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

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Both the RMM and CPC velocity potential-based MJO indices depicted an MJO signal during the past week over the eastern Indian Ocean and Maritime Continent region.

Most dynamical models predict a weak, incoherent signal during Week-1, and the possible re-emergence of a more substantial intraseasonal signal over the Indian Ocean during Week-2.

Other modes of tropical variability (especially kelvin waves) are also likely to influence the pattern over the global tropics.

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
850-hPa Vector Wind Anomalies (m s\(^{-1}\))

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

Over the past week, westerly wind anomalies expanded over western and central portions of the North Indian Ocean. Easterly anomalies persisted over the western Pacific and Maritime Continent area.

Westerly anomalies diminished in spatial extent over the East Pacific.
Westerly anomalies (orange/red shading) represent anomalous west-to-east flow

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

Persistent westerly (easterly) anomalies, shown by the red (blue) box at right, were associated with the negative phase of the Indian Ocean Dipole (IOD), and later, La Niña.

During late January, Rossby wave activity was evident, with destructive interference on the base state evident through 100E.

During February, MJO activity also destructively interfered with the base state. During mid-March and early April, the low frequency state seemed to reemerge, with some intraseasonal variability evident in late March.

Recently, westerly anomalies continued over the Indian Ocean/Maritime Continent region, while easterlies persisted across the western and central Pacific. This suggests the net convergence of low-level atmospheric mass in the vicinity of the Maritime Continent.
Drier-than-normal conditions, positive OLR anomalies (yellow/red shading)

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

During early May, suppressed convection persisted over much of the Indian Ocean. Over the Pacific north (south) of the equator suppressed (enhanced) convection developed in long, west-east oriented patterns.

In mid-May, enhanced convection developed over the Americas and Atlantic Ocean, as well as over the Maritime Continent. Suppressed convection generally persisted over the Pacific along and north of the equator.

In late May, enhanced convection was noted across the eastern Indian Ocean and Maritime Continent region. Suppressed convection was noted over much of the remainder of the global tropics.
A low frequency state favoring enhanced convection over the eastern IO and the Maritime Continent has been evident from July through early April (green box), with suppressed convection near the Date Line (right black box). The remainder of the IO generally had suppressed convection during this period (left black boxes), with the exception of an MJO-related wet period from mid-Feb to early March.

From mid-April to early June, convective anomalies were generally weak; in mid-May, enhanced convection was noted over the Indian Ocean with some eastward propagation.
200-hPa Velocity Potential Anomalies (5°S - 5°N)

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

Negative anomalies (green shading) indicate favorable conditions for precipitation

The pattern, during December and January, was more related to seasonal variability.

A signal emerged over the Maritime Continent and continued propagating through early March, creating alternating periods of constructive and destructive interference with the base state.

During March, a low frequency signal favoring enhanced (suppressed) convection over the Maritime Continent (Indian Ocean) once again became the primary component of the anomaly field. Kelvin wave activity has been apparent from April through the present. During mid-late May, a disruption of the low-frequency state is evident, with eastward propagating variability consistent with atmospheric Kelvin wave activity.
The spatial distribution of the upper-level VP anomaly field has shifted toward a wave-1 pattern, which is considerably more coherent than it was last week.

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\(^{-1}\))

The top panel shows a largely incoherent structure over the global tropics.

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

The bottom panel shows easterly anomalies over the low latitudes of Africa and the Indian Ocean, and enhanced westerlies primarily over the east-central Pacific. Mid-latitude influences in the tropics are apparent near the date line.
Near the end of 2016 a period of westerlies disrupted the low frequency state between 80-130E and continued propagating eastward through the Western Hemisphere.

Easterly anomalies returned to the East Pacific during late April. Over the past two weeks, easterly (westerly) anomalies returned to the Indian Ocean and western Maritime Continent, as well as the central Pacific (western and eastern thirds of the 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.

An eastward expansion of below average heat content over the western Pacific is evident through June 2016, with negative upper-ocean heat content anomalies persisting through the end of 2016.

During the current year, positive anomalies have developed and generally persist over the entire basin.
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.

During the past week, the RMM index suggested a brief burst of intra-seasonal activity propagated eastward across the eastern Indian Ocean and Maritime Continent region, then weakened rapidly.
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.
The GEFS forecast predicts a weak sub-seasonal signal for the Week-1 period, followed by the possible emergence of a more substantial signal over the western Indian Ocean during Week-2.
The GEFS RMM-based OLR anomaly forecasts the decay of enhanced convection currently over the Indian Ocean/Maritime Continent region; with the re-emergence of a sub-seasonal signal across the Indian Ocean later in Week-2.
The statistical RMM-based OLR anomaly prediction indicates eastward propagation of enhanced convection across the Indian Ocean, Maritime Continent and much of the Pacific; followed by the development of suppressed convection over the Indian Ocean. This solution is directly opposite to that of the dynamical GEFS solution.
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.

