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



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Overview

- The MJO remains active with its enhanced phase propagating eastward to the Maritime Continent. It contributed to the development of Tropical Cyclone Yaas over the Bay of Bengal.
- The GFS ensemble mean depicts a continued eastward propagation of the MJO over the Pacific Ocean during the remainder of May and into the beginning of June.
- Tropical cyclone (TC) development is likely over the West and East Pacific during week-1. The large-scale environment is expected to remain favorable for additional TC formation across these basins through week-2.

200-hPa Velocity Potential Anomalies



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

- During mid-May, an atmospheric Kelvin wave propagated rapidly east to the East Pacific and northern South America with the MJO centered over the Indian Ocean.
- As the Kelvin wave continued to progress eastward to Africa, a more coherent wave-1 pattern returned with strong anomalous upper-level divergence (convergence) over the Maritime Continent and West Pacific (Americas and Atlantic).

200-hPa Wind Anomalies

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



- Anomalous upper-level westerlies continue have strengthened across much of the Tropical Pacific.
- Wavebreaking from both hemispheres has increased upper-level convergence across the eastern Indian Ocean during mid-May, with this being exacerbated by outflow aloft by the active MJO envelope.

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- Enhanced westerlies over the western Indian Ocean are linked to the enhanced MJO envelope, and helped induce a cyclonic circulation that was favorable for the formation of Tropical Cyclone Tauktae.
- Enhanced trades persist across the Equatorial Pacific despite the demise of La Niña.

Outgoing Longwave Radiation (OLR) Anomalies

Blue shades: Anomalous convection (wetness). Red shades: Anomalous subsidence (dryness).



- Objective wavenumber/frequency filtering analyzes a Kelvin wave propagating over the Western Hemisphere during early to mid-May.
- This Kelvin wave enhanced convection to the southeast of Hawaii, while anomalous convection associated with the MJO shifted east from Africa to the Indian Ocean and Maritime Continent during the past ten days.



- Upper-ocean heat content is above-normal along the equator for areas west of 90°W as a result of multiple downwelling oceanic Kelvin waves since March.
- Niño indices still generally remain below-normal, although the vertically-integrated heat content suggests any cold water is extremely shallow.

- The RMM index looped westward from May 10 to 15, due to an equatorial Rossby wave over the Indian Ocean.
- The MJO has propagated eastward from the Indian Ocean to the Maritime Continent.



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 GFS ensemble mean depicts a continued eastward propagation of the MJO over the Pacific but ensemble spread is large on its amplitude.
- The ECMWF ensemble members (from May 21) are in good agreement with the GEFS on the MJO evolution during late May and into the beginning of June.

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 features suppressed convection expanding over the Indian Ocean to the western Maritime Continent during the next two weeks with enhanced convection persisting across the Pacific Ocean. Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:20-Nov-2020 to 22-May-2021 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 (23 May 2021)

 The constructed analog forecast is faster than the GEFS with the suppressed envelope shifting eastward while also favoring enhanced convection developing over Africa later in week-2. Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm^{-s}) Period:21-Nov-2020 to 23-May-2021 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.

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