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

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Overview

Recent Evolution and Current Conditions

MJO Index Information

MJO Index Forecasts

MJO Composites
The MJO signal remains fairly disorganized, as other modes of tropical variability, including Pacific tropical cyclone activity and the developing low-frequency state, continue to influence the pattern.

Broad enhanced (suppressed) convective envelopes persist over the Pacific (Americas and Indian Ocean), but smaller-scale features yield a somewhat disorganized overall pattern.

Dynamical model MJO index forecasts are mixed, with the GEFS depicting development of a coherent MJO signal during Week-2, while the ECMWF forecasts a weaker subseasonal signal.

Based on recent observations and the forecast guidance, the MJO is only expected to play a modest role in the evolution of the global tropical convective pattern during the next two weeks. Other modes, including tropical cyclones and the low-frequency base state are expected to be important.

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
Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies
Red shades: Westerly anomalies

Strong westerlies, partly associated with tropical cyclone (TC) activity, remained entrenched over the tropical Northwest Pacific.

Broad westerly anomalies likewise continue to be observed over the central equatorial Pacific.
850-hPa Zonal Wind Anomalies (m s⁻¹)

Westerly anomalies (orange/red shading) represent anomalous west-to-east flow.

Easterly anomalies (blue shading) represent anomalous east-to-west flow.

MJO activity was observed during March, but the signal rapidly broke down by early April.

The MJO was active again during late April and May. Westward moving variability, including TC activity over the Pacific and equatorial Rossby waves, weakened the signal during June.

A weak intraseasonal signal re-emerged during mid to late July.

More recently in August, widespread westerly anomalies have developed over the Pacific basin, due in part to TC activity.
Enhanced convection shifted northward over Southeast Asia and the West Pacific during mid-July, while suppressed convection persisted over the far East Pacific and Central America. Enhanced convection spread eastward across the North Pacific.

During late July, suppressed convection overspread the Bay of Bengal and the western Maritime Continent while enhanced (suppressed) convection, including tropical cyclone activity, persisted over the North Pacific (near and south of the equator). An influx of tropical moisture is notable over the eastern U.S.

By early August OLR anomalies became somewhat less coherent, though enhanced convection due to TC activity is still evident over the North Pacific, with suppressed convection observed over the Indian Ocean and over the central equatorial Pacific.
Outgoing Longwave Radiation (OLR) Anomalies (2.5°N - 17.5°N)

Drier-than-normal conditions, positive OLR anomalies (yellow/red shading)

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

MJO activity during April weakened in early May as the suppressed phase destructively interfered with the low frequency La Niña base state. Stronger MJO activity emerged in late May, and weakened again during June coincident with pronounced Rossby wave activity.

The MJO remained weak during most of June.

During July, the intraseasonal signal re-emerged, with some eastward propagation evident in the OLR field. Other modes, particularly Rossby wave and tropical cyclone activity, continued to strongly influence the pattern.

Most recently, a strong atmospheric Kelvin wave has propagated across the western and central Pacific.
Robust MJO activity was observed throughout the cold season despite the background La Niña state. Stationary upper-level divergence over the Maritime Continent associated with the base state began to wane by April.

The enhanced phase of the MJO weakened east of the Date Line during June. Eastward propagation of broad suppressed convection continued into early July.

The upper-level footprint of the MJO re-emerged during mid-July, with a broad divergent signal propagating from the Maritime Continent to the central Pacific.

More recently, a somewhat stationary pattern of enhanced (suppressed) convection over the east-central Pacific (Indian Ocean) has emerged. Influence from Rossby wave activity, including strong tropical cyclones, may be contributing to this slowdown, as is the gradual transition to El Niño.
Positive anomalies (brown contours) indicate unfavorable conditions for precipitation
Negative anomalies (green contours) indicate favorable conditions for precipitation

The upper-level velocity potential pattern remains somewhat disorganized, but broad-scale enhanced divergence (convergence) is apparent over the Pacific (Americas and southern Indian Ocean). Robust Southeast Asia monsoon activity and tropical cyclone activity over the Northwest Pacific continue to dominate the pattern, along with a Kelvin wave over the eastern Pacific.
An upper-level wave train is observed from East Asia through the Northeast Pacific and western North America.

Note that shading denotes the zonal wind anomaly.
Blue shades: Easterly anomalies
Red shades: Westerly anomalies
Low-frequency anomalous westerlies remained in place east of 140E through late April 2018, with a few periods of brief interruptions.

Since the beginning of May, weak westerly anomalies have continued to propagate eastward from the Indian Ocean to the Americas; this pattern broke down in early June.

Anomalous westerlies amplified over the Maritime Continent in mid-June and have propagated eastward at MJO-like phase speeds since then.

More recently, the intraseasonal pattern weakened as predominantly easterly anomalies emerged.
Negative upper-ocean heat content anomalies persisted in the central and eastern Pacific from August-December.

A downwelling Kelvin wave associated with the intraseasonal signal weakened the negative anomalies across the east-central Pacific during late January and early February.

Several downwelling oceanic Kelvin waves (associated with a relaxation of the trade winds) have contributed to the eastward expansion of relatively warm subsurface water (as much as 1.5-2.0°C above normal between 160E and 170W during February). Positive anomalies have now observed over most of the basin since April-May.
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 RMM-based MJO index continues to project an enhanced convective phase over the West Pacific, but the index has remained stationary over the past two weeks. Tropical cyclone activity over the Pacific may be influencing the index, as is the gradual shift toward an El Niño base state.
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.
RMM1 and RMM2 values for the most recent 40 days and forecasts from the GFS ensemble system (GEFS) for the next 15 days

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

The GEFS RMM index forecast depicts continued West Pacific enhanced convection early, but suggests the reemergence of a coherent subseasonal signal over the Indian Ocean during Week-2.
Ensemble GFS (GEFS) MJO Forecast

Spatial map of OLR anomalies for the next 15 days

OLR anomalies based on the GEFS RMM-index forecast show weakening amplitude early, followed by eastward propagation of a coherent MJO signal.

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.)

Time-longitude section of (7.5° S-7.5° N) OLR anomalies - last 180 days and for the next 15 days

Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:10-Feb-2018 to 12-Aug-2018

The unfilled contours are GEFS forecast reconstructed anomaly for 15 days
The constructed analog RMM-based OLR anomaly forecast shows a weakening signal with little eastward propagation.
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.


U.S. MJO Composites - Precipitation

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.
