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

Update prepared by
Climate Prediction Center / NCEP
February 25, 2008

Outline

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

Overview

- **The MJO has weakened during the past week.**

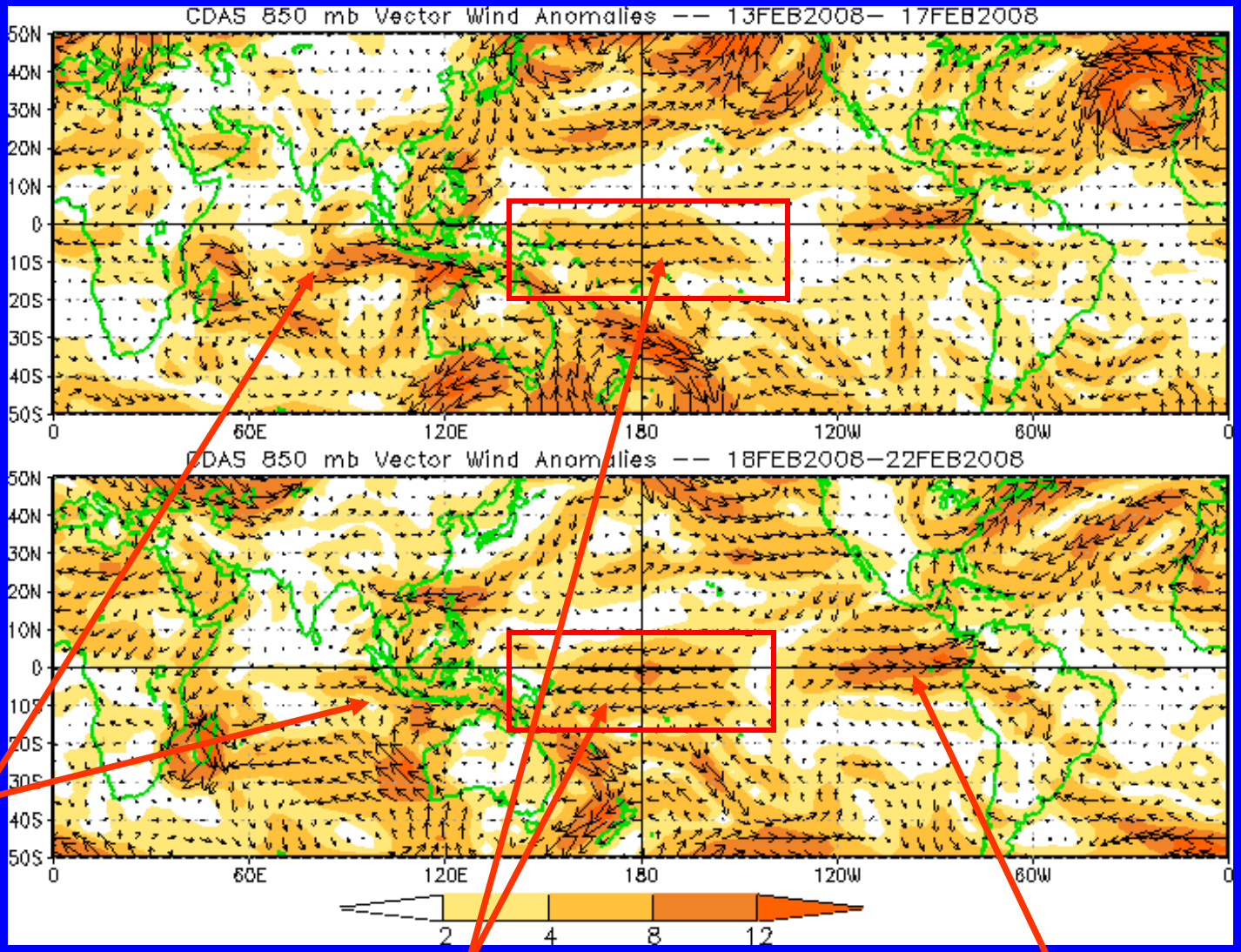
- **Recent observations and forecast tools point towards weak MJO activity during the upcoming week. During week 2, however, the potential exists for more coherent MJO activity as indicated by dynamical model forecast tools.**

- **Enhanced tropical rainfall across the global tropics is expected to position across the Indian Ocean and western Maritime continent over the period due to the combined influence of La Nina and the MJO.**

- **For the US during week 1, ridging is favored along the US West Coast with troughing across the eastern US. This pattern is anticipated to shift westward during week 2 resulting in frequent troughing across the western US. Interests across the Plains and Midwest should monitor the potential for an active storm track during weeks 2-3.**

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

Note that shading denotes the magnitude of anomalous wind vectors



Westerly anomalies are now mainly located across the eastern Indian Ocean and Maritime continent and have decreased across the rest of the Indian Ocean.

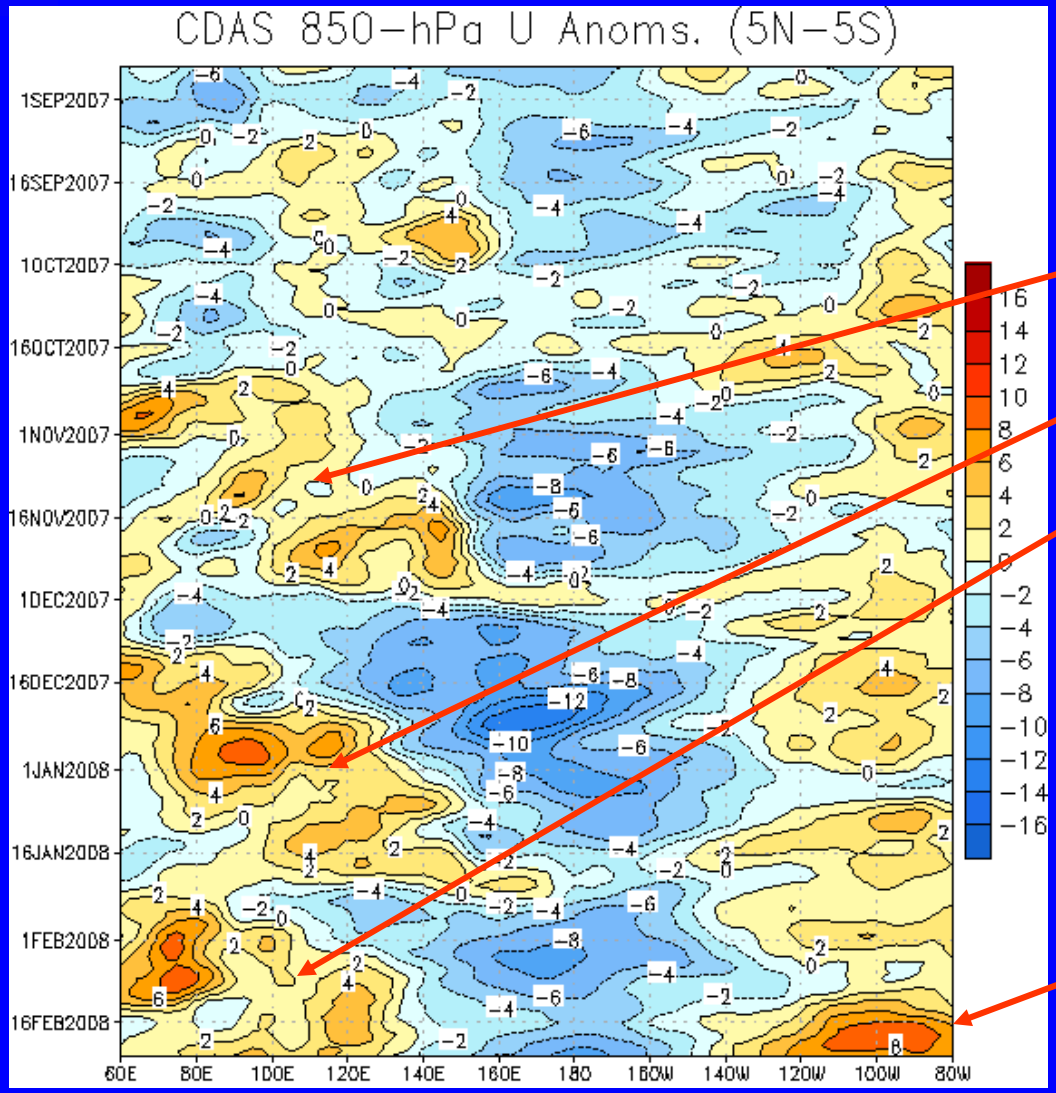
Easterly anomalies continue across the western Pacific.

Large westerly anomalies have developed across the eastern Pacific 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

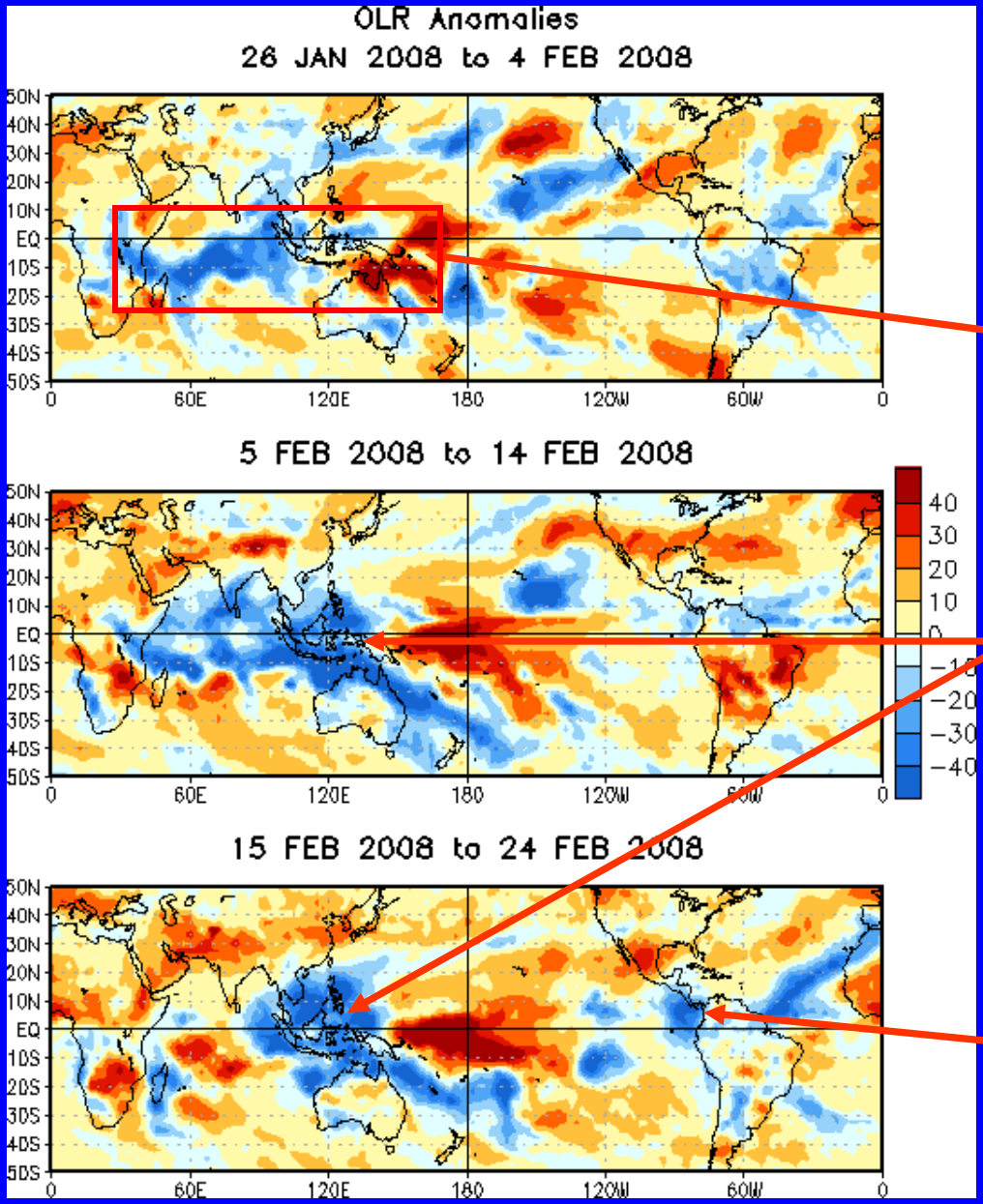
Longitude

Moderate-to-strong MJO activity has been evident since late October 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 December, mid-January and mid-February.

The period of the MJO activity has decreased during 2008.

Large westerly anomalies are evident across the eastern Pacific during the last week.

OLR Anomalies: Last 30 days



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

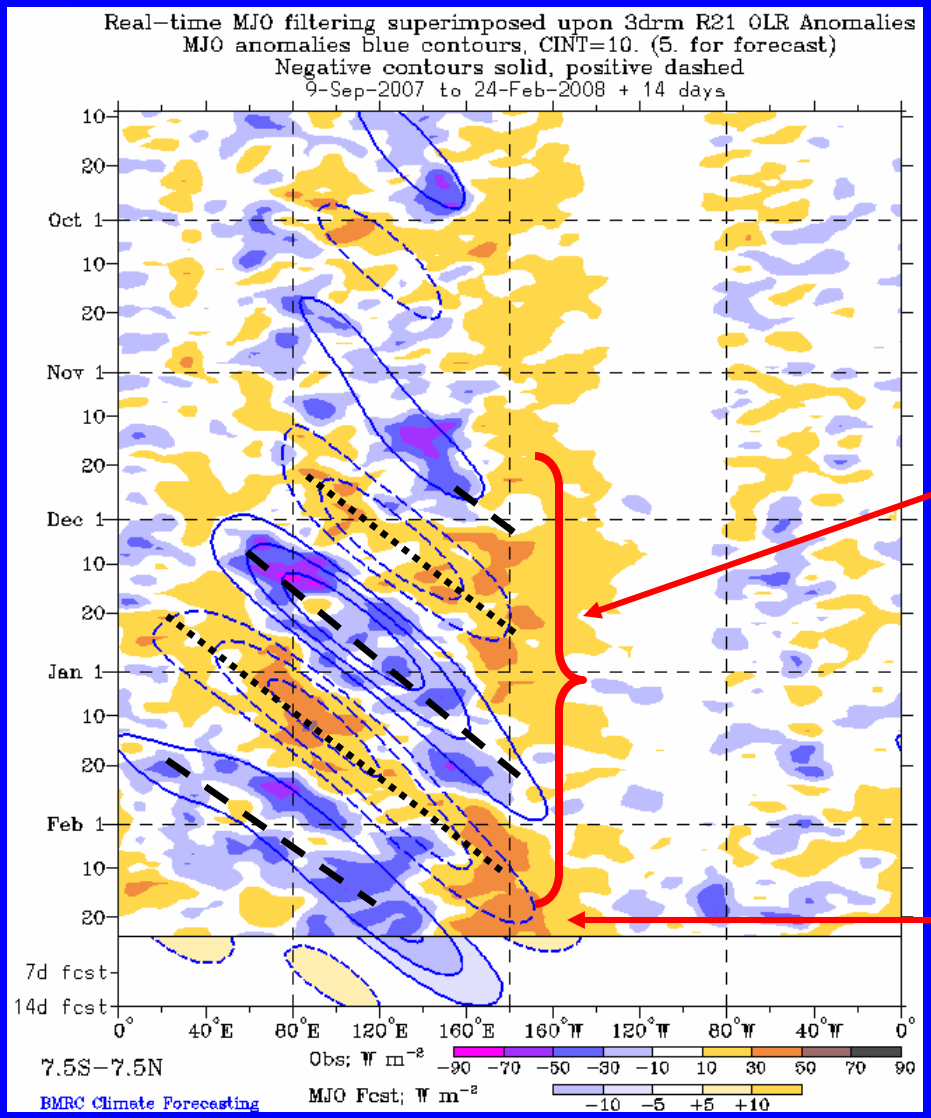
Wetter-than-normal conditions, negative OLR anomalies (blue shading)

Dry conditions were observed across eastern Indonesia and northern Australia during late January and early February while wet conditions re-entered the Indian Ocean.

As the MJO propagated eastwards, enhanced rainfall once again developed across Indonesia and Australia by mid-February. Dry conditions prevailed across much of the western Pacific.

Enhanced convection is recently evident across the eastern Pacific.

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



Time

Longitude

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

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

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

Moderate-to-strong MJO activity has been evident since November and is shown by coherent eastward propagation of enhanced (suppressed) convection indicated by the dashed (dotted) lines.

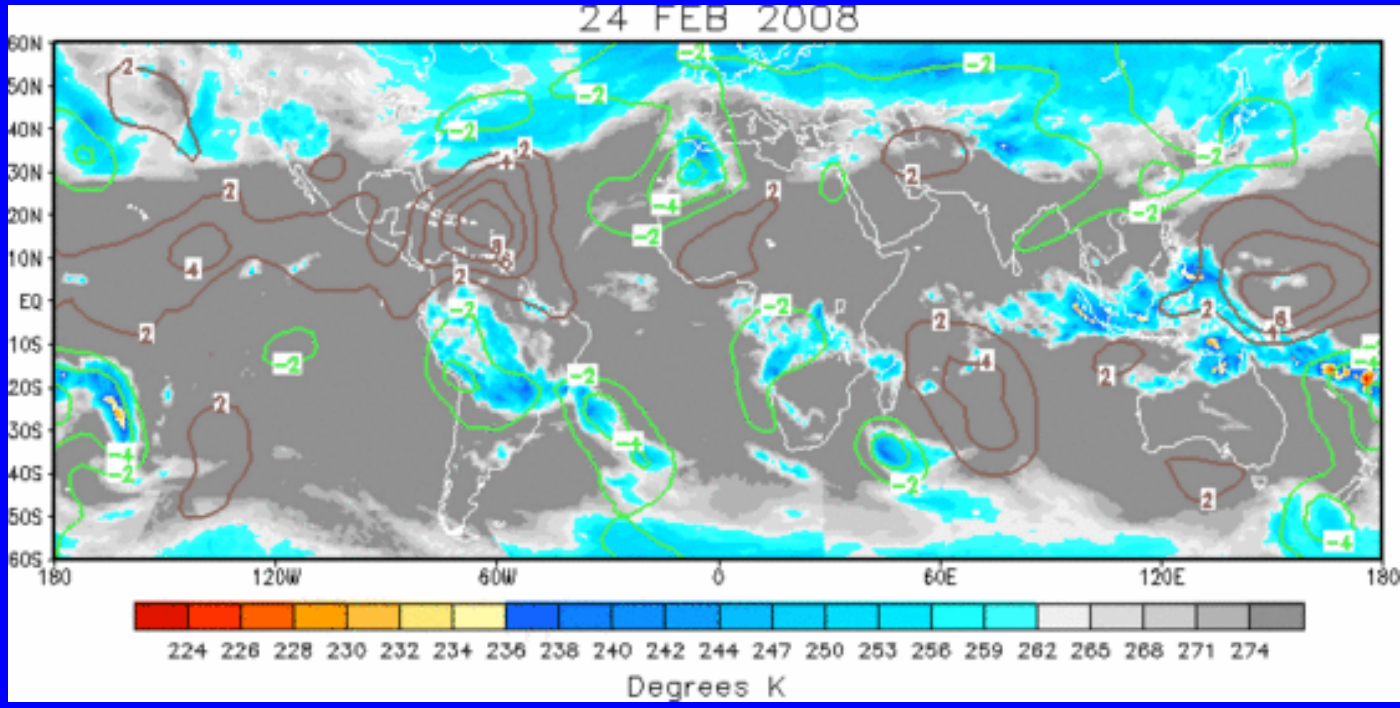
Considerable intraseasonal variability is also evident across the western hemisphere during this period.

Equatorial anomalous convection across Indonesia and the western Pacific has become more stationary in nature during mid-late February.

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

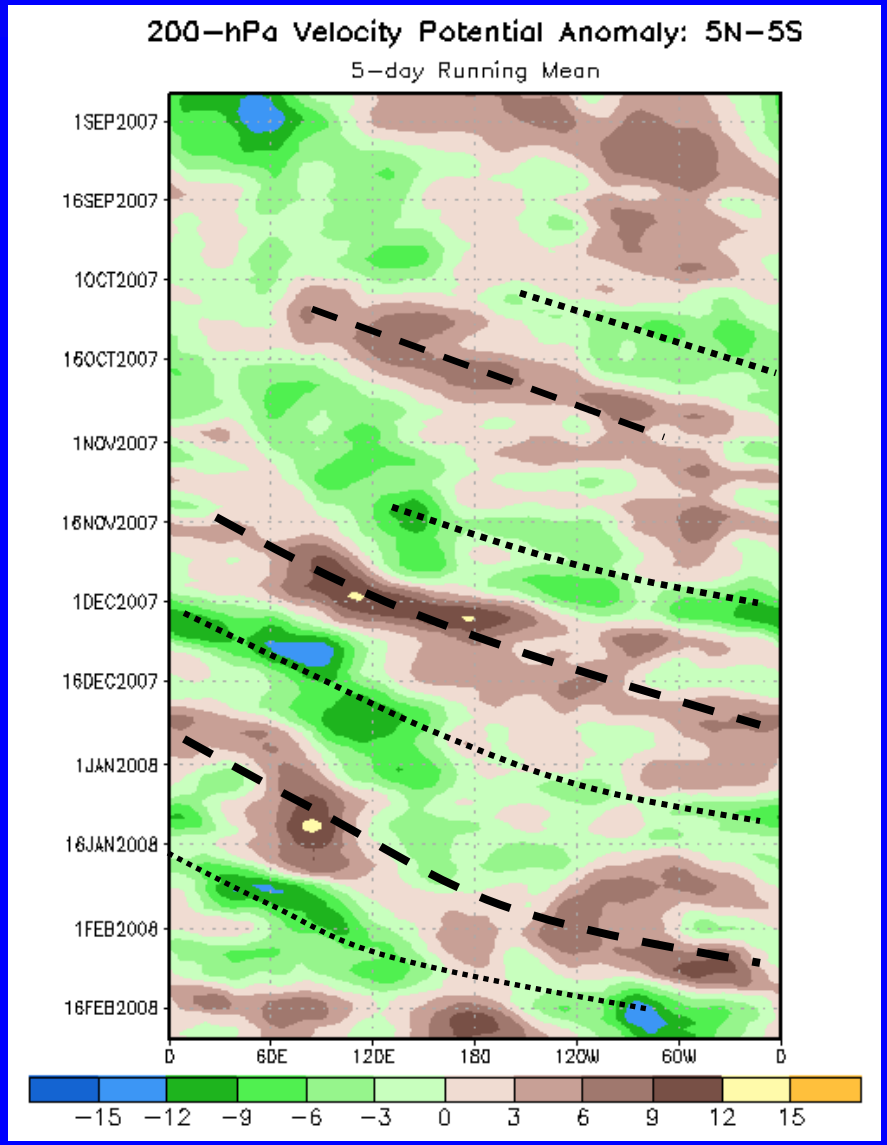


The current global velocity potential anomalies indicate a much more fragmented pattern. Upper-level divergence continues across parts of South America.

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

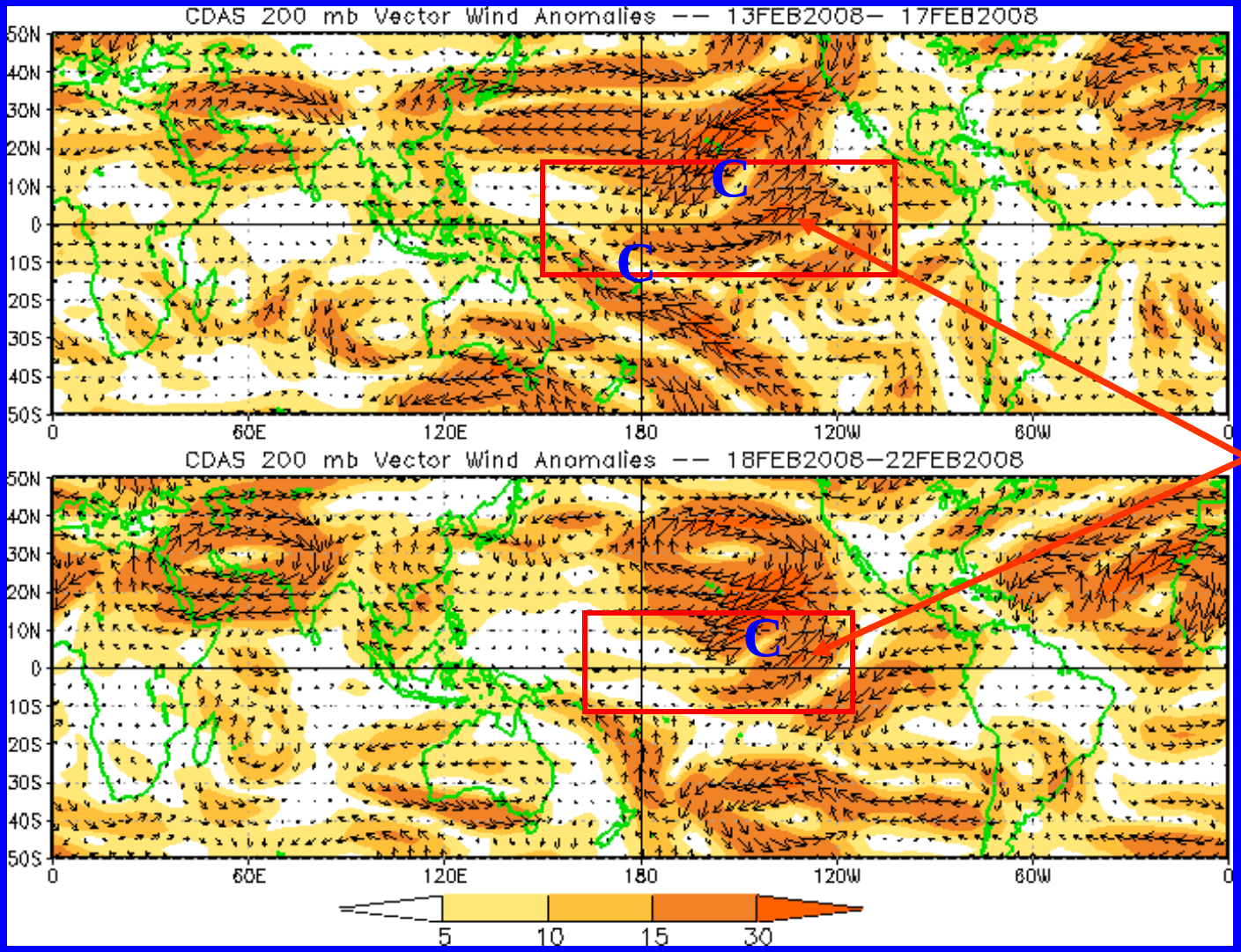
The MJO was weak or incoherent during much of August and September.

The MJO strengthened during October but coherent propagation was short-lived.

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

The MJO has become less organized during the last week as velocity potential anomalies have decreased in some equatorial regions and eastward propagation is not as clear.

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

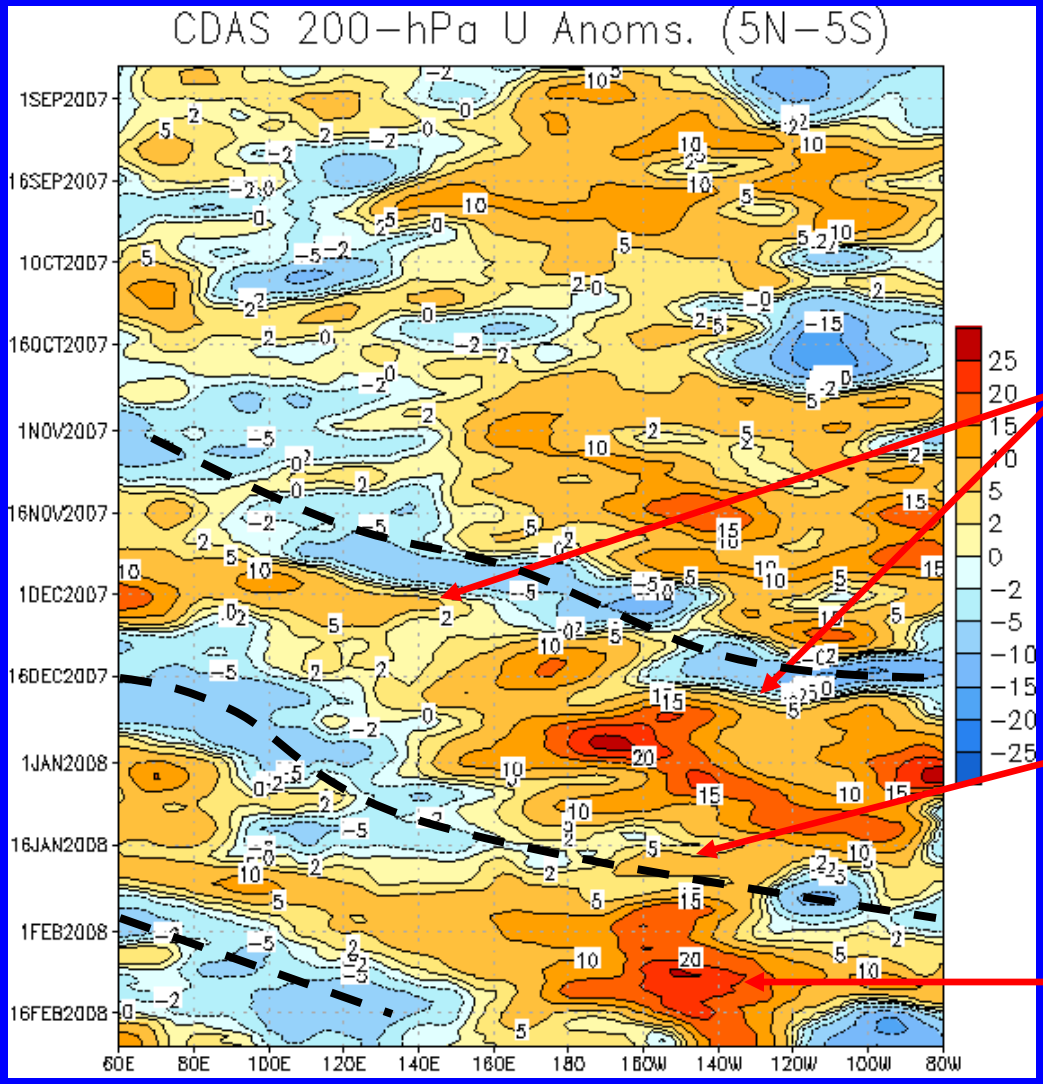


Note that shading denotes the magnitude of anomalous wind vectors

The pattern has become less defined during the last five days.

Westerly anomalies have decreased across the central Pacific Ocean with the cyclonic (C) circulations less distinct in some areas.

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



Time

Longitude

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

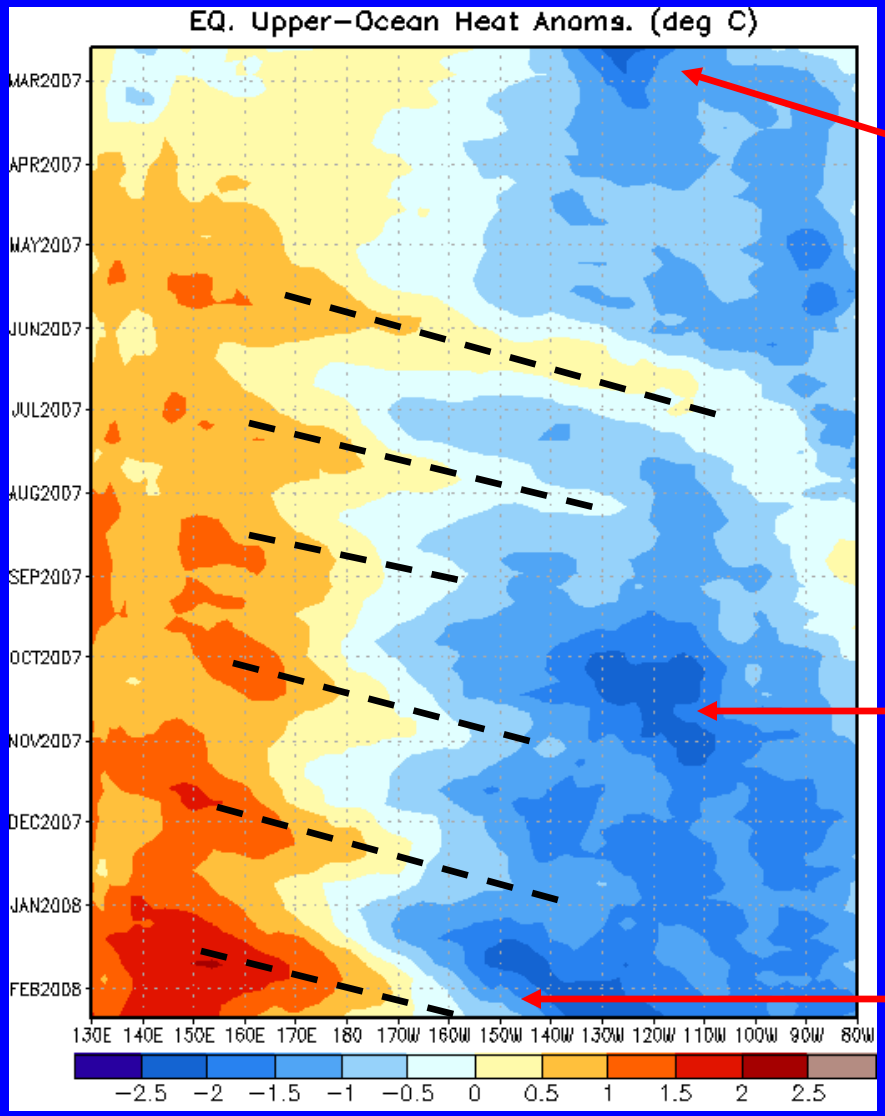
Easterly anomalies (blue shading) represent anomalous east-to-west flow

Cycle 1 of the ongoing MJO activity is evident in the upper-levels by eastward propagation of easterly anomalies globally from early November to mid-December.

MJO cycle 2 signal was somewhat weaker especially as it shifted across the central Pacific Ocean due to the strengthening La Nina.

During early February, both the MJO and La Nina contributed to strong westerly anomalies between 160°W – 130°W.

Weekly Heat Content Evolution in the Equatorial Pacific



Time

Longitude

Beginning in February, negative heat content anomalies developed across the eastern equatorial Pacific and continued until June 2007.

Kelvin wave activity (downwelling phases indicated by dashed lines) has been observed since May and has affected the sub-surface temperature departures at varying degrees across the Pacific Ocean. The strongest wave occurred during May and June.

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

Most recently, increasingly positive anomalies have developed across the western Pacific and have shifted eastward associated with the latest downwelling Kelvin wave.

MJO Index -- Information

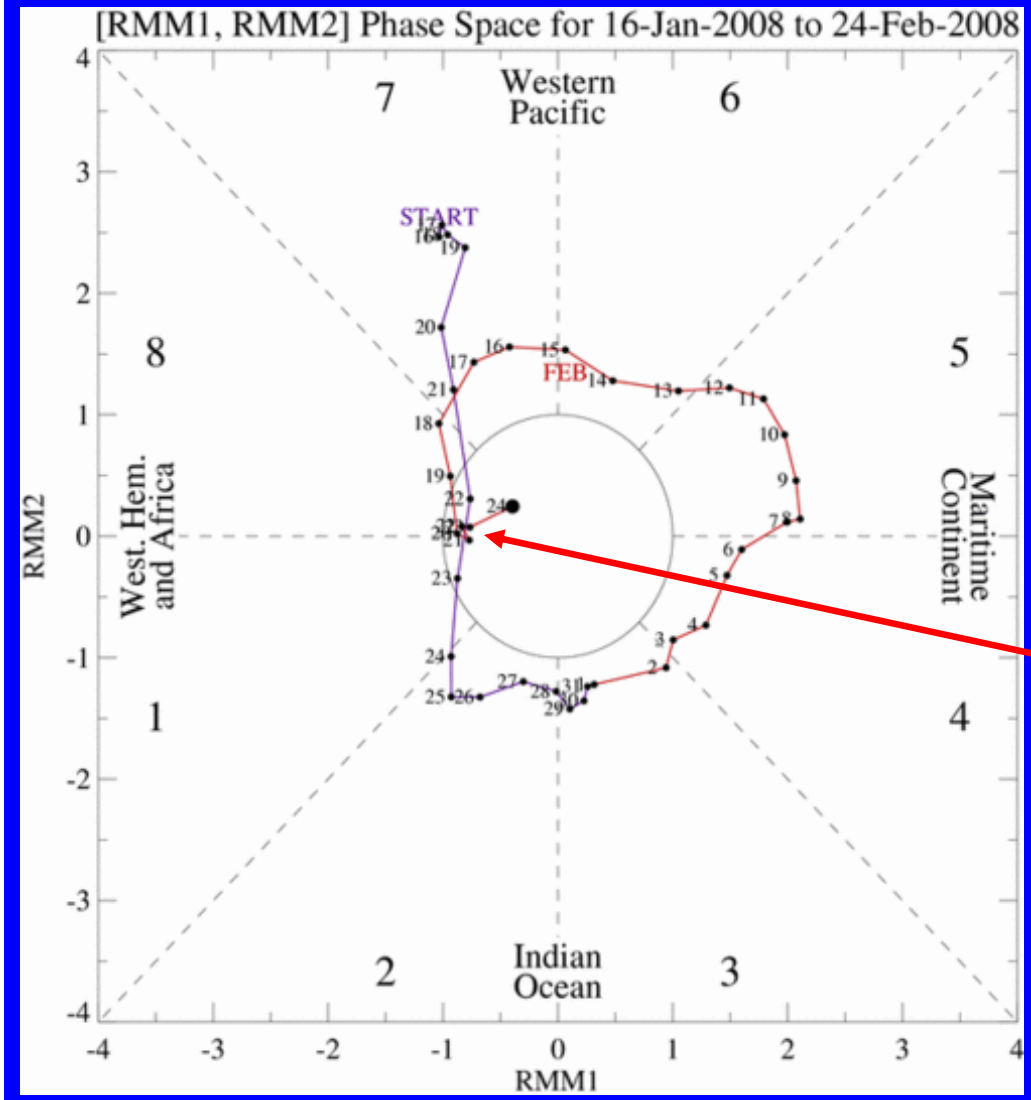
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

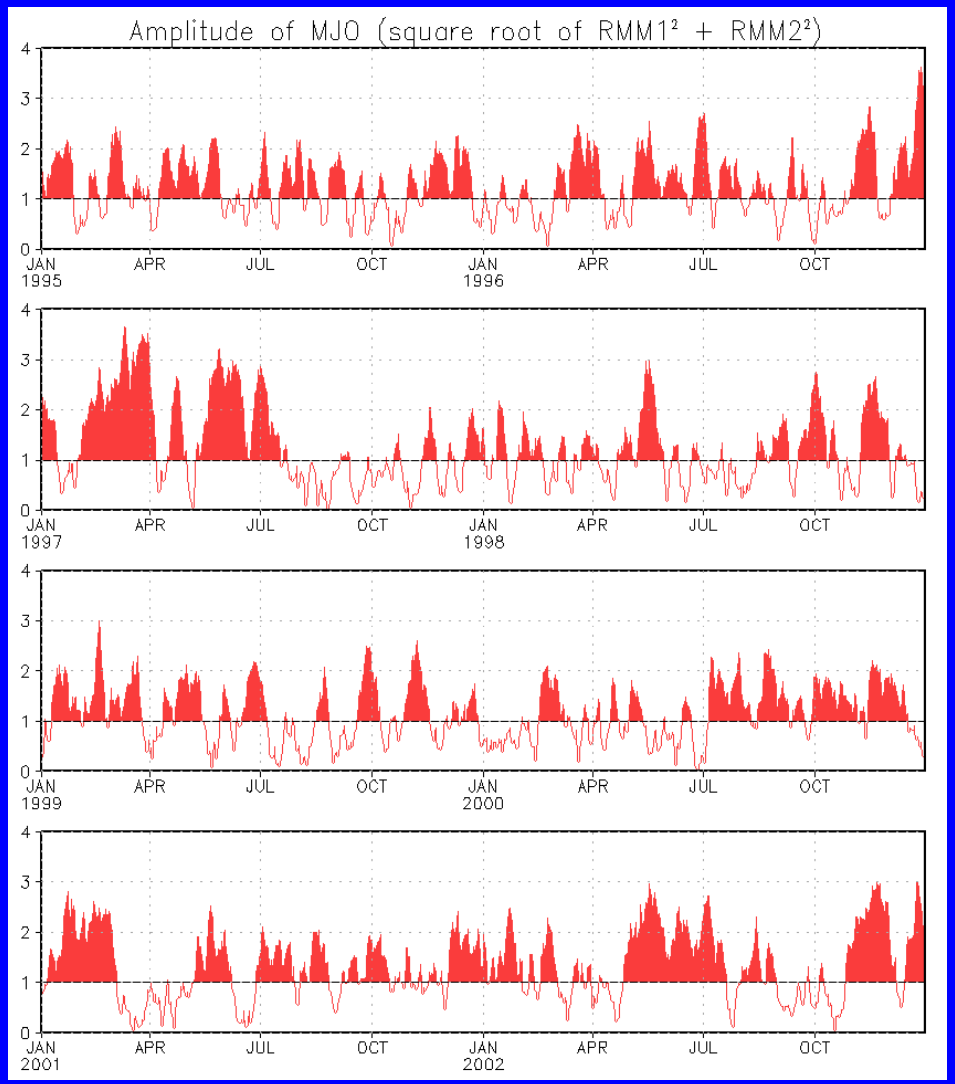
MJO Index -- Recent Evolution

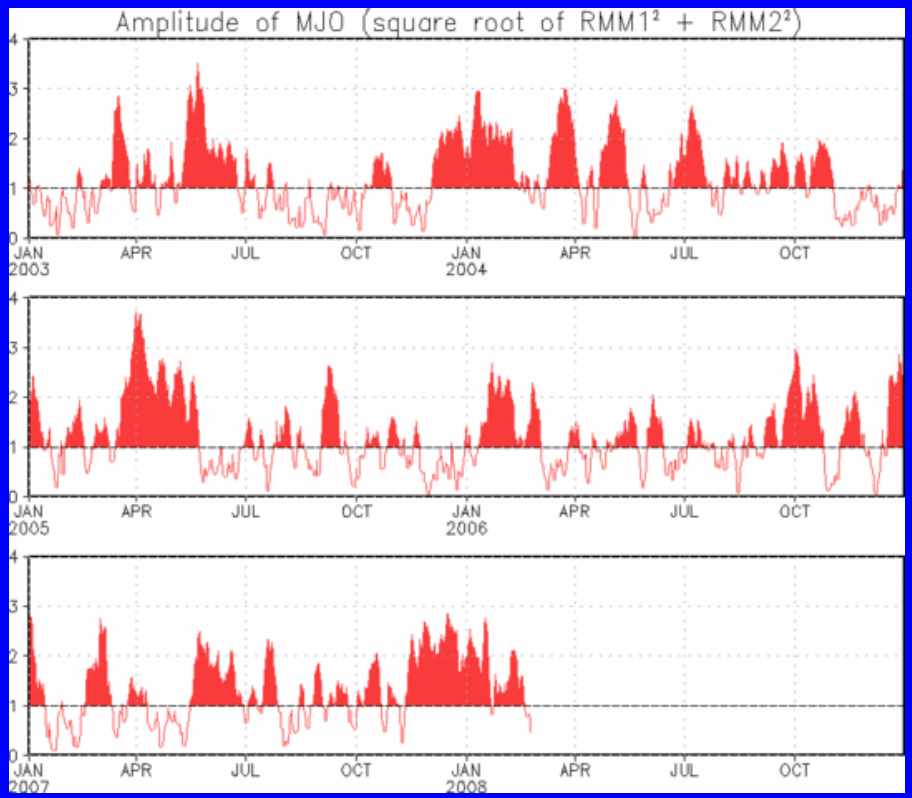


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation
- Distance from the origin is proportional to MJO strength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

The MJO signal has propagated into the western hemisphere but has decreased in strength. Little eastward propagation is evident in recent days.

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

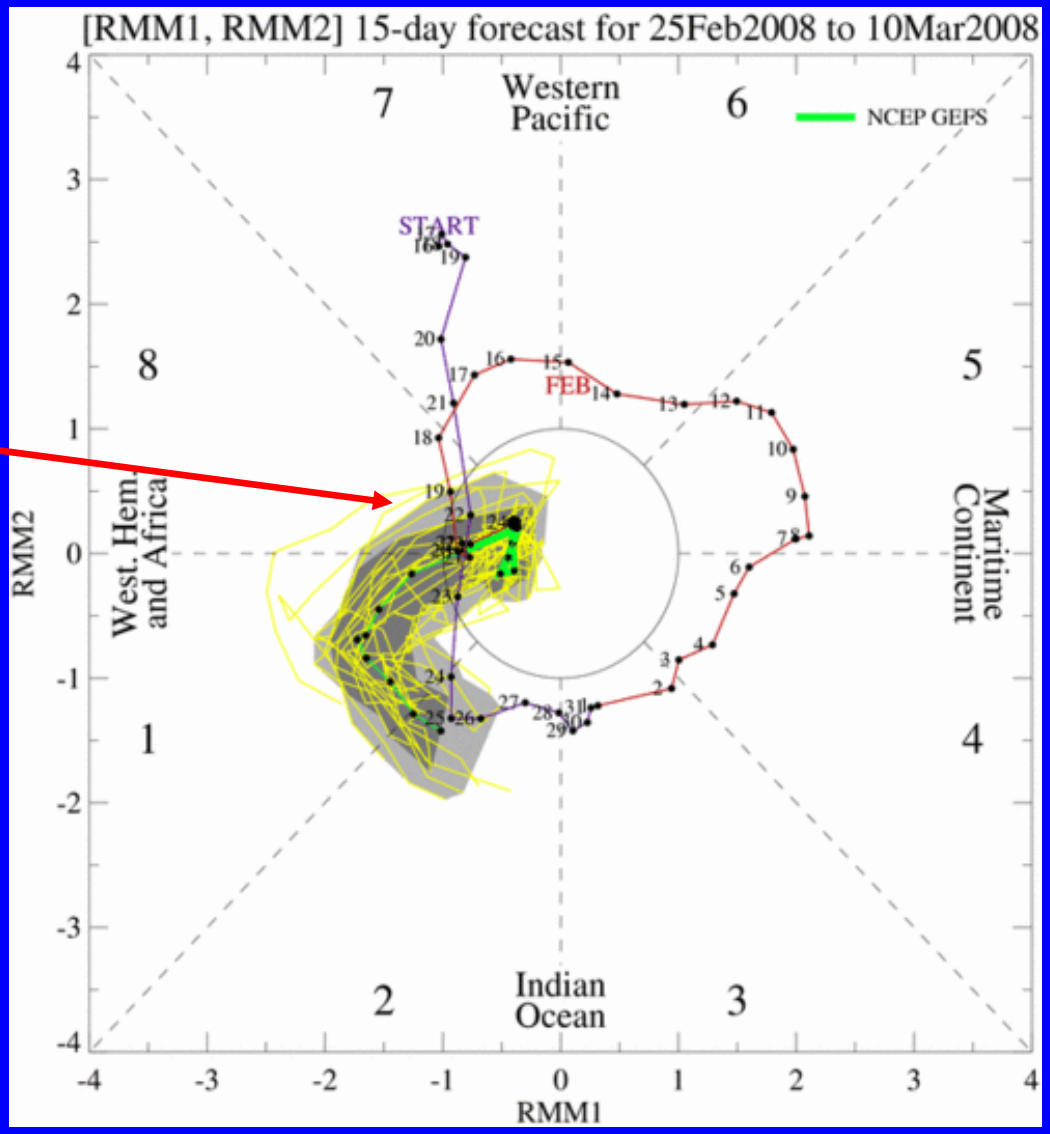
Yellow Lines – 20 Individual Members
Green Line – Ensemble Mean

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 ensemble mean predicts a generally weak MJO signal with no eastward propagation during the next week.

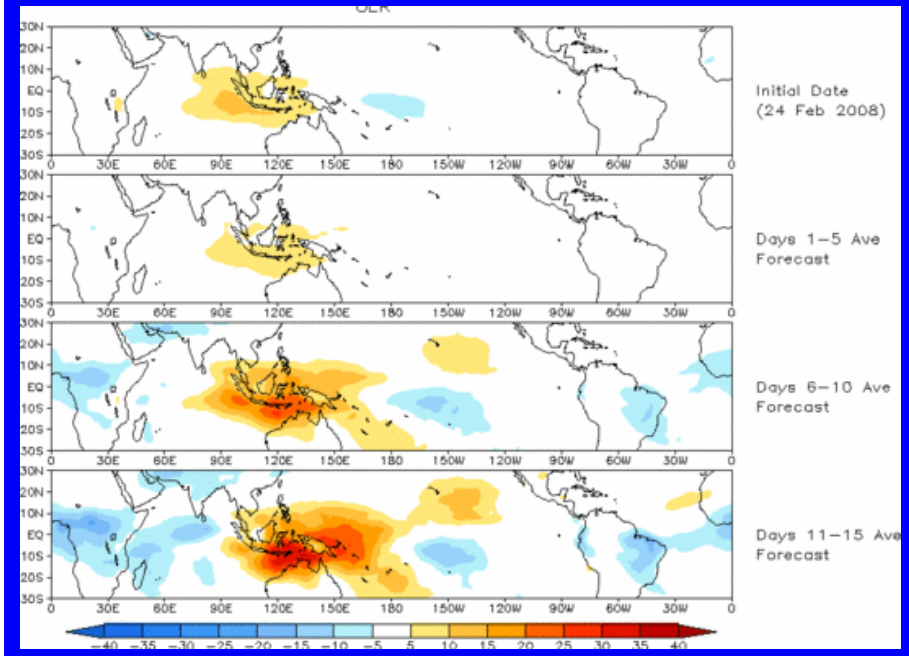
Considerable uncertainty exists in the individual ensemble members during week 2. Some forecasts indicate renewed propagation at a greater amplitude.



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)

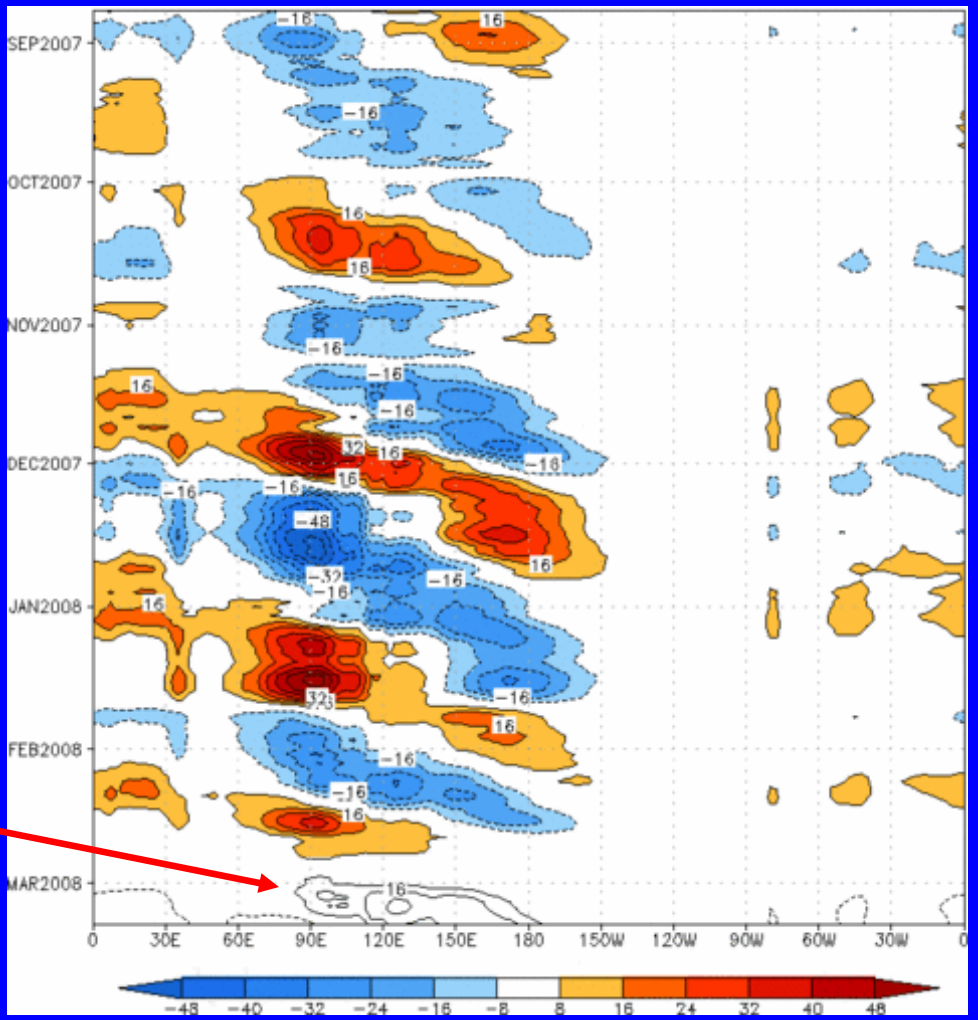
Spatial map of OLR anomalies for the next 15 days



The contribution from the MJO is expected to be minimal during week 1 based on the GEFS forecast.

Some eastward propagation is expected by week 2.

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



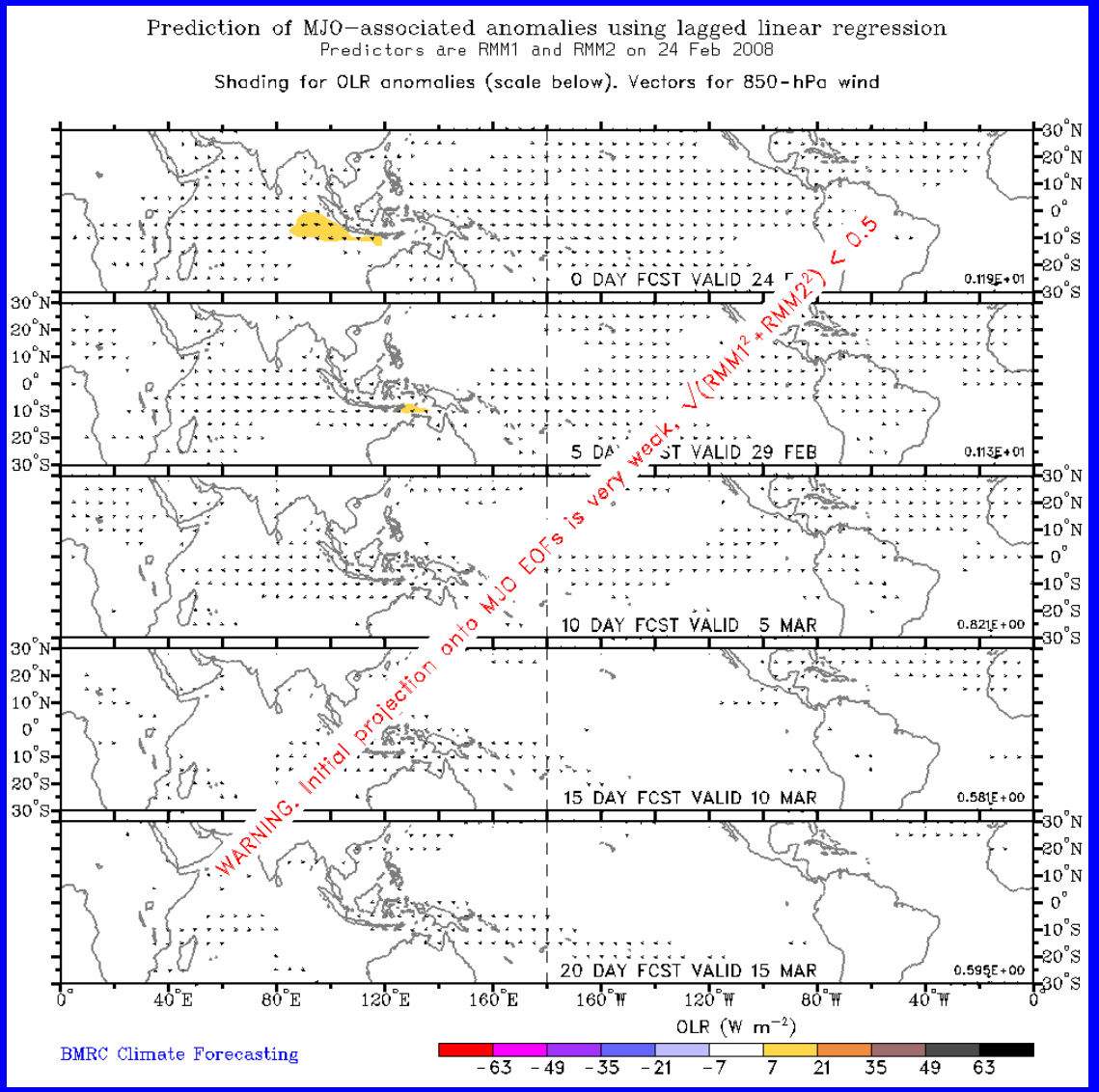
Statistical MJO Forecast

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

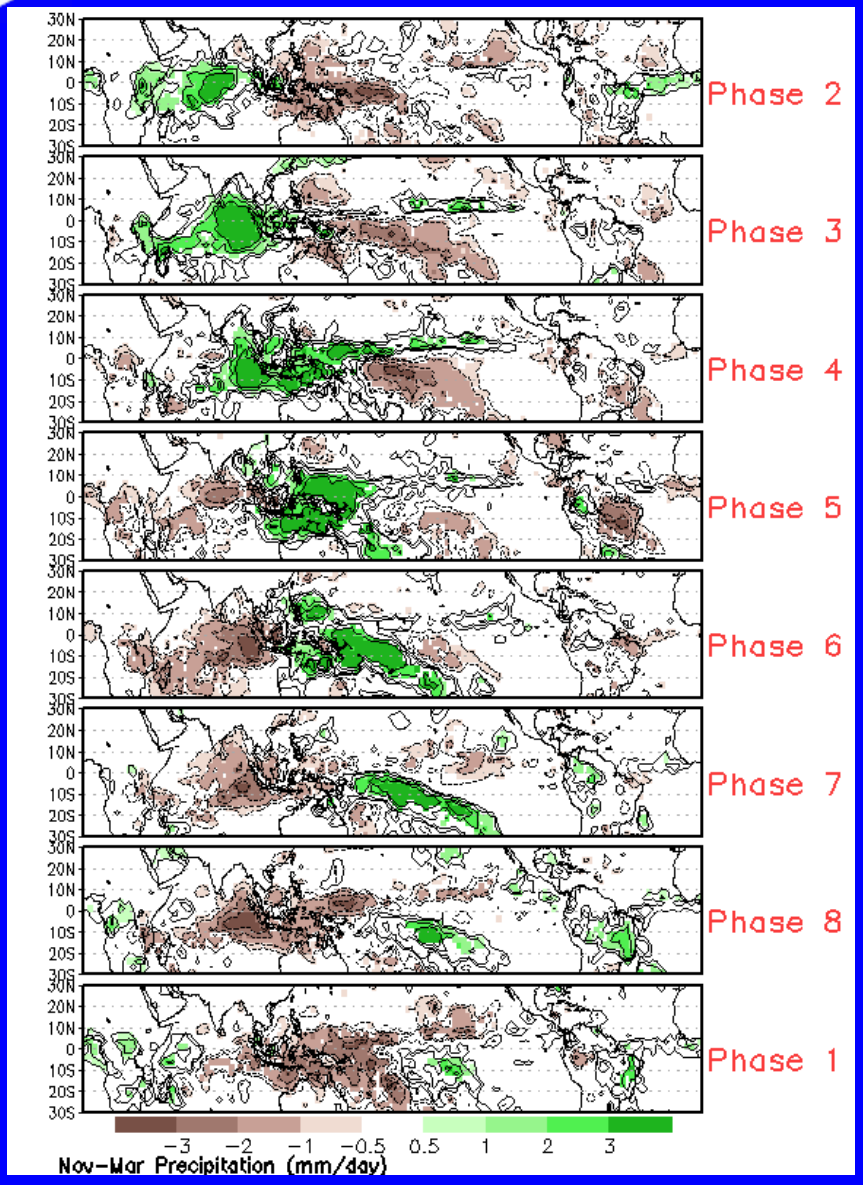
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

The statistical MJO forecast indicates weak MJO activity during the upcoming 1-2 week period.



MJO Composites – Global Tropics

Precipitation Anomalies



850-hPa Wind Anomalies