



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

**Update prepared by
Climate Prediction Center / NCEP
July 14, 2008**



Outline

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



Overview

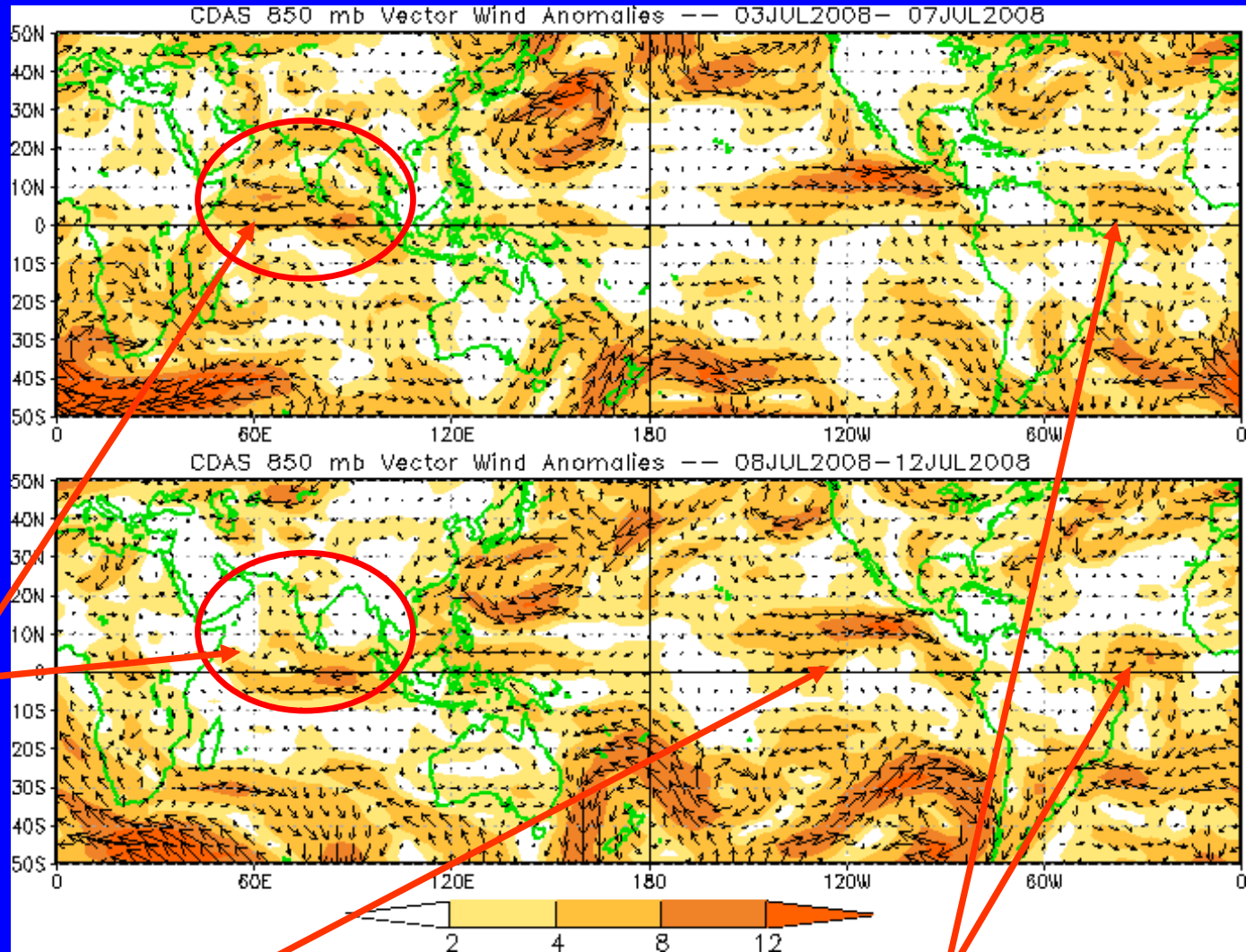
- **A more coherent MJO pattern is emerging and needs to be closely monitored for further development.**
- **Some forecast tools indicate movement of an MJO signal into the Indian Ocean during the next 1-2 weeks.**
- **During week 1, an increased chance of above average rainfall exists across the eastern Pacific, Mexico, central America, western Africa, and the Indian Ocean. Also during week 1, a favorable environment for tropical cyclogenesis can be expected in the eastern Pacific and tropical Atlantic. During week 2, an increased chance for above average rainfall exists across the eastern Pacific, Mexico, and India.**

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



Cross-equatorial flow has recently diminished, but low-level easterly wind anomalies continue in the Indian Ocean.

Westerly anomalies have persisted across the eastern Pacific during the last five days.

Equatorial westerly anomalies continue in the Atlantic.

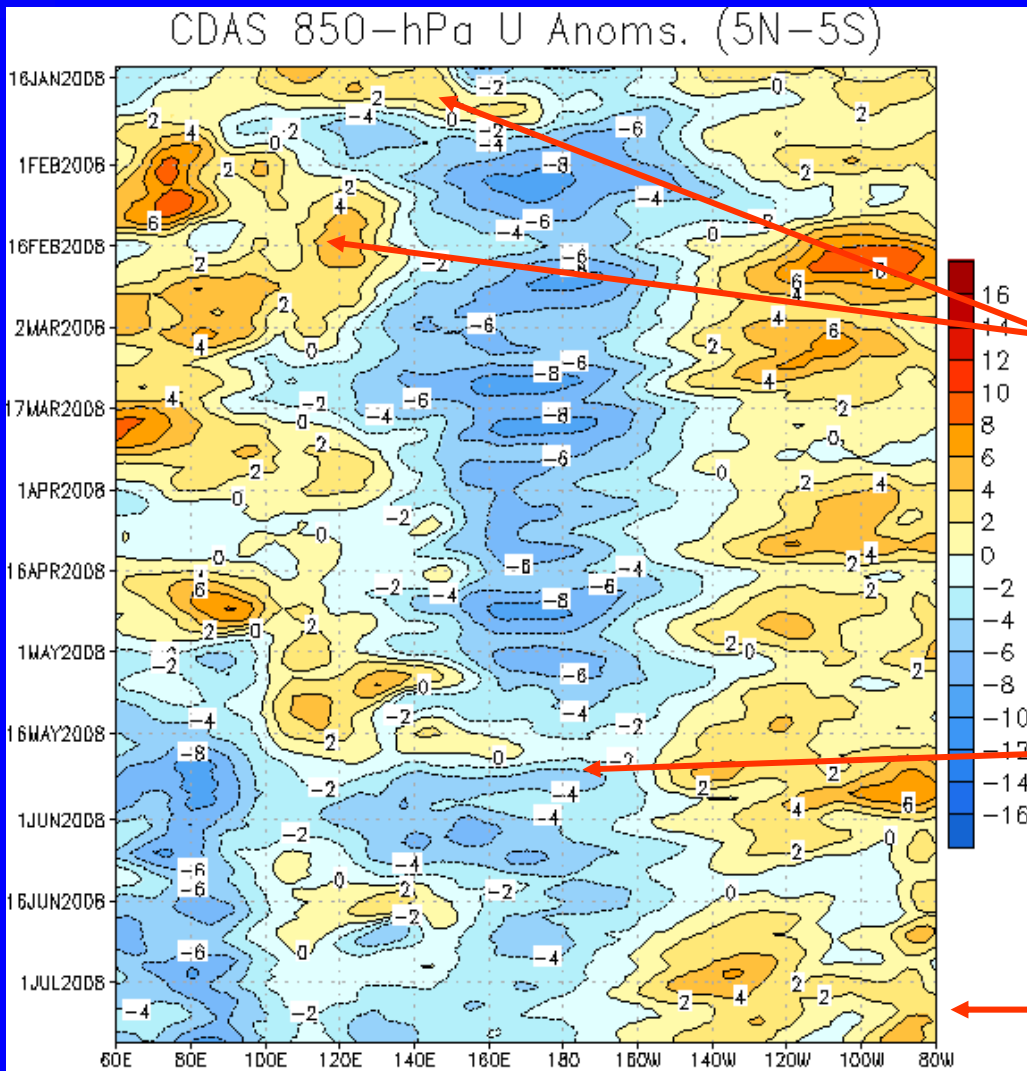


850-hPa Zonal Wind Anomalies (m s^{-1})

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 during January into 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 mid-January.

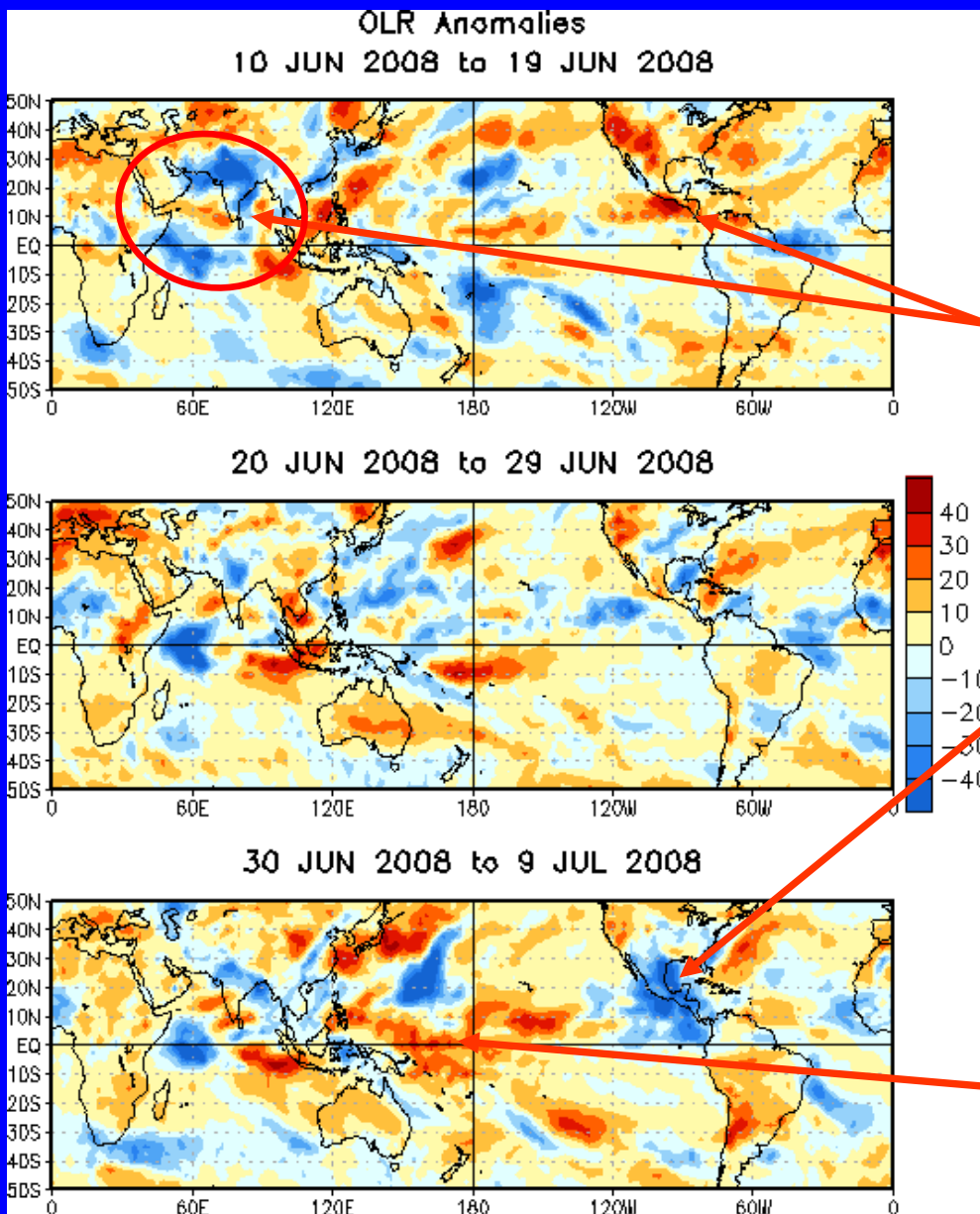
MJO activity was weaker during much of March and April.

During mid-May, easterlies weakened near the Date Line associated with moderate MJO activity.

Easterly anomalies have prevailed across much of the eastern hemisphere from late May into early July. Westerly anomalies persist across the east Pacific.



OLR Anomalies: Last 30 days



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

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

During mid June, wet conditions continued across the western Indian Ocean and India. Suppressed convection replaced the wet conditions across the eastern Pacific and Central America during the period.

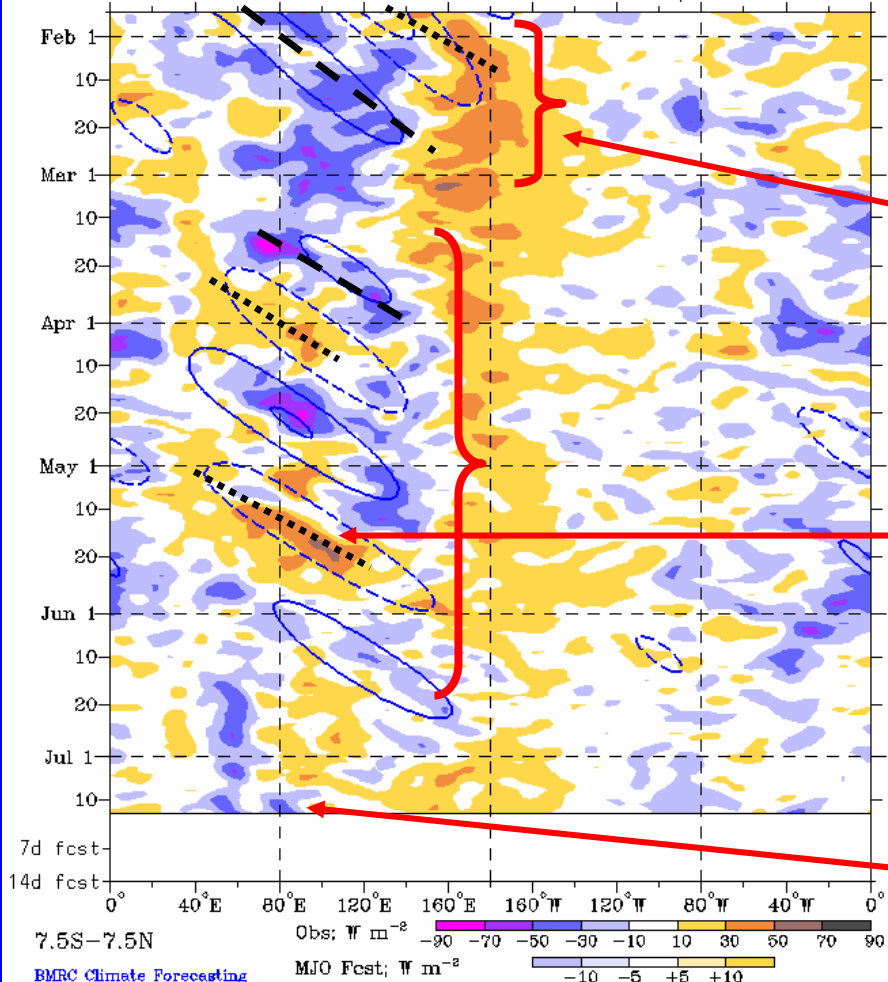
During early July, active convection developed across the eastern Pacific, Central America, Mexico into the southwest US in part associated with a very active North American monsoon.

Drier-than-average conditions have developed across much of the western Pacific in early July.



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

Real-time MJO filtering superimposed upon 3drn R21 OLR Anomalies
MJO anomalies blue contours, CINT=10. (5. for forecast)
Negative contours solid, positive dashed
27-Jan-2008 to 13-Jul-2008 + 14 days



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

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

(Courtesy of the Bureau of Meteorology - Australia)

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

MJO activity was evident from mid-March into early June at varying levels of intensity. The strongest MJO activity occurred as strong suppressed convection organized across the Indian Ocean and shifted eastward during mid-to-late May.

Convection has generally been near-average across much of the equatorial tropics during the past few weeks. Enhanced convection has recently shifted east across the western Indian Ocean.

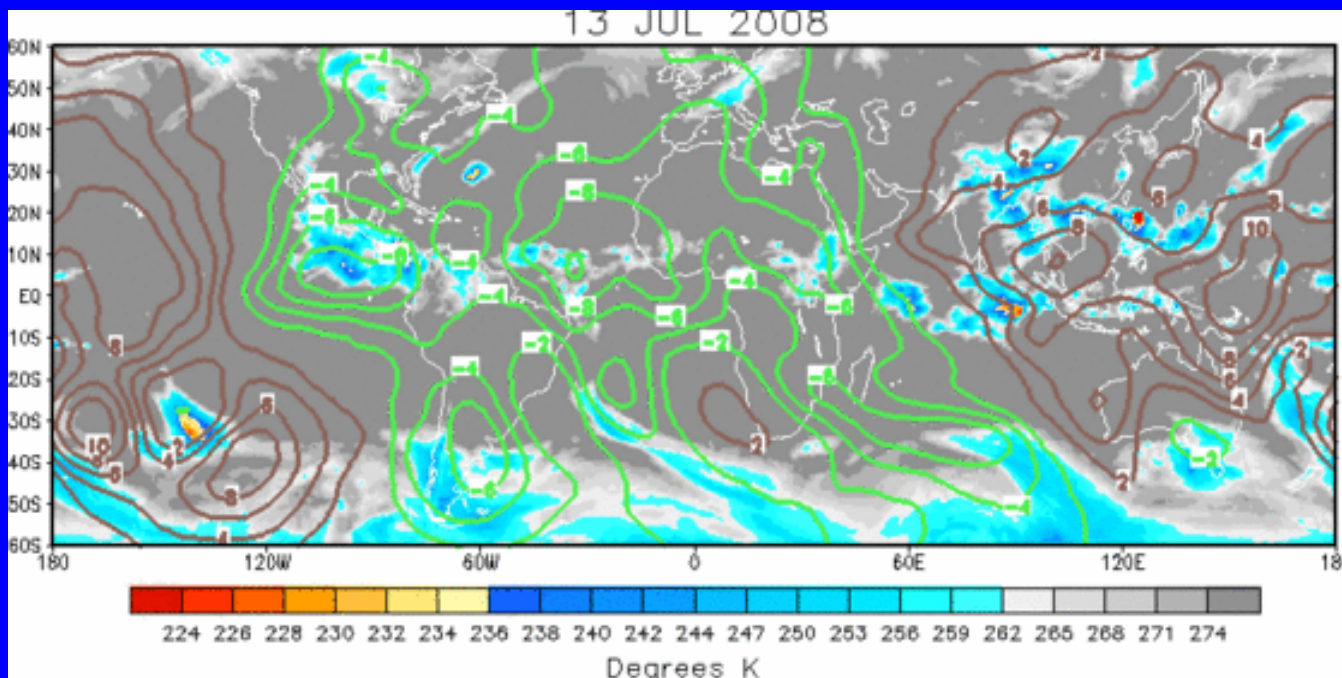
Longitude



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



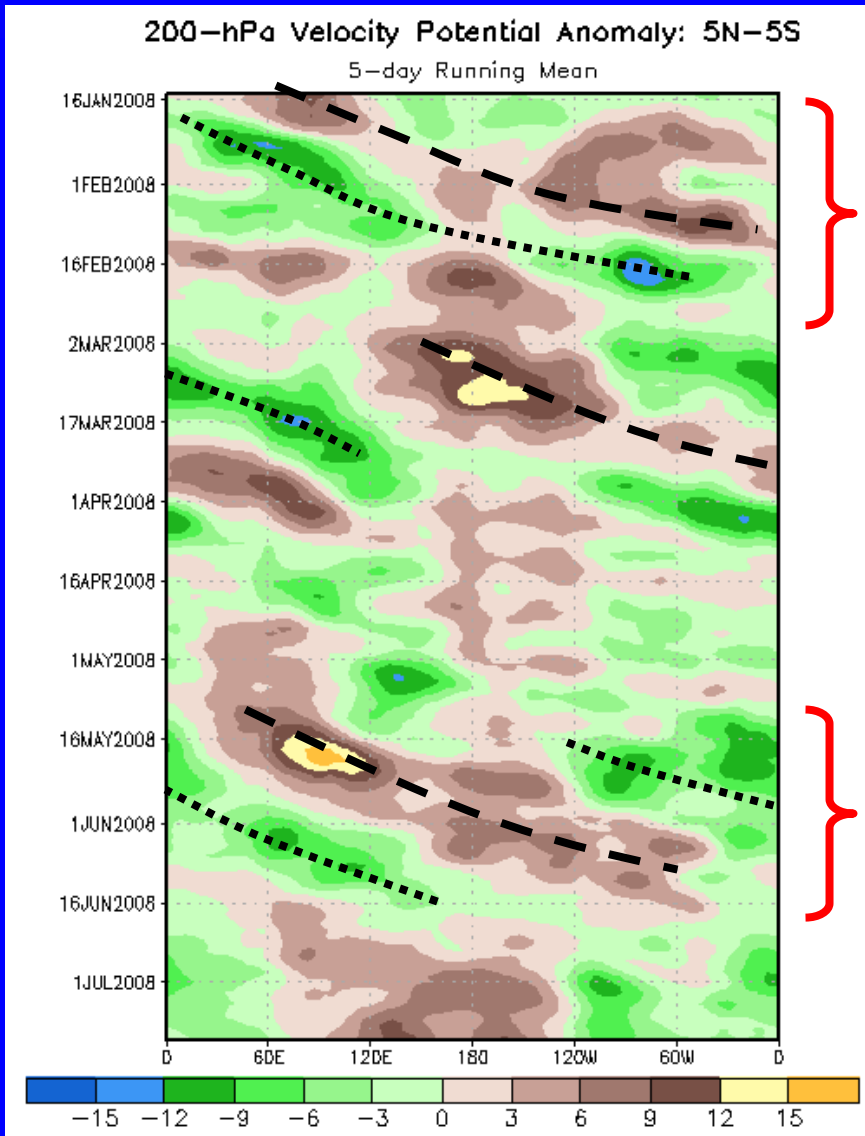
Strong and persistent upper-level divergence is evident across the eastern Pacific Ocean, Central America, and Mexico. An extensive area of upper-level convergence continues across parts of the Indian Ocean, Maritime Continent and western Pacific.



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



Moderate-to-strong MJO activity was evident during January to mid-February.

Weak MJO activity was evident during parts of March.

The MJO was largely incoherent during the month of April.

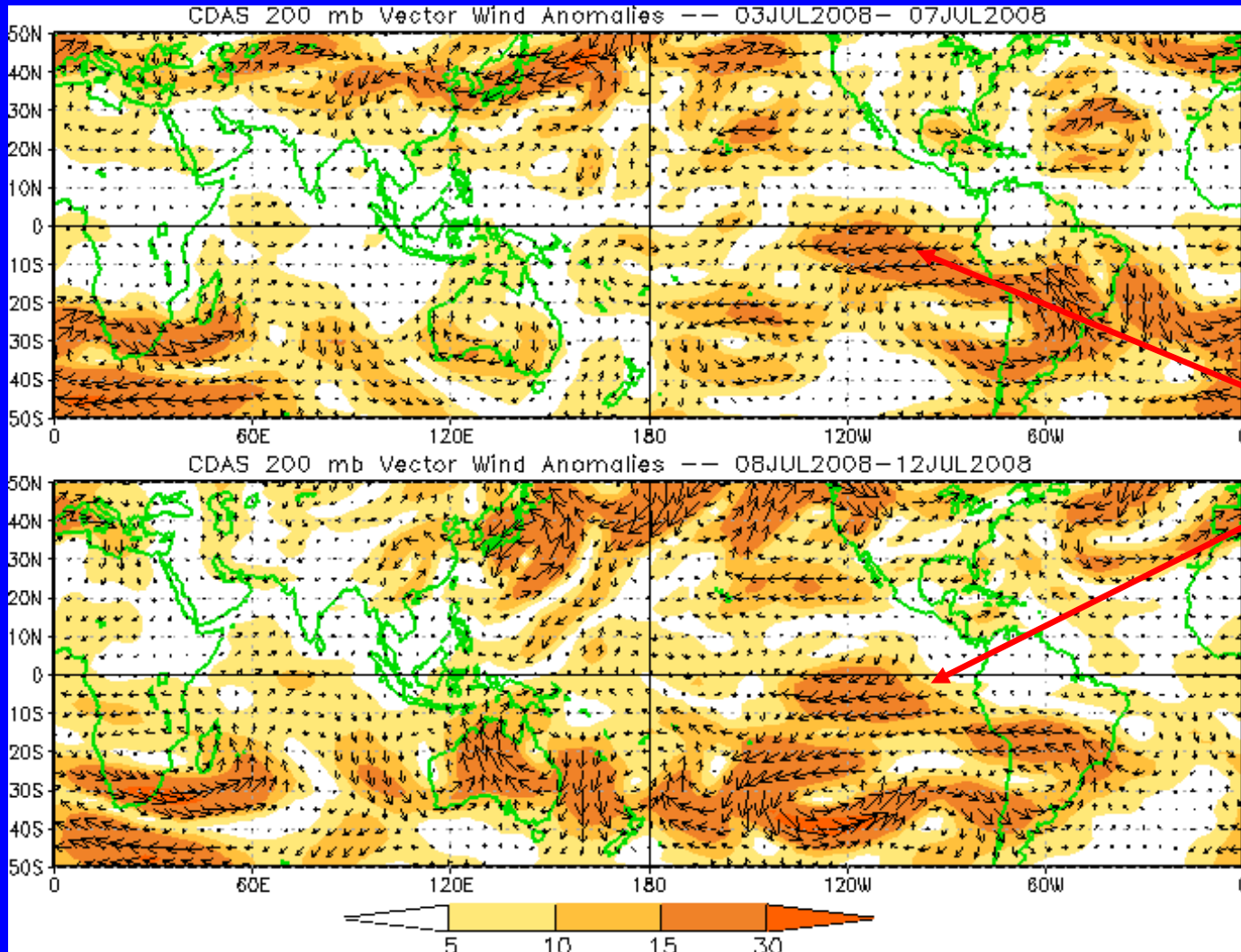
A moderate-to-strong MJO was observed from mid-May through mid-June.

Anomalies in velocity potential have become more stationary in nature during the last couple of weeks.



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

Note that shading denotes the magnitude of anomalous wind vectors

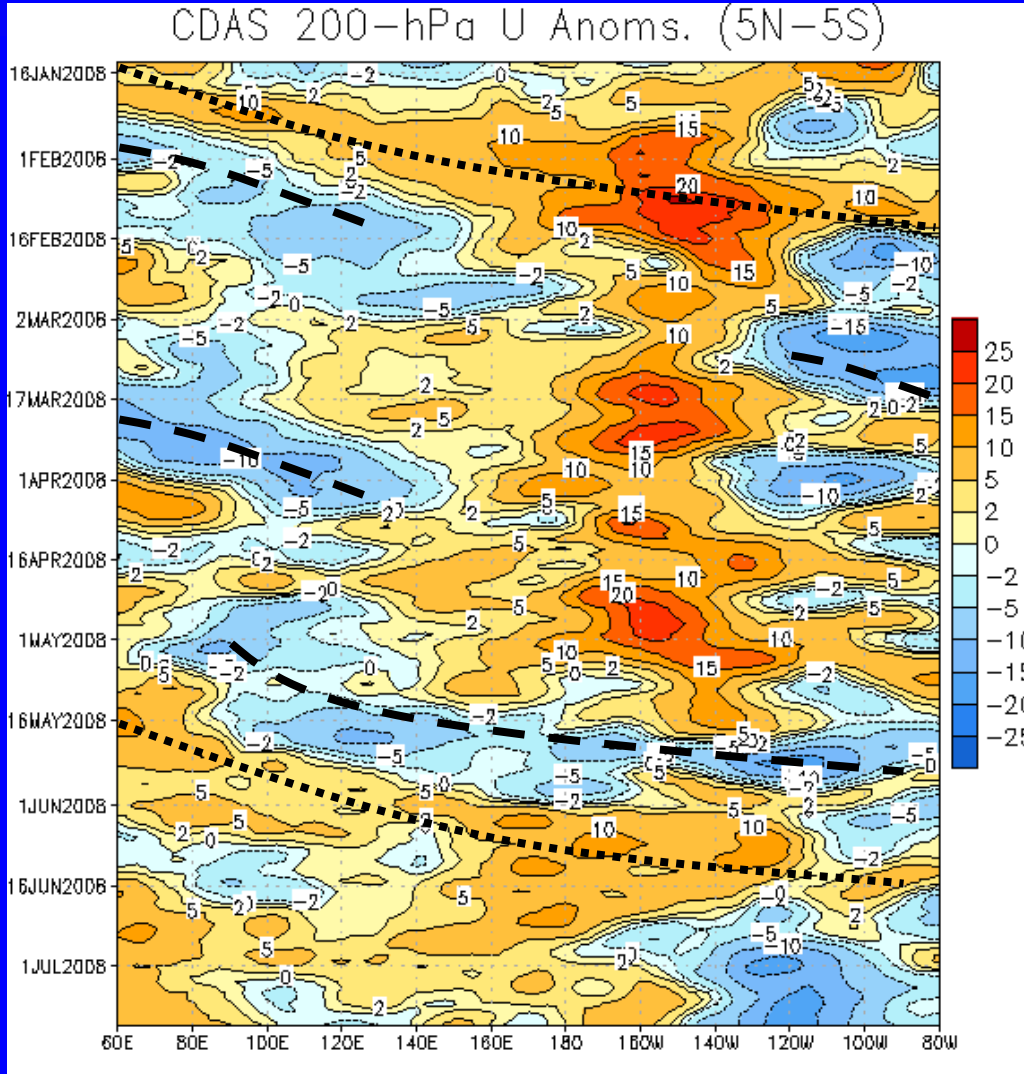


Equatorial easterly anomalies continue across the eastern Pacific Ocean.



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

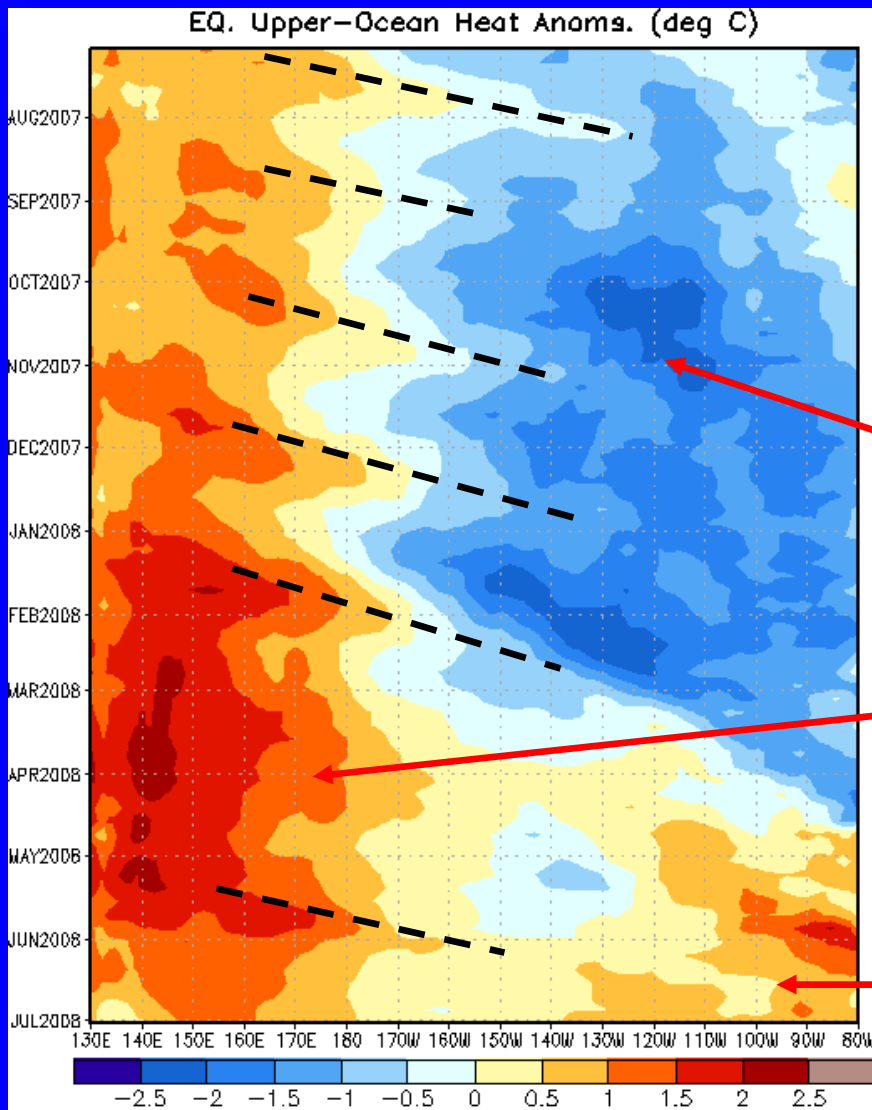
MJO activity is evident in the upper-levels by eastward propagation of easterly (westerly) anomalies by dashed (dotted) lines during January to mid-February.

During May and early June, eastward propagation was evident in the upper-level wind field and was associated with the MJO.



Weekly Heat Content Evolution in the Equatorial Pacific

Time
↓



Longitude

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

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.

Positive heat content anomalies now encompass the entire Pacific basin in part associated with a Kelvin wave initiated during May 2008.



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).

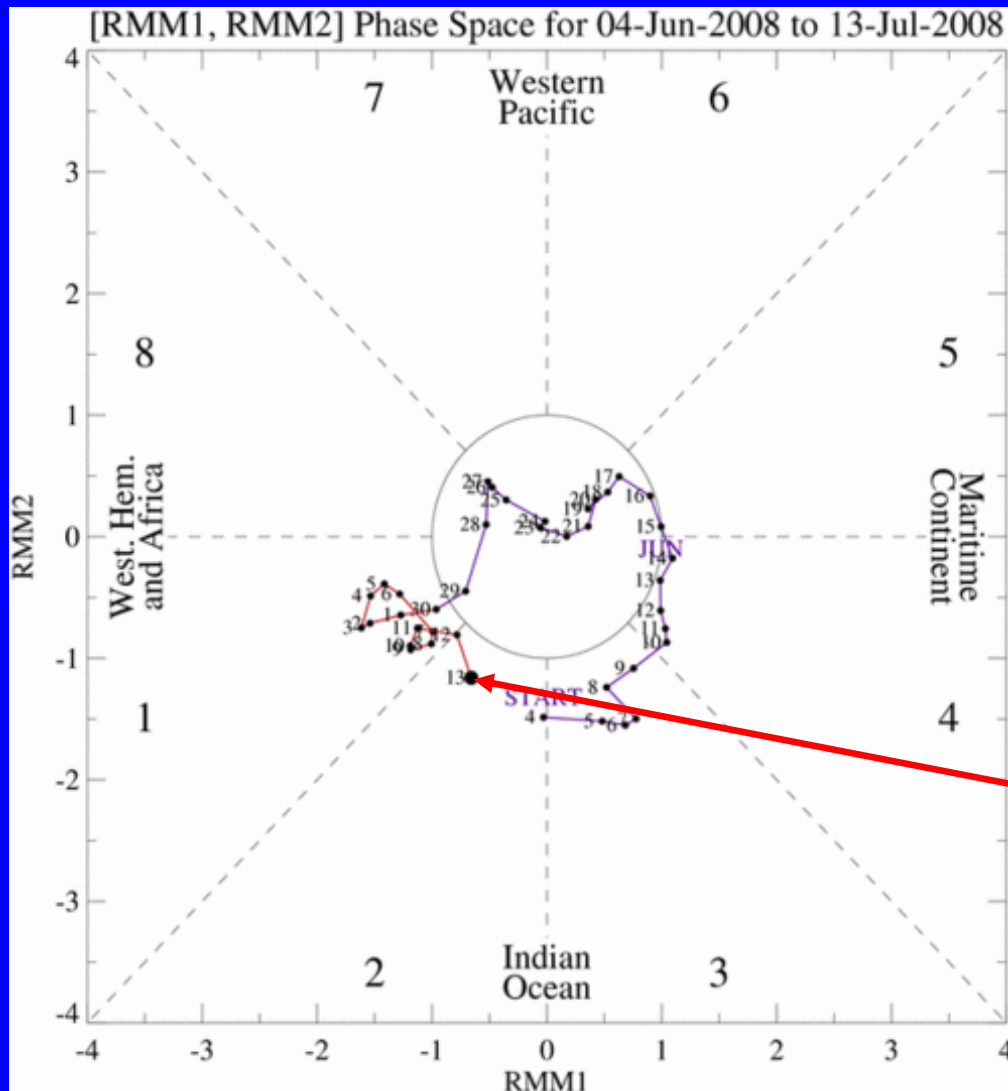
Wheeler M. and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction, *Monthly Weather Review*, 132, 1917-1932.

- 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

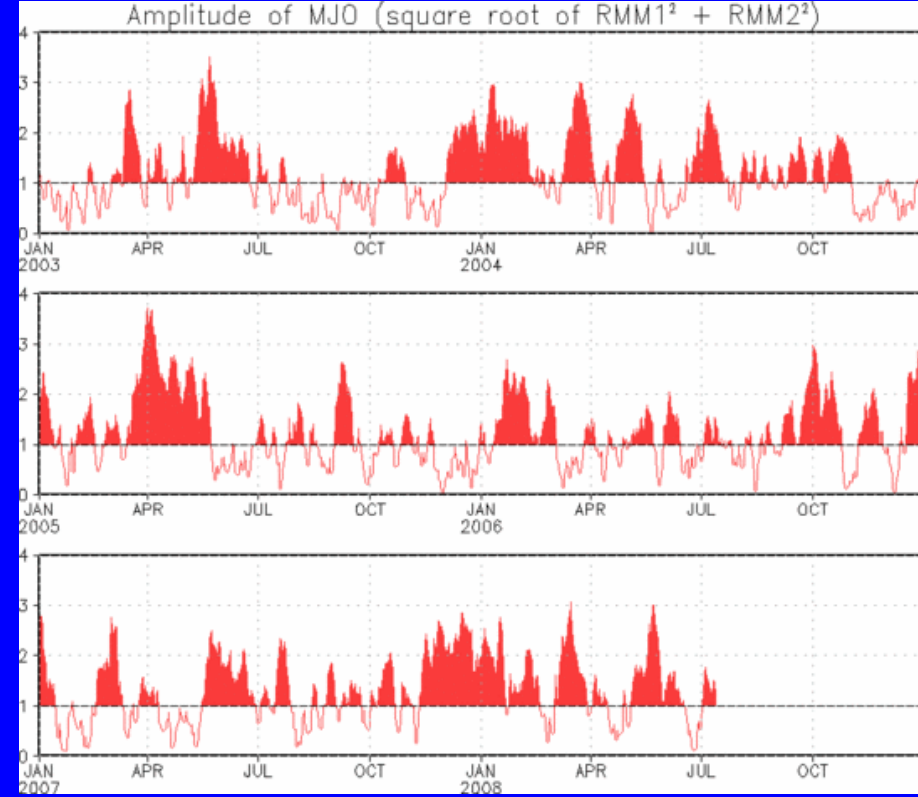
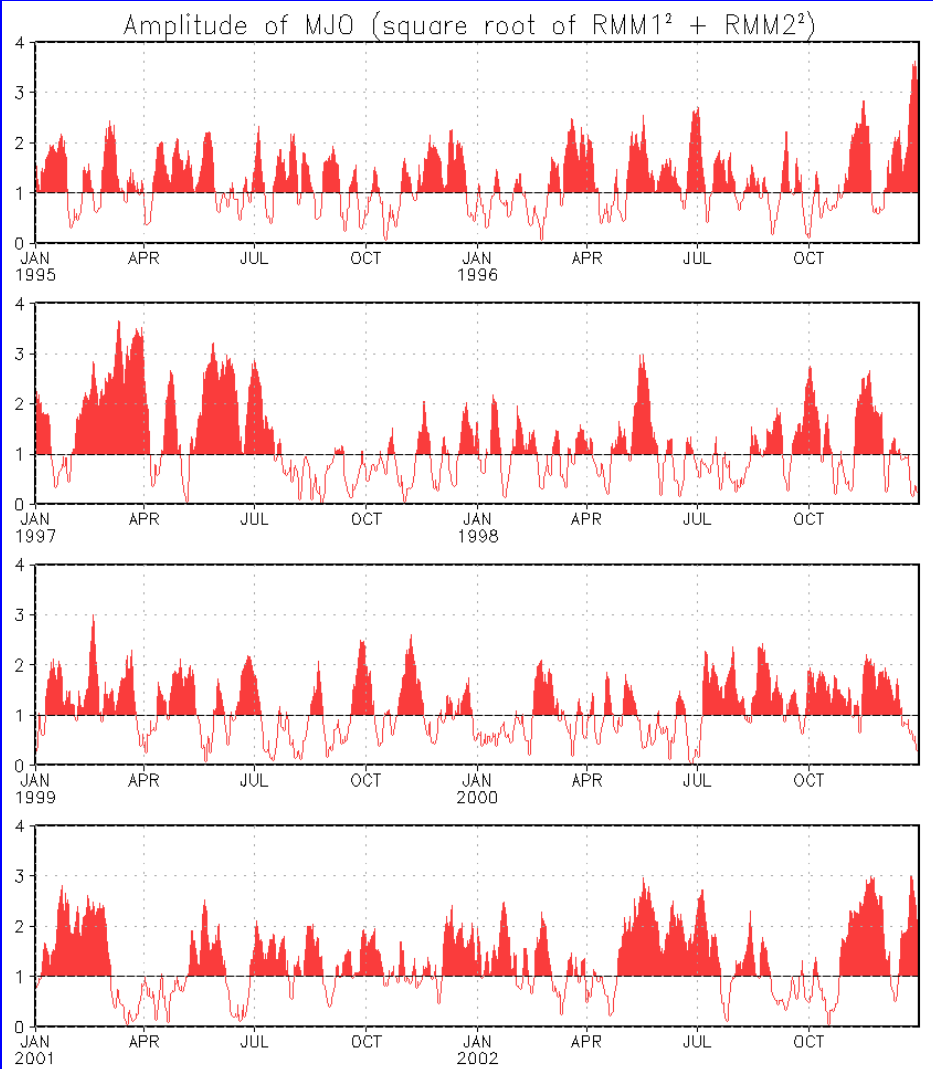
- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation
- Distance from the origin is proportional to MJO strength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



The MJO index has increased in amplitude during the past two weeks and an eastward propagation is now evident.



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

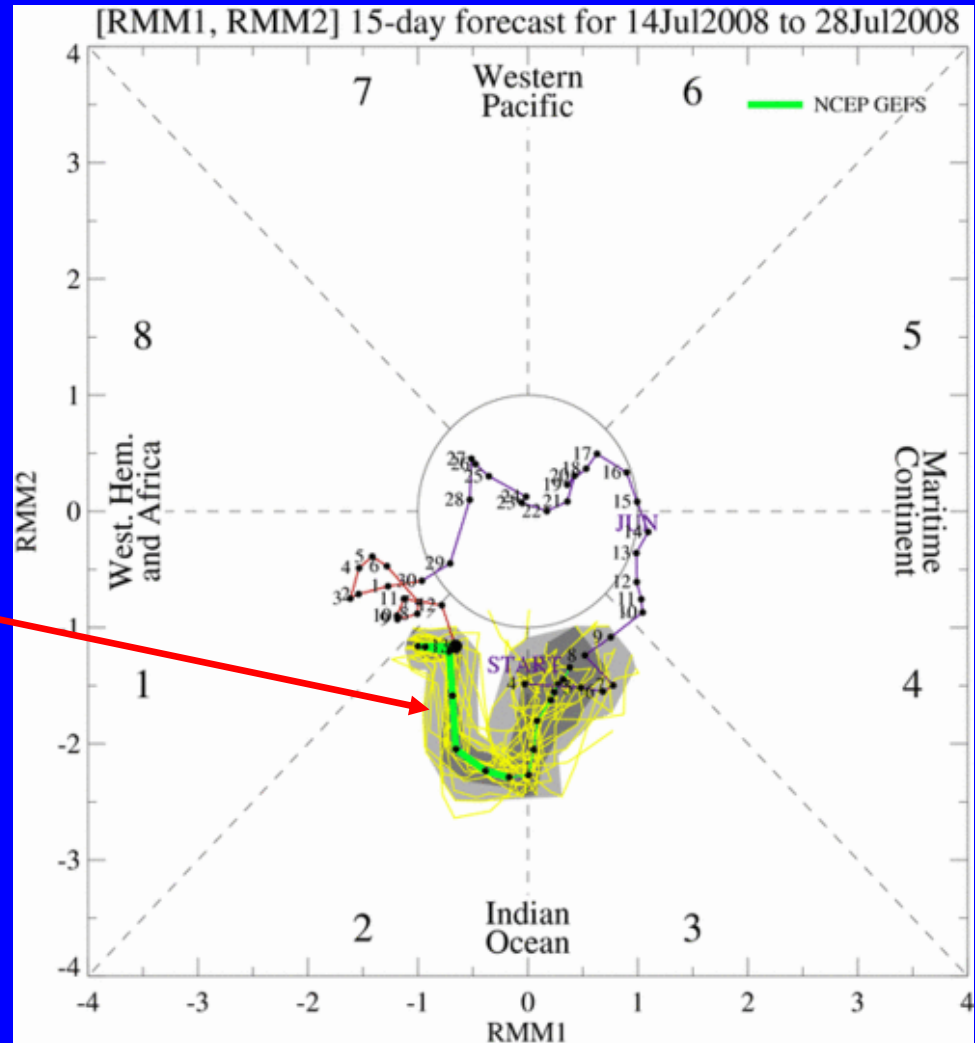
Yellow Lines – 20 Individual Members
Green Line – Ensemble Mean

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 an increase in the MJO signal during the next 1-2 weeks with some eastward propagation.

All forecast members indicate a shift across the Indian Ocean.



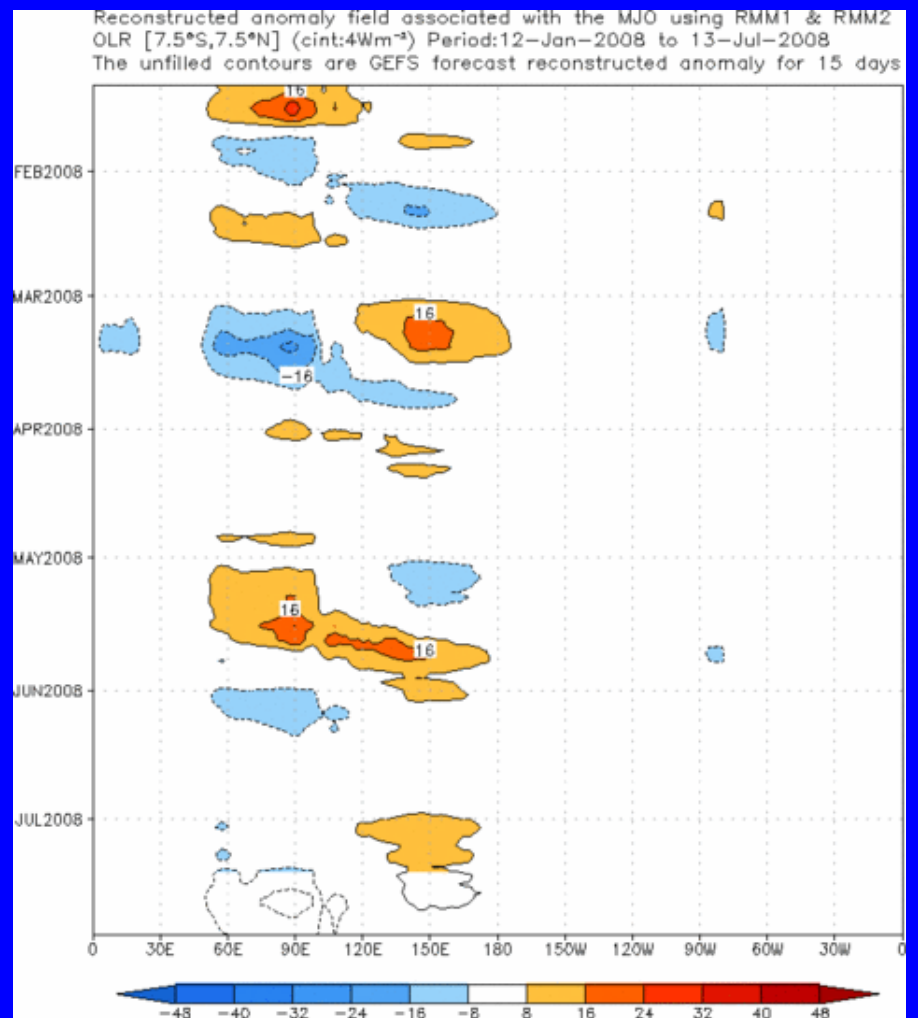
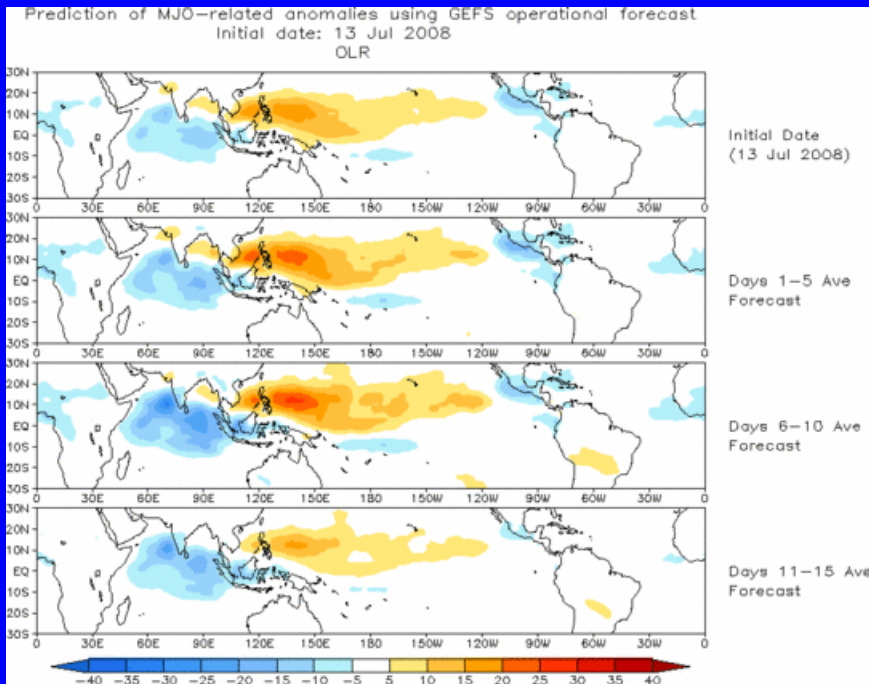


Ensemble Mean GFS MJO Forecast

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 ensemble mean GEFS indicates suppressed convection across the western Pacific with enhanced convection increasing across the Indian Ocean during the period.



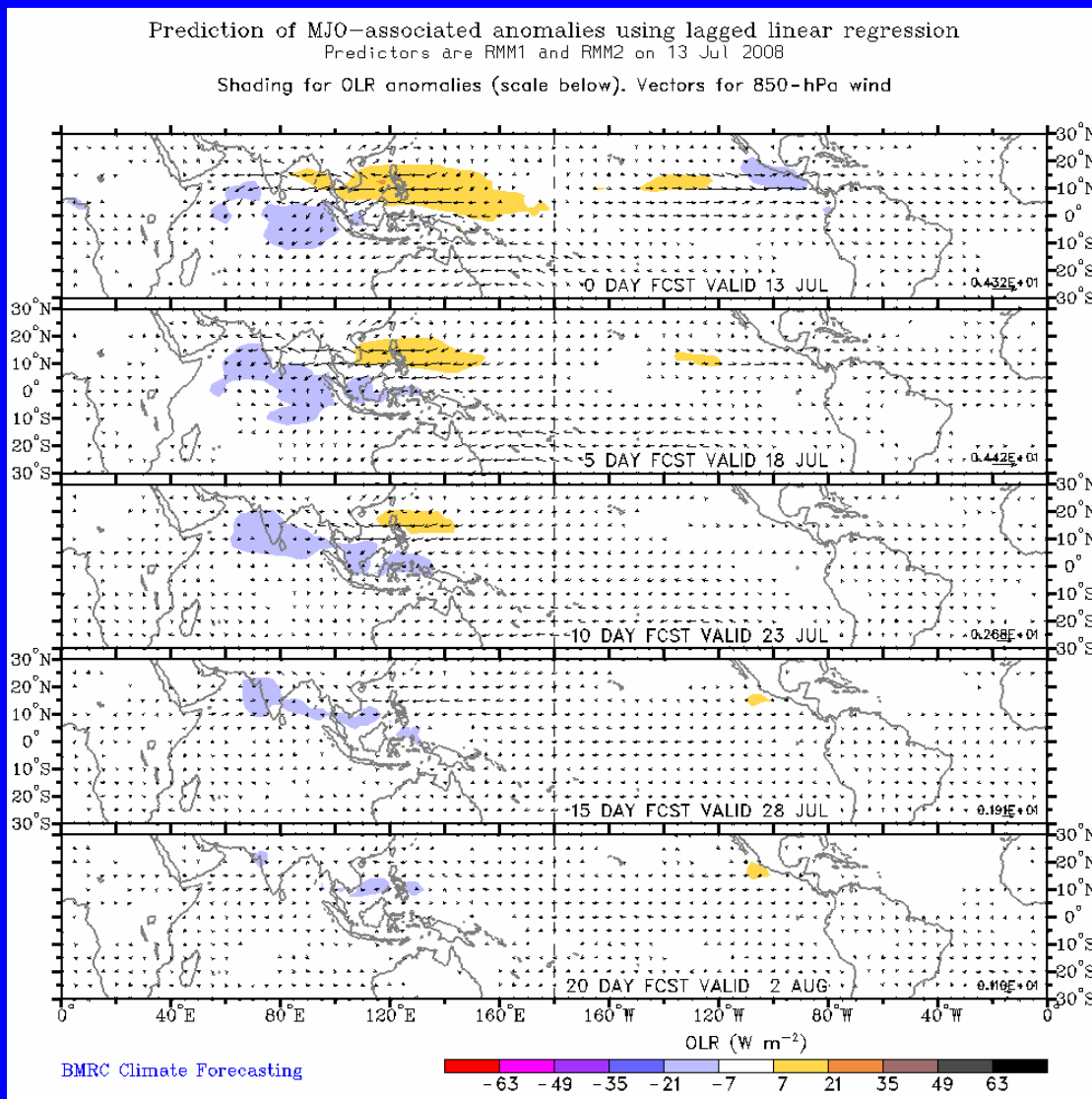
Statistical MJO Forecast

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-to-moderate MJO activity is forecast with dry conditions across the western Pacific and wet conditions shifting from the Indian Ocean into the Maritime Continent during the period.





MJO Composites – Global Tropics

Precipitation Anomalies (May-Sep)

850-hPa Wind Anomalies (May-Sep)

