiation (OLR) Anomalies

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



OLR Anomalies

- OLR observations in the time-longitude plot since mid-May are erroneous.
- MJO activity since late May has been strongly influenced by Kelvin wave activity.
- A confluence of MJO and Rossby wave activity over the West Pacific appears associated with the formation of Typhoon Mawar.
- The GEFS forecast shows lessened MJO activity, with Rossby wave activity and an emerging suppressed signal over the central Indian Ocean dominating the pattern.



- Increasingly positive subsurface temperature anomalies engulf the entire Pacific, driven by multiple MJO events and subsequent oceanic downwelling Kelvin Waves beginning in March.
- SSTs in all of the Niño basins are now above normal, where the warmest anomalies remain over the eastern Pacific.

- After circumnavigating the globe since early April, the MJO signal has become more incoherent.
- Kelvin wave activity interfered with the signal during early to mid-May.
- Constructive interference with Rossby wave activity promoted a re-amplifying signal and the development of Typhoon Mawar.
- More recently, the signal has decreased somewhat in amplitude as interference with the Rossby wave has become more destructive.



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



- The GEFS and ECMWF forecasts are increasingly divergent, with the ECMWF depicting a fairly fast but weak eastward propagation of the MJO across the Pacific and Western Hemisphere.
- The GEFS shows a much slower evolution, with many ensemble members exhibiting high amplitude over the West Pacific, possibly in association with Rossby wave activity and Typhoon Mawar. Many ensemble members depict some eastward propagation to the Western Hemisphere by Week-2.

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.)



• Similar to last week, the GEFS RMM-based forecast depicts a nearly stationary OLR anomaly pattern, that increases in magnitude during the next two weeks.

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

• The constructed analog RMM-based forecast depicts a more progressive and robust MJO signal crossing the Pacific and Western Hemisphere over the next two weeks.

Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:19-Nov-2022 to 21-May-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.

