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

Update prepared by
Climate Prediction Center / NCEP
June 9, 2008

Outline

- Overview
- Recent Evolution and Current Conditions
- MJO Index Information
- MJO Index Forecasts
- MJO Composites

Overview

- MJO activity continues with the enhanced phase centered across the eastern Indian Ocean.

- Based on the latest observations, the MJO is expected to continue for the next 1-2 weeks. MJO dynamical forecast tools have not performed well with the current MJO activity.

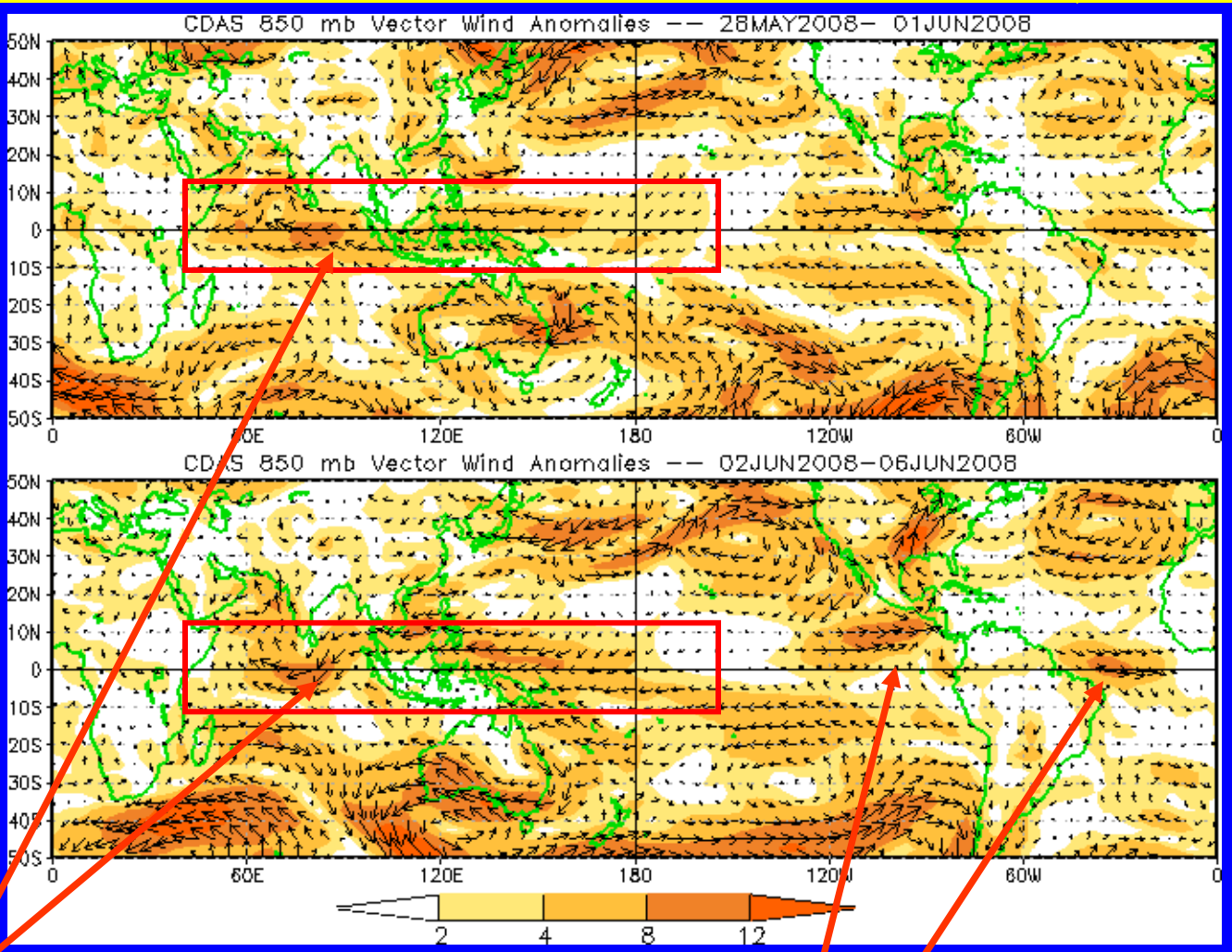
- The MJO will contribute to wet conditions stretching from the Arabian Sea across southern India and parts of Indonesia to the western Pacific Ocean during Week 1.

- The region of active convection is expected to shift slightly northeastward during Week 2.

Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/ghaz.shtml

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

Note that shading denotes the magnitude of anomalous wind vectors



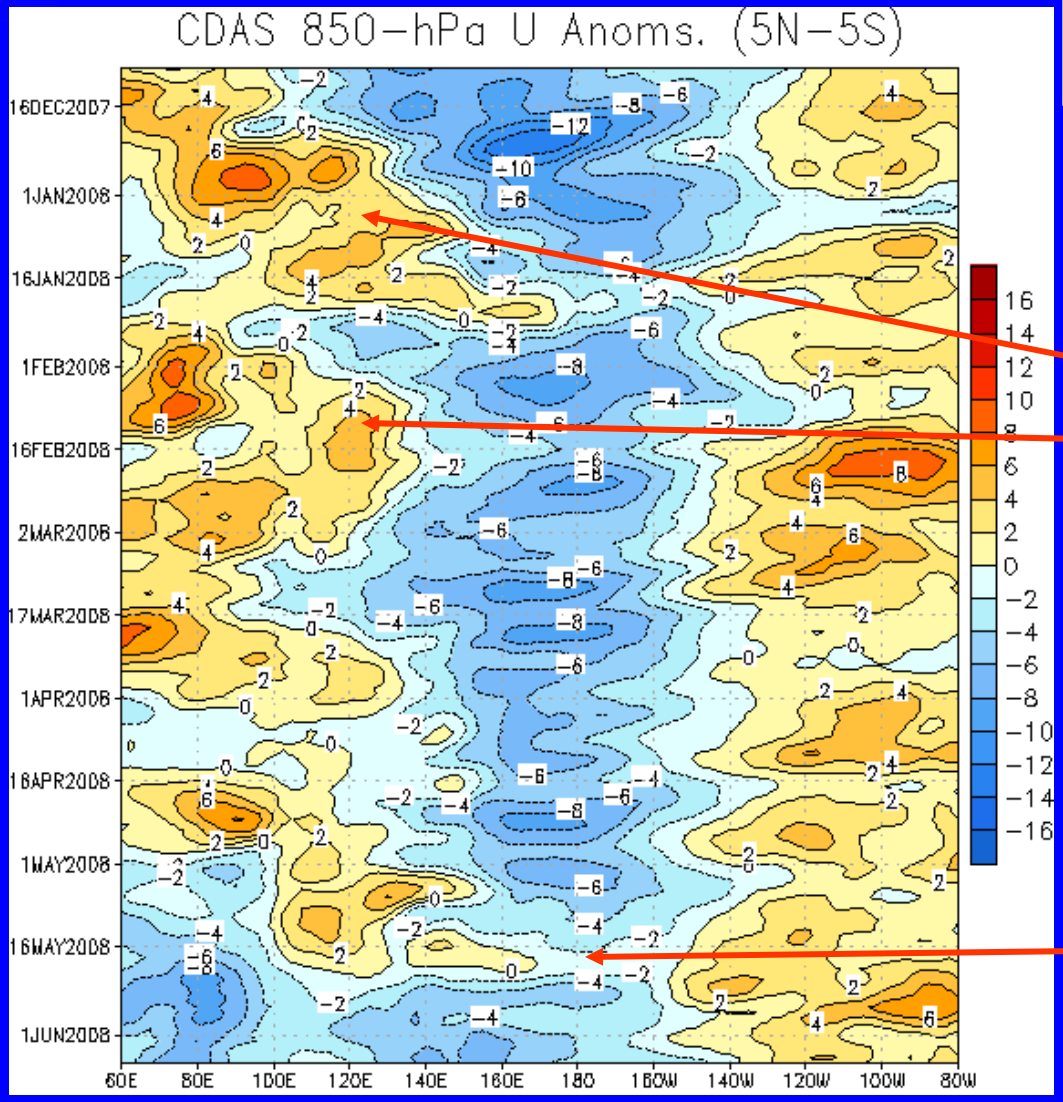
Easterly anomalies continue in the Indian Ocean and have strengthened across the western Pacific.

Westerly anomalies continue across the eastern Pacific and Atlantic during the last five days.

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



Time

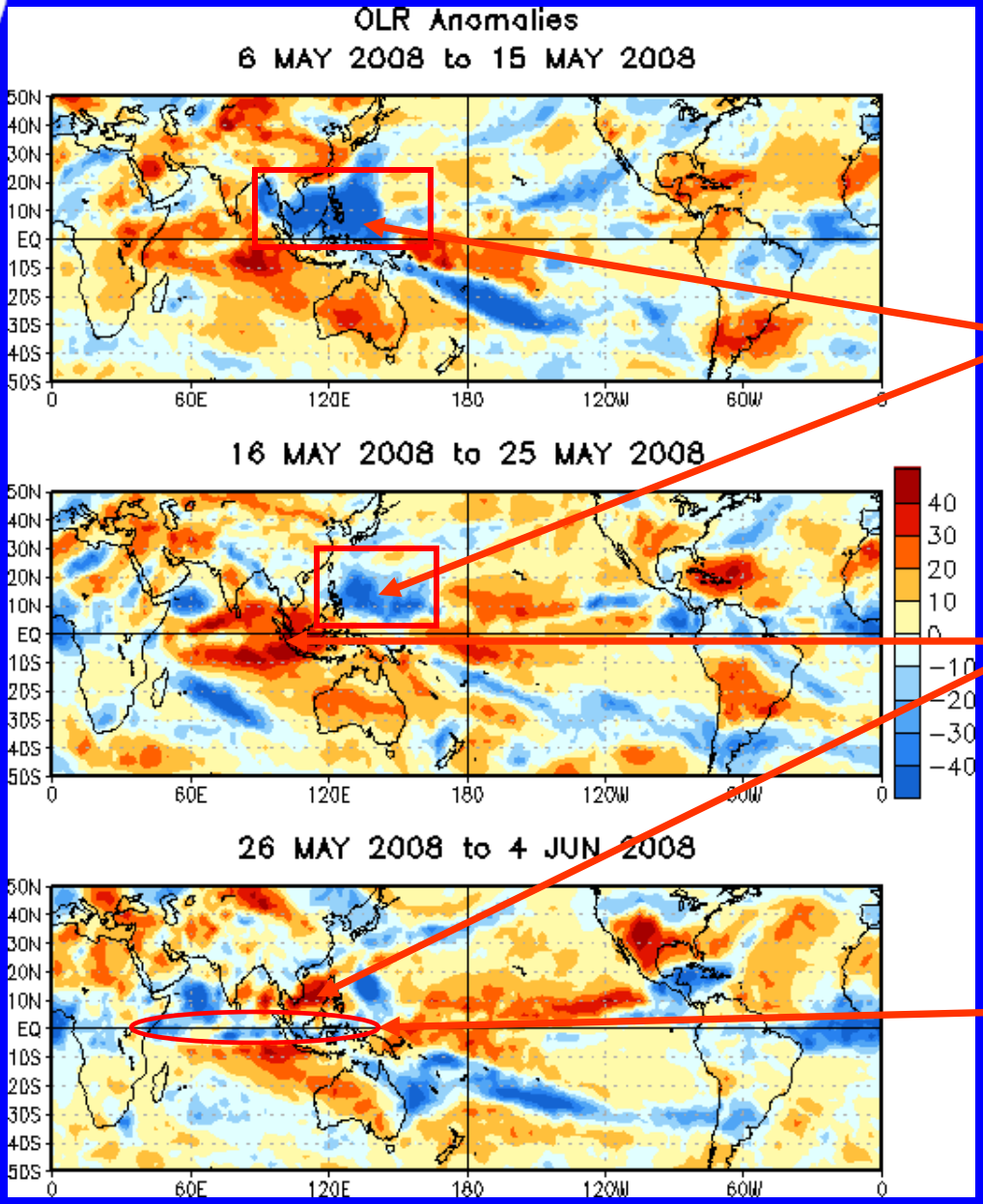
Longitude

Moderate-to-strong MJO activity is evident from late November to mid-late February as shown by westerly anomalies shifting eastward from the Indian Ocean across Indonesia and a weakening of the easterlies at the Date Line during early mid-January and mid-February.

MJO activity was weaker during much of March and April.

During mid-May, easterlies weakened near the Date Line associated with the latest MJO activity. Since this time easterly anomalies have increased across much of the eastern hemisphere.

OLR Anomalies: Last 30 days



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

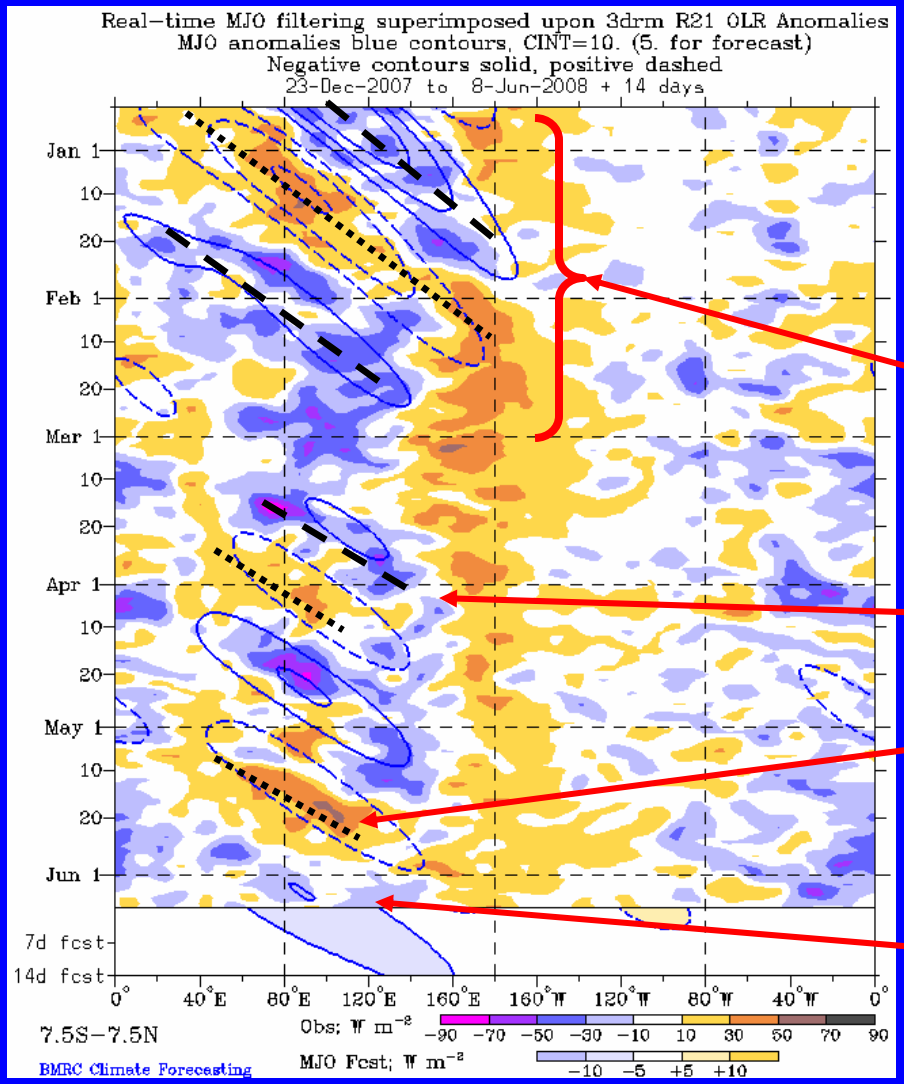
Wetter-than-normal conditions, negative OLR anomalies (blue shading)

Enhanced convection shifted east of the Philippines by mid-May.

Suppressed convection developed across the equatorial Indian Ocean in late May. While the area of suppressed convection has shifted eastward, convection has become active right at the equator.

During late-May and early June, wet conditions increased across the equatorial Indian Ocean and Maritime Continent.

Outgoing Longwave Radiation (OLR) Anomalies (7.5°S-7.5°N)



Time

Longitude

Drier-than-normal conditions, positive OLR anomalies (blue shading)

Wetter-than-normal conditions, negative OLR anomalies (yellow/red shading)

(Courtesy of the Bureau of Meteorology - Australia)

Moderate-to-strong MJO activity was evident from mid-November to mid-February with coherent eastward propagation of enhanced (suppressed) convection indicated by the dashed (dotted) lines.

Weak MJO activity was evident during mid-late March.

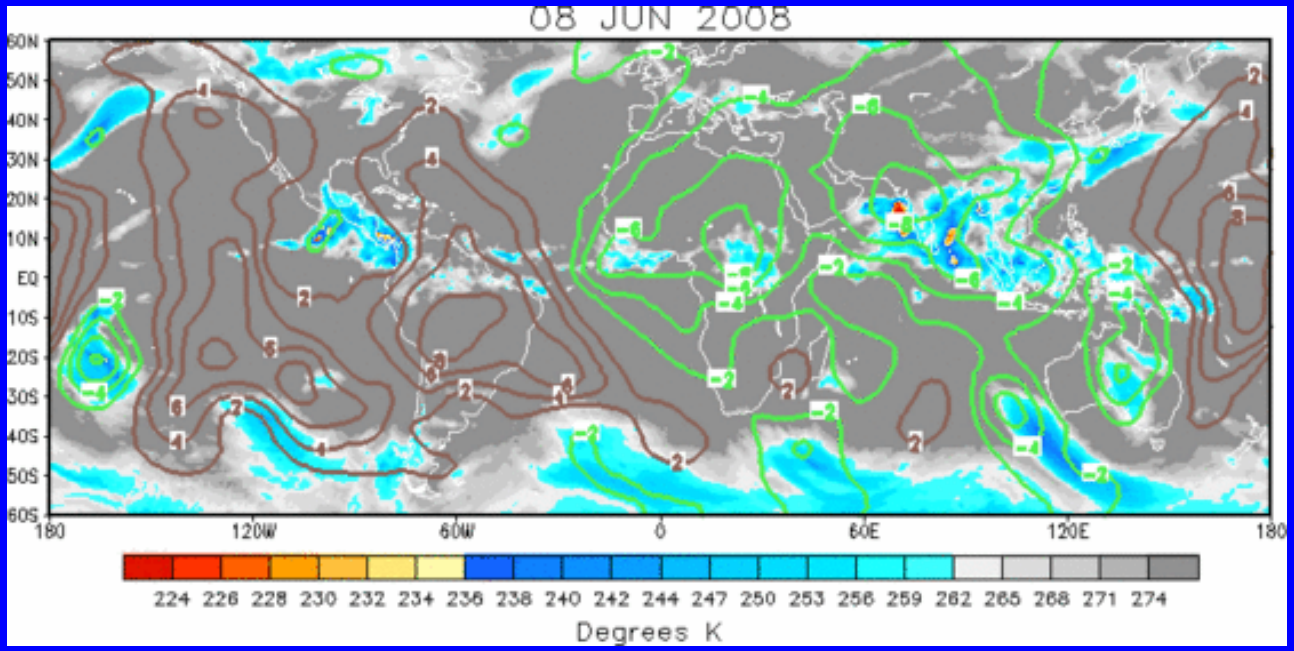
Strong suppressed convection organized across the Indian Ocean and shifted eastward during mid-May.

Currently, a weaker area of normal-to-enhanced convection is shifting through the Indian Ocean and Maritime Continent.

IR Temperatures (K) / 200-hPa Velocity Potential Anomalies

Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

Negative anomalies (green contours) indicate favorable conditions for precipitation

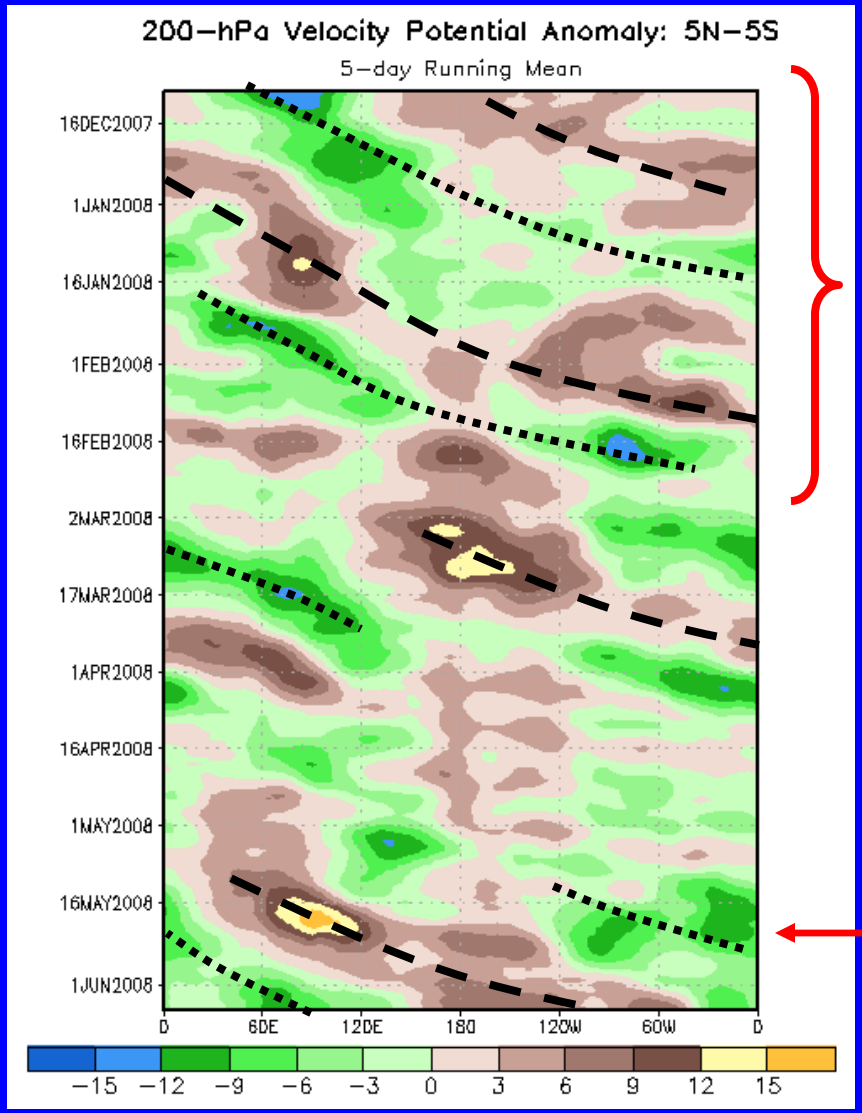


The large-scale wave structure in anomalous velocity potential continues as upper-level convergence is present across much of the Pacific and western Atlantic Ocean. Upper-level divergence is observed across Africa, throughout the Indian Ocean, and western Maritime continent.

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



Time

Longitude

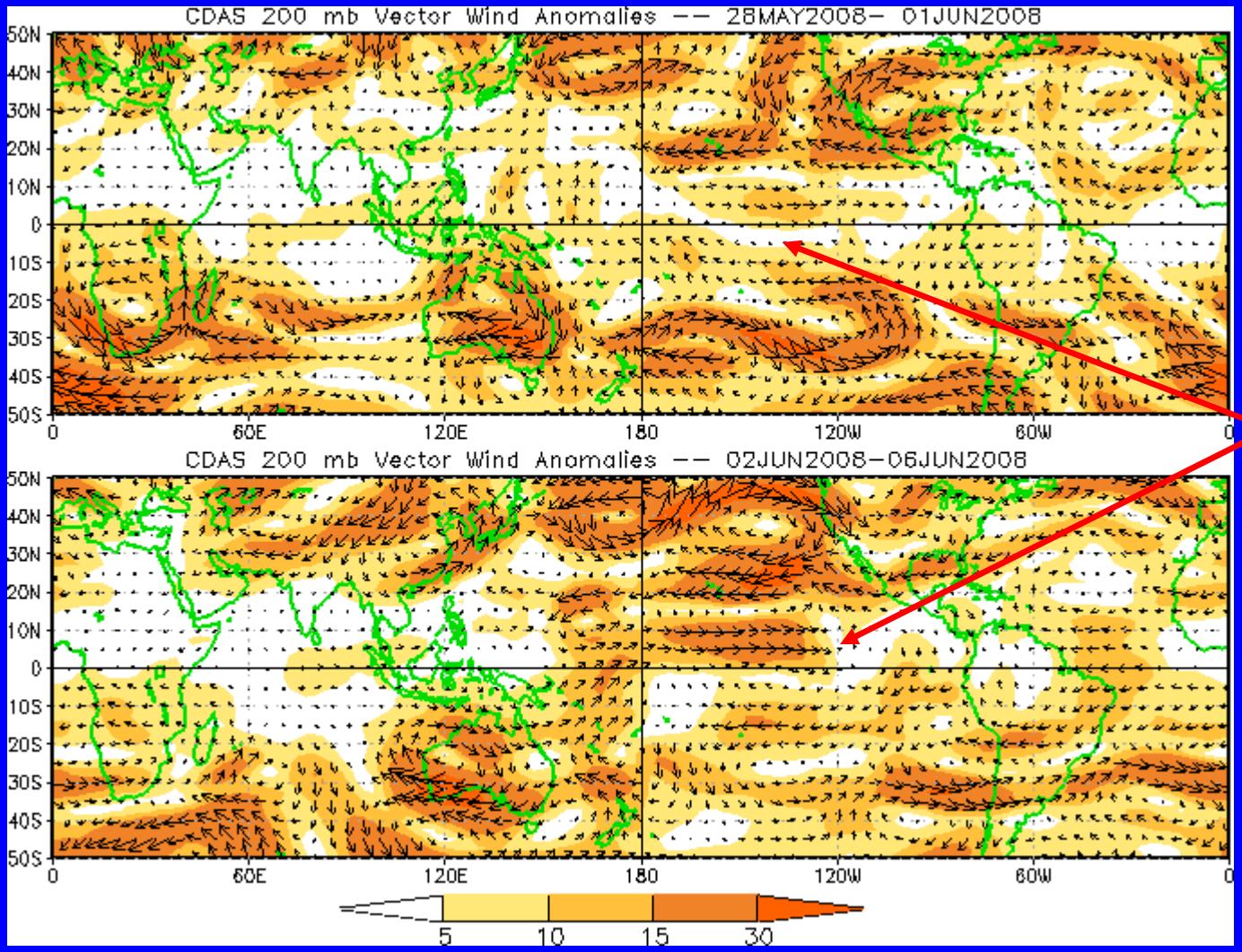
Moderate-to-strong MJO activity developed in mid-November and continued into mid-February.

Weak MJO activity was evident during parts of March.

The MJO was largely incoherent during the month of April.

The MJO strengthened during May as velocity potential anomalies increased with eastward propagation evident.

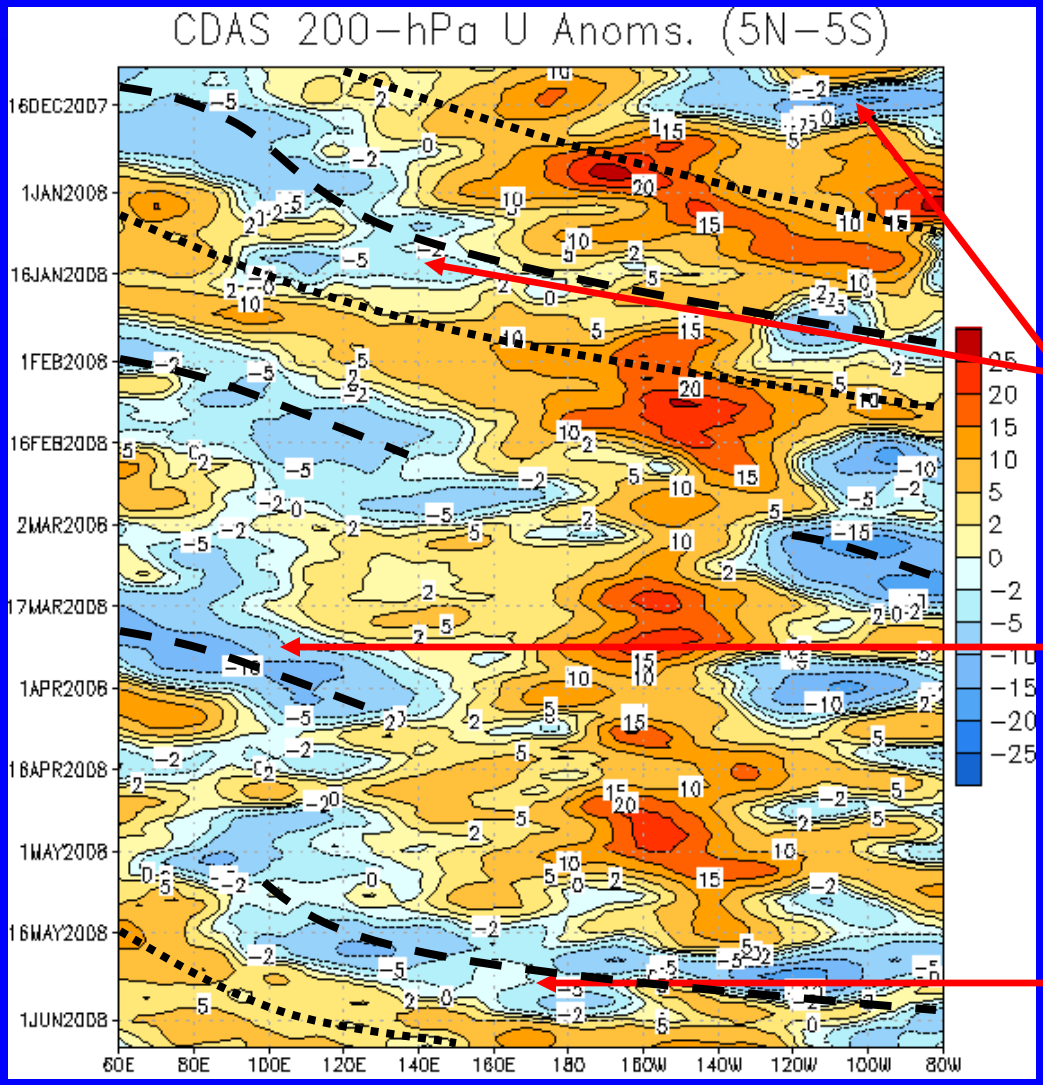
200-hPa Vector Wind Anomalies (m s^{-1})



Note that shading denotes the magnitude of anomalous wind vectors

Westerly anomalies over the central Pacific Ocean have increased during the last five days.

200-hPa Zonal Wind Anomalies (m s^{-1})



Time

Longitude

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

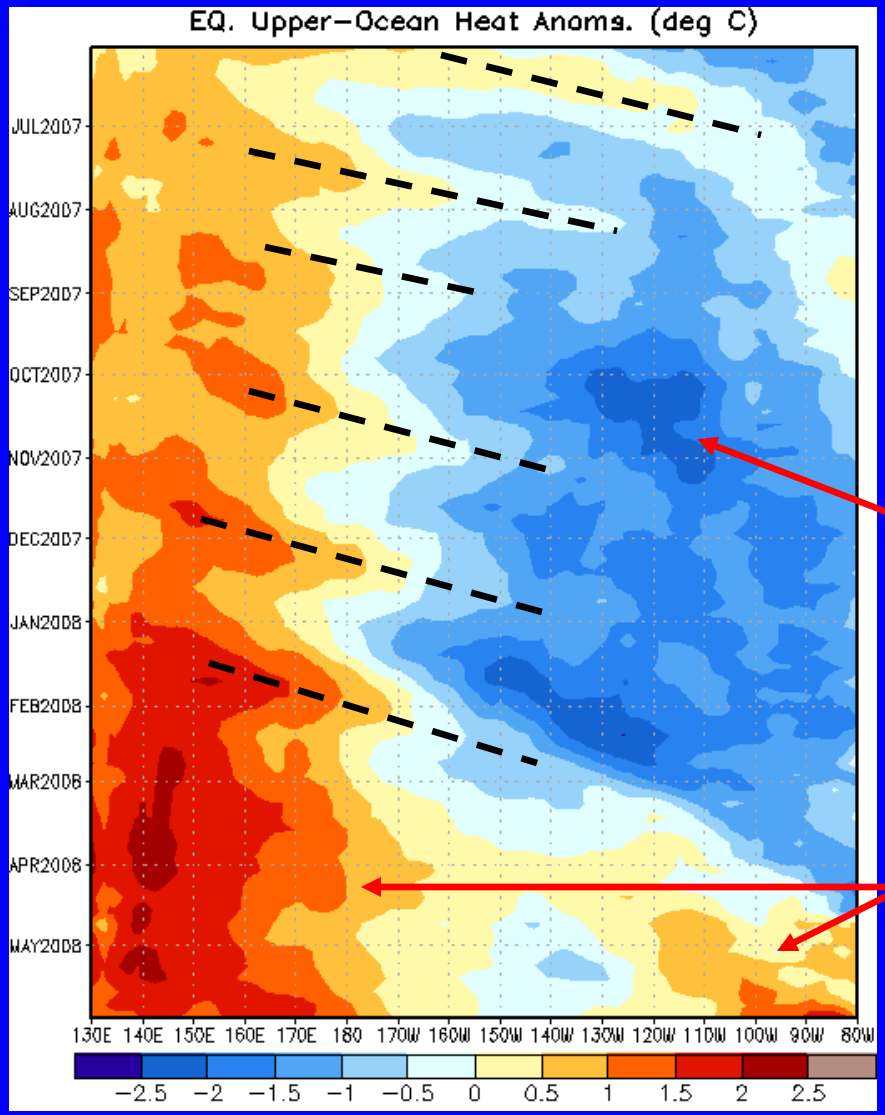
Easterly anomalies (blue shading) represent anomalous east-to-west flow

MJO activity is evident in the upper-levels by eastward propagation of easterly (westerly) anomalies by dashed (dotted) lines globally from late November to mid-February.

During March, MJO activity was evident as easterly anomalies propagated eastward from the western hemisphere to the Maritime continent.

Easterly anomalies increased during early May over Indonesia and have shifted eastward. Now westerly anomalies extend from across the Indian Ocean into the central Pacific.

Weekly Heat Content Evolution in the Equatorial Pacific



Time

Longitude

Kelvin wave activity (downwelling phases indicated by dashed lines) was observed from May 2007 to February 2008 and affected sub-surface temperature departures at varying degrees across the Pacific Ocean. The strongest wave occurred during May and June 2007.

During September and October, negative heat content anomalies increased markedly across the eastern Pacific Ocean and continued until February 2008.

Beginning in March, increasingly positive anomalies have developed across parts of the western and central Pacific and have extended eastward into parts of the eastern Pacific during April and May.

MJO Index -- Information

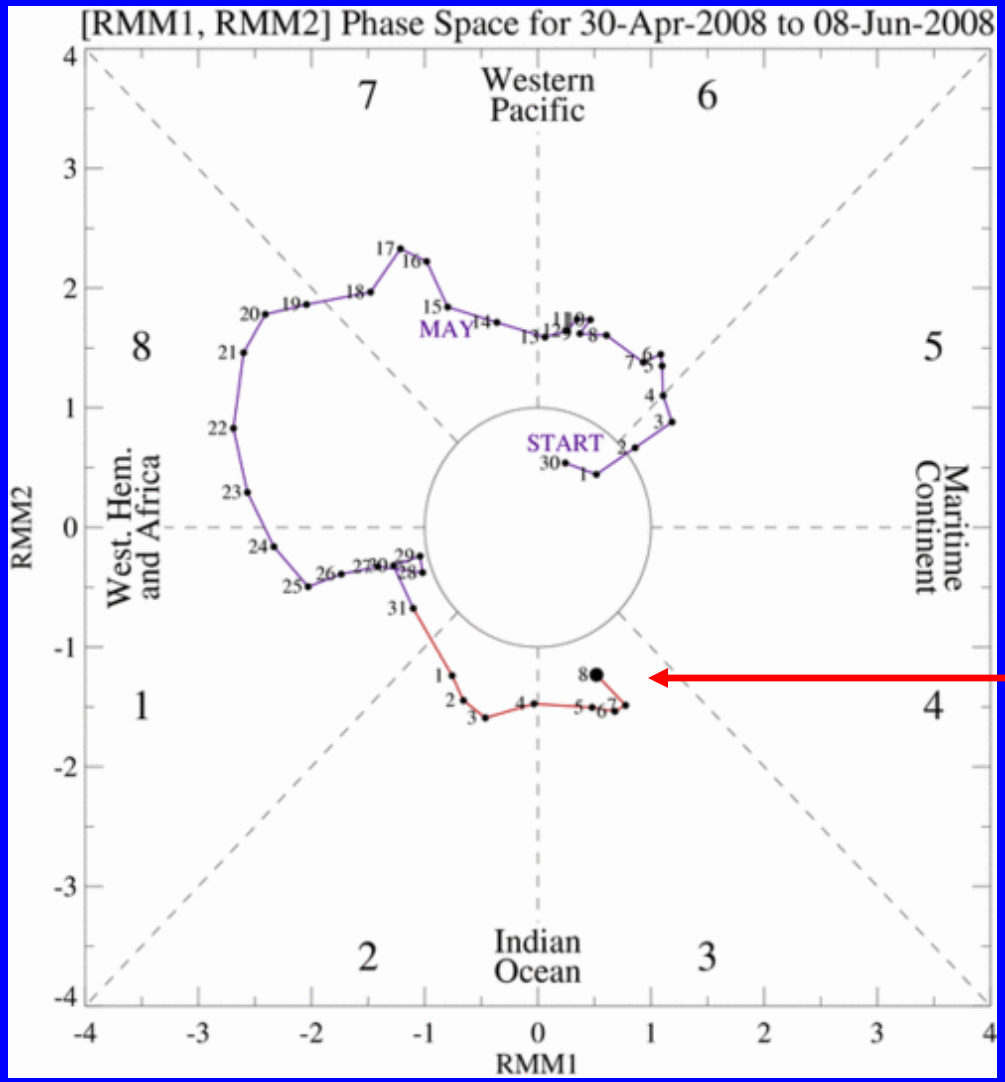
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

Wheeler M. and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction, *Monthly Weather Review*, 132, 1917-1932.

- **The methodology is nearly identical to that described in WH2004 but small deviations from the BMRC figure are possible at times due to differences in input data and methodology. These typically occur during weak MJO periods.**

- **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).**

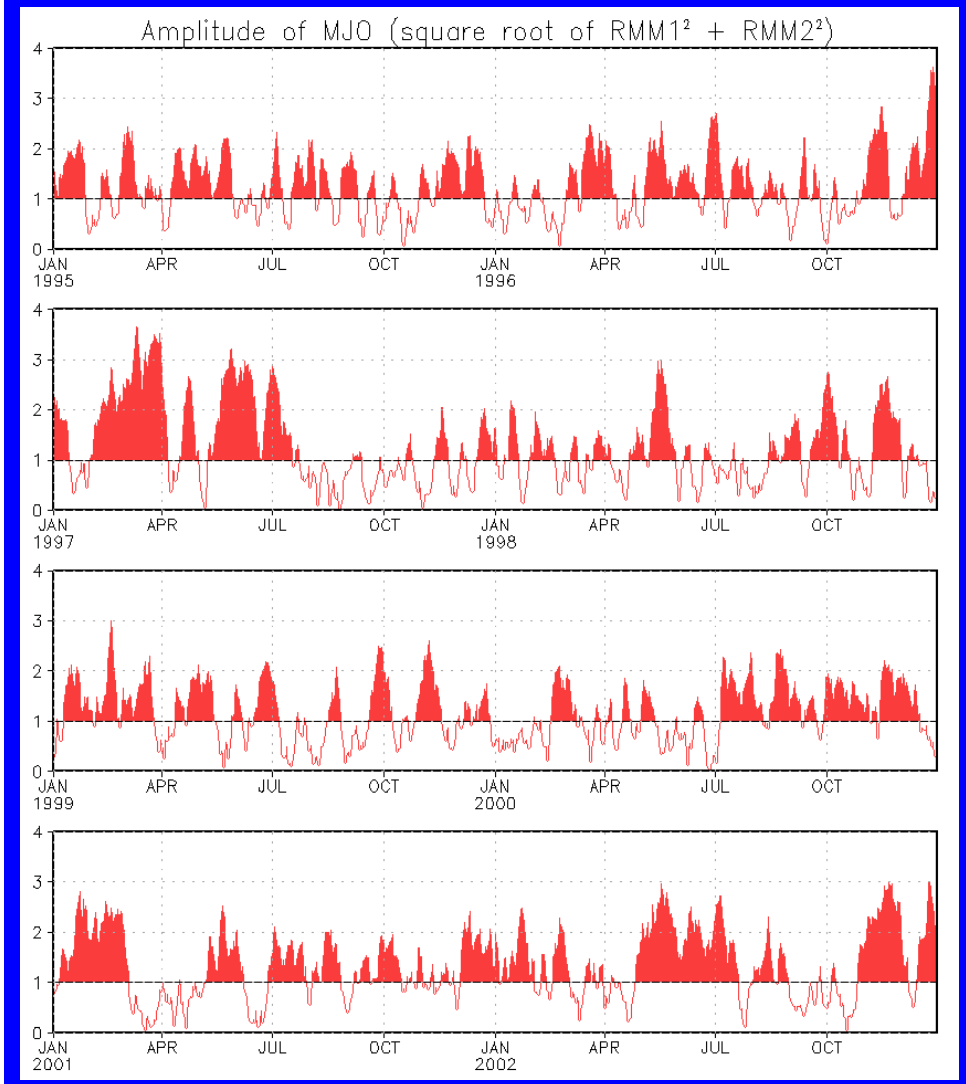
MJO Index -- Recent Evolution

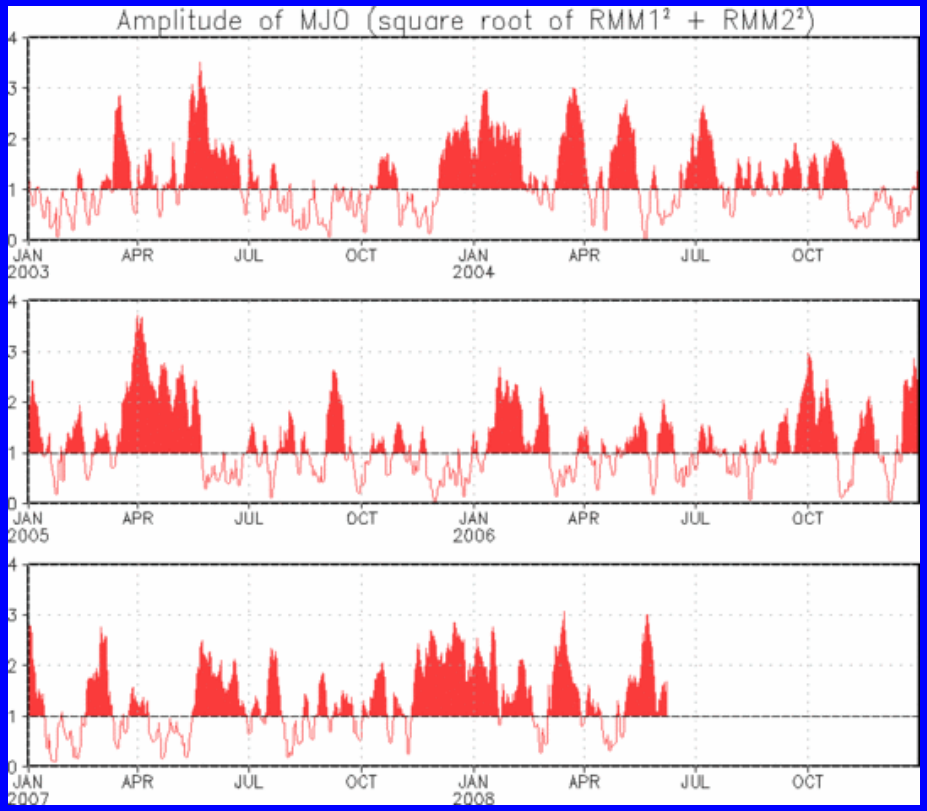


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation
- Distance from the origin is proportional to MJO strength
- Line colors distinguish different months

The MJO index has decreased in amplitude since mid-May, but has continued to propagate into the eastern Indian Ocean.

MJO Index – Historical Daily Time Series





Time series of daily MJO index amplitude from 1995 to present

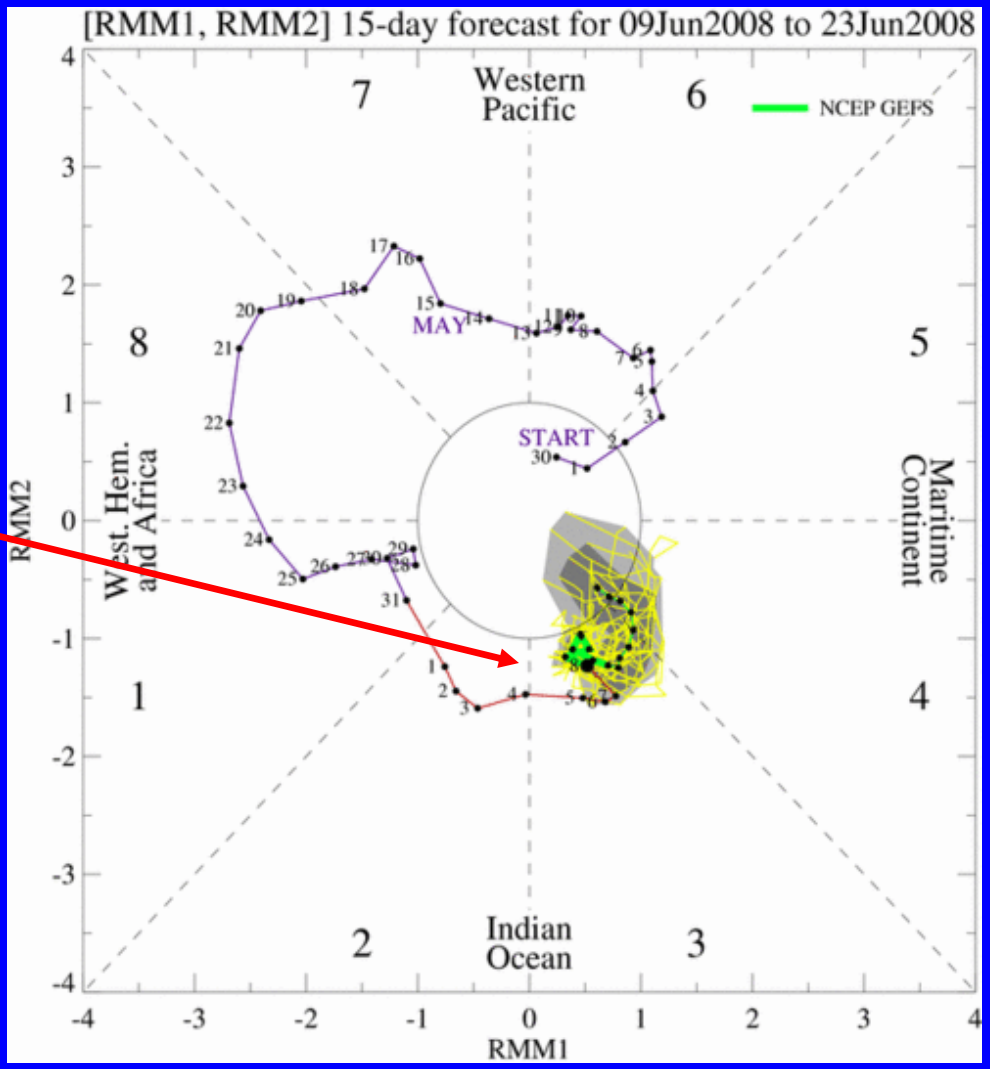
Plots put current MJO activity in historical context

Ensemble GFS MJO Forecasts

Yellow Lines – 20 Individual Members
Green Line – Ensemble Mean

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



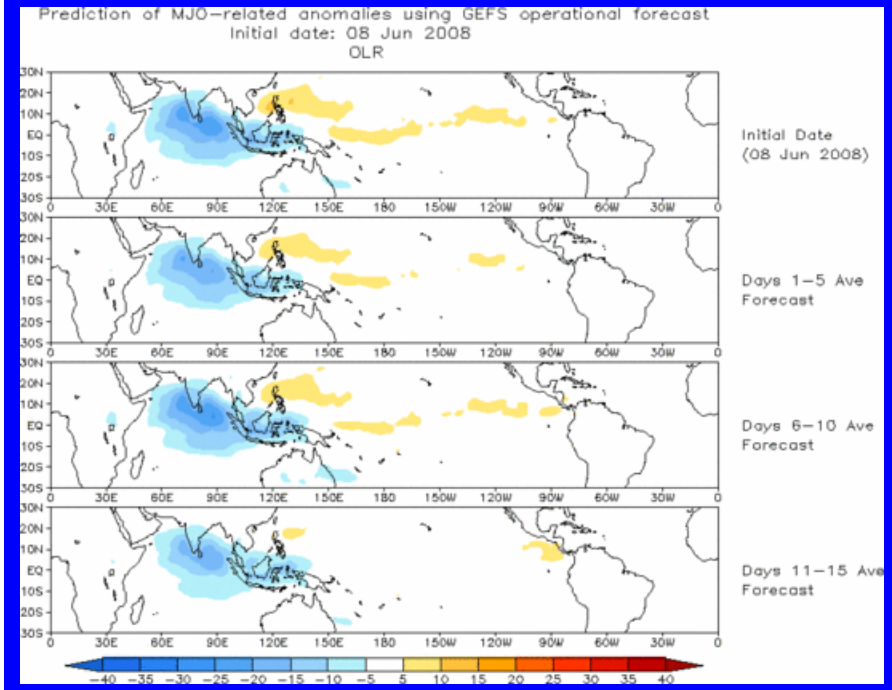
The GEFS predicts the MJO signal to diminish within the next week.

The GEFS has consistently underestimated the eastward propagation and strength of the current MJO activity.

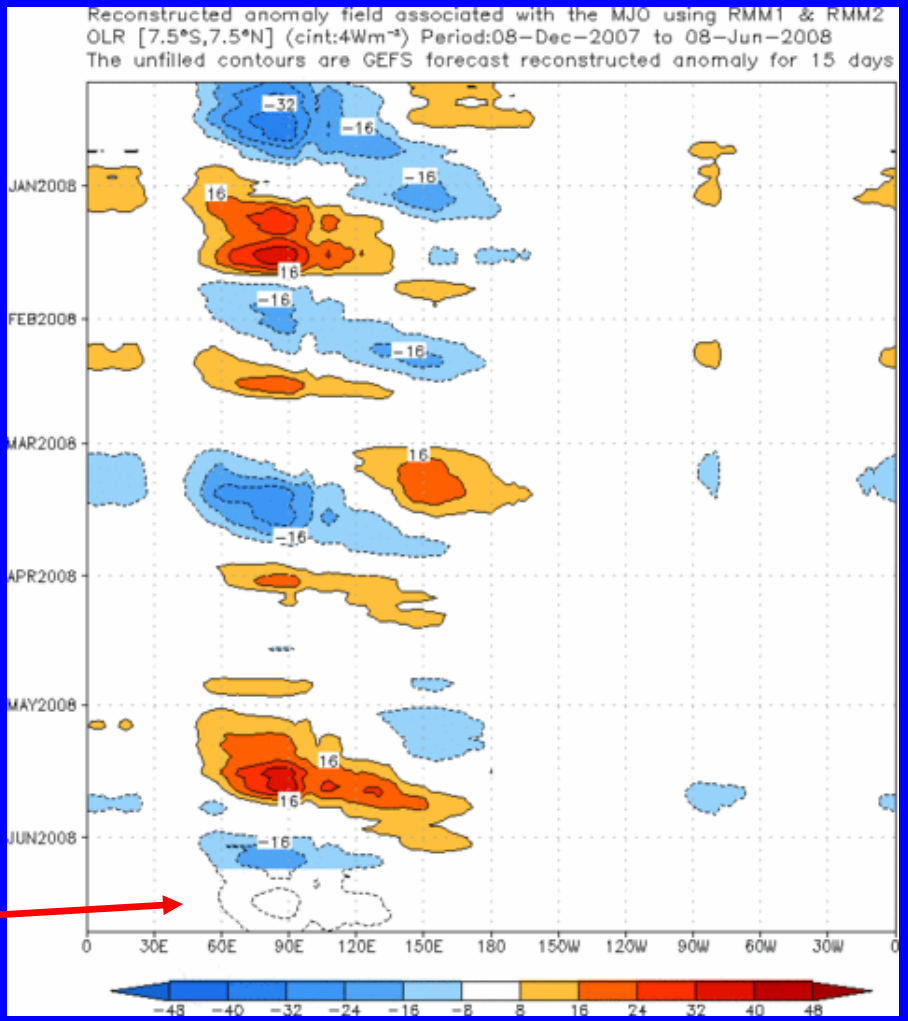
Ensemble Mean GFS MJO Forecast

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)

Spatial map of OLR anomalies for the next 15 days



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



The forecast from the GEFS for MJO-associated convection indicates weak suppressed convection across the western Pacific and wet conditions for the Indian Ocean and Maritime continent during much of the period.

Little eastward propagation is forecast over the next 2 weeks.

Statistical MJO Forecast

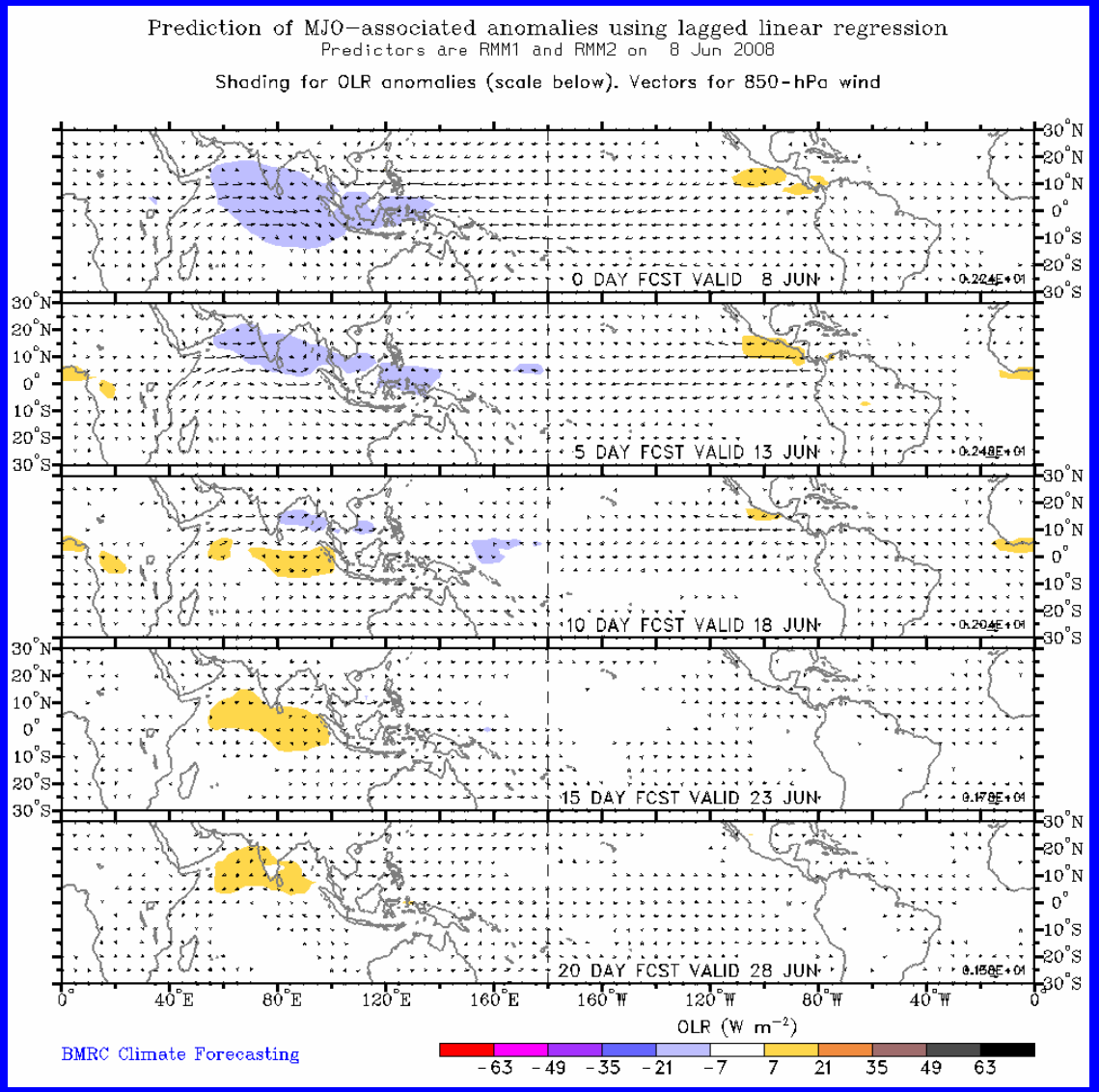
Figure below shows MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies and 850-hPa wind vectors for the next 20 days

(Courtesy of the Bureau of Meteorology Research Centre - Australia)

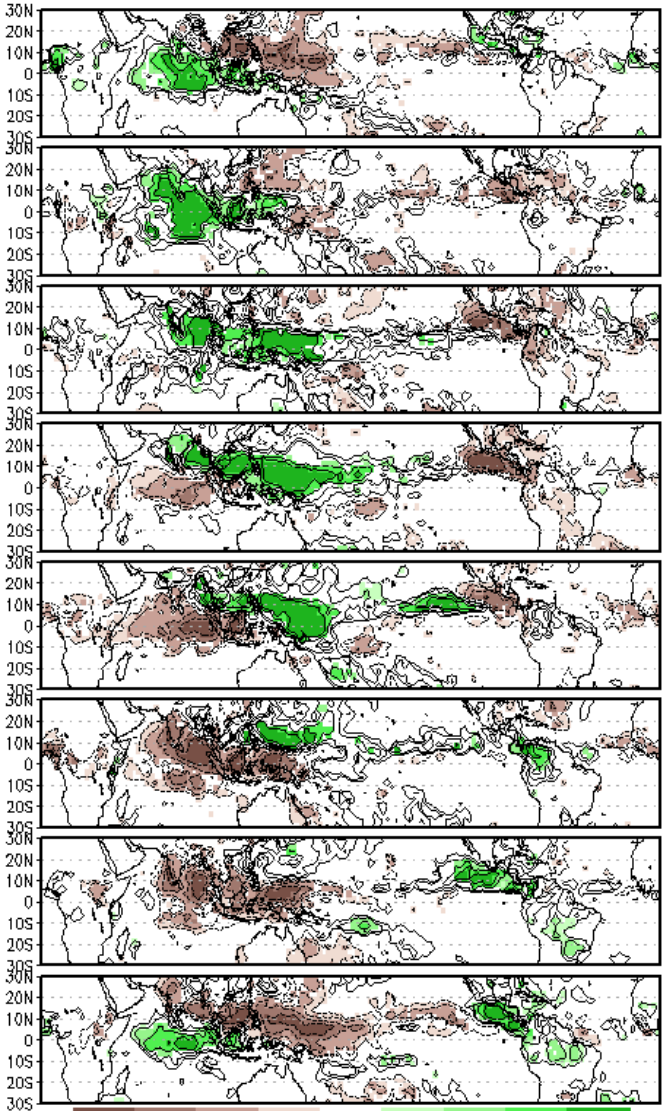
Weak MJO activity is forecast with enhanced convection shifting northeastwards toward southern Asia during the period.

Dry conditions are forecast to develop in the Indian Ocean during week 2.



MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)



850-hPa Wind Anomalies (May-Sep)