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

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Outline

Overview

Recent Evolution and Current Conditions

MJO Index Information

MJO Index Forecasts

MJO Composites
The MJO remained weak during the past week.

Other types of variability, including the ongoing El Niño and tropical cyclone activity over the Pacific basin, remain the primary drivers of the global tropical convective pattern.

Dynamical models continue to be highly divergent due to the incoherent intraseasonal pattern, with most depicting little MJO signal over the next two weeks.

The MJO is not expected to play a role in the pattern of tropical convection during the next two weeks. The low frequency ENSO state and other types of tropical variability, such as tropical cyclones, are expected to have more influence.

Additional potential impacts across the global tropics and a discussion for the U.S. are available at: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php
Strong westerly wind anomalies persisted over the central north Pacific, partly due to ongoing tropical cyclone activity.

Easterly anomalies persisted over parts of South Asia, the northern Indian Ocean, and the western Maritime Continent.

Note that shading denotes the zonal wind anomaly.
Blue shades: Easterly anomalies
Red shades: Westerly anomalies
Westerly anomalies (orange/red shading) represent anomalous west-to-east flow.
Easterly anomalies (blue shading) represent anomalous east-to-west flow.

The MJO, Rossby wave activity, and El Niño conditions contributed to a strong westerly wind burst in early March.

The red box highlights the persistent low-frequency westerly wind anomalies associated with ENSO. Some transient variability is observed as well.

A robust MJO event was observed in late June through mid-July, constructively interfering with the background state.

Recently, the background ENSO remains the primary signal, but other modes, including tropical cyclone activity near and east of the Date Line, continue to influence the pattern.
Drier-than-normal conditions, positive OLR anomalies (yellow/red shading)

Wetter-than-normal conditions, negative OLR anomalies (blue shading)

During early August, the ENSO signal remained prominent, with generally suppressed (enhanced) convection over the Indian Ocean and parts of the Maritime Continent (central and eastern Pacific).

The suppressed signal intensified over the Maritime Continent during mid-August, while enhanced convection persisted across the Pacific.

During late August, the large-scale pattern remained relatively unchanged, with suppressed (enhanced) convection over the Maritime Continent (eastern Pacific). Tropical cyclone activity both west and east of Hawaii was evident in the OLR field.
Since April, the ongoing El Niño is observed (red box) as a tendency toward a dipole of anomalous convection extending from the Maritime Continent (suppressed) to the East Pacific (enhanced).

During June and early July, the MJO become active, interfering with the ENSO signal at times.

Recently, the MJO signal has weakened and other types of tropical variability, including El Niño and tropical cyclones, are more influential.
Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

Negative anomalies (green shading) indicate favorable conditions for precipitation

The MJO strengthened in early March as seen in the upper-level velocity potential anomalies.

The developing ENSO state is highlighted by the red box, showing anomalous divergence over the central and eastern Pacific. This pattern has only been temporarily interrupted by strong Kelvin wave/MJO activity at times.

During June and early July, a high-amplitude MJO event was observed, constructively interfering with the El Niño signal in early July. By the end of July, the MJO weakened as the low-frequency state dominated the pattern of tropical variability.

More recently, a generally stationary pattern reflective of El Niño conditions was observed.
The upper-level velocity potential pattern continues to show anomalous upper-level divergence over the central and eastern Pacific with upper-level convergence over the Indian Ocean and the Maritime Continent.

Positive anomalies (brown contours) indicate unfavorable conditions for precipitation.
Negative anomalies (green contours) indicate favorable conditions for precipitation.
200-hPa Vector Wind Anomalies (m s⁻¹)

Note that shading denotes the zonal wind anomaly
Blue shades: Easterly anomalies
Red shades: Westerly anomalies

Westerly anomalies weakened somewhat over the far eastern Pacific.
Easterly anomalies have persisted over the central and eastern Pacific associated with El Niño since mid-April (red box).

During June, these easterly anomalies were interrupted by robust atmospheric Kelvin wave/MJO activity.

During August, some westward propagation of westerly anomalies from the Maritime Continent to the Indian Ocean was evident.

Recently, easterly anomalies strengthened over the eastern Pacific.
Weekly Heat Content Evolution in the Equatorial Pacific

Oceanic Kelvin waves have alternating warm and cold phases. The warm phase is indicated by dashed lines. Downwelling and warming occur in the leading portion of a Kelvin wave, and upwelling and cooling occur in the trailing portion.

During October-November, positive subsurface temperature anomalies increased and shifted eastward in association with the downwelling phase of a Kelvin wave. During November - January, the upwelling phase of a Kelvin wave shifted eastward.

Following a strong westerly wind burst in March, another downwelling phase of a Kelvin wave propagated eastward, reaching the South American coast during May. Reinforcing downwelling events have followed, resulting in persistently above-normal heat content from the Date Line to 90W.

Heat content anomalies greater than 2.5°C were observed over the east-central Pacific with the latest oceanic Kelvin Wave.
The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).


The methodology is very similar to that described in WH2004 but does not include the linear removal of ENSO variability associated with a sea surface temperature index. The methodology is consistent with that outlined by the U.S. CLIVAR MJO Working Group.


The index is based on a combined Empirical Orthogonal Function (EOF) analysis using fields of near-equatorially-averaged 850-hPa and 200-hPa zonal wind and outgoing longwave radiation (OLR).
The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes.

The triangular areas indicate the location of the enhanced phase of the MJO.

Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.

Distance from the origin is proportional to MJO strength.

Line colors distinguish different months.

The MJO index indicated weak MJO activity during the past few weeks.
MJO Index - Historical Daily Time Series

Time series of daily MJO index amplitude for the last few years.
Plot puts current MJO activity in recent historical context.
Ensemble GFS (GEFS) MJO Forecast

RMM1 and RMM2 values for the most recent 40 days and forecasts from the ensemble Global Forecast System (GEFS) for the next 15 days

- light gray shading: 90% of forecasts
- dark gray shading: 50% of forecasts

The GFS ensemble MJO index forecast depicts no coherent MJO signal during the next two weeks.
The GEFS MJO index-based OLR forecast depicts a weak anomaly pattern during the next two weeks, consistent with the weak MJO index forecasts.
The constructed analog model also depicts a weak anomaly pattern.

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.)
MJO Composites - Global Tropics

850-hPa Velocity Potential and Wind Anomalies (May-Sep)

Precipitation Anomalies (May-Sep)
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 (orange) 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.

