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



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Overview

- The MJO is currently over the Maritime Continent, but is being interfered with the suppressed phase of an equatorial Rossby wave.
- Dynamical models are mixed with the propagation of this signal into the Pacific during Week-2. Some
 models show propagation over the Pacific at a reduced amplitude due to destructive interference with the
 ongoing La Niña event, while others maintain the signal over the Maritime Continent.
- The MJO reaching the Pacific could help increase tropical cyclogenesis potential over the East Pacific during Week-2. A Kelvin wave currently over the Central Pacific could similarly increase development potential to a lesser extent over the Atlantic during Week-2. The Atlantic is likely to continue to be in a relatively suppressed state during Week-1 due to large-scale subsidence from the Phase 5 MJO signal.

200-hPa Velocity Potential Anomalies



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

- Since earlier this year, a slow westward shift of suppressed convection across the Pacific was apparent.
- Since July, more robust and slower evolving MJO activity was evident, especially across the Indian Ocean. The signal progressed rapidly across the Pacific, influenced by the low-frequency state.
- The current enhanced intraseasonal envelope lies near 120°E, with a general wave-1 pattern apparent featuring enhanced (suppressed) convection across the eastern (western) hemisphere.

200-hPa Wind Anomalies

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



- Upper-level zonal wind anomalies are consistent with MJO activity, as a couplet of easterly/westerly
 anomalies propagated eastward across the Indian Ocean during early September with a larger pattern
 suggestive of a wave-1 asymmetry.
- Easterly anomalies remain in place across much of the tropical Atlantic, helping to maintain a favorable environment for tropical cyclone development.

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- The intraseasonal signal is less apparent in the low levels, where easterly anomalies over the Pacific associated with the developing La Niña dominate the pattern.
- Westerly anomalies remain in place over the tropical Atlantic main development region, tied to anomalous cyclonic flow between 10-20°N.

Outgoing Longwave Radiation (OLR) Anomalies

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



- Eastward propagation of the MJO over the Indian Ocean is evident in the OLR field with some additional constructive interference from equatorial Rossby wave activity. The MJO envelope is currently approaching a more hostile environment with the suppressed phase of this Rossby wave and the La Niña suppression near 150°E that is not highlighted in the Hovmöller diagram.
- A Kelvin wave is currently propagating across the central Pacific.



- Following destructive interference with the base state by a downwelling Kelvin wave, the subsequent upwelling
 phase has pushed the Pacific into La Niña conditions.
- Heat content anomalies in the Niño 3.4 region have become strongly negative since July.
- A second downwelling Kelvin wave is evident over the central Pacific.

• The RMM index slipped inside the unit circle over the weekend, after spending much of last week in Phase 4.



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



- The GEFS features eastward propagation during the next two weeks with its ensemble mean at an amplitude just inside the unit circle. Some members rapidly push the envelope toward phases 8/1.
- The ECMWF ensemble mean features some initial strengthening and eastward propagation over the Maritime Continent in Phase 5 during Week-1, before weakening and a westward loop (likely tied to equatorial Rossby wave activity) during Week-2.
- The last intraseasonal event in Phases 6/7 remained within the unit circle before emerging in Phase 7, which could be the case again given the base state being unfavorable for Pacific convection.

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 OLR anomaly evolution based on the GEFS RMM index forecast shows a relatively stationary pattern the next two weeks, with the biggest change being increased convective suppression across the Indian Ocean. Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻⁴) Period:21-Mar-2020 to 20-Sep-2020 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 forecast is more progressive than the GEFS, but still fairly slow and highlights little to no enhancement of convection over the Pacific during Week-2. Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:21-Mar-2020 to 20-Sep-2020 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.

