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

Update prepared by
Climate Prediction Center / NCEP
February 19, 2008

Outline

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

Overview

- Moderate MJO activity continues with the enhanced convective phase in the western hemisphere. Enhanced rainfall associated with La Nina remains across Indonesia.

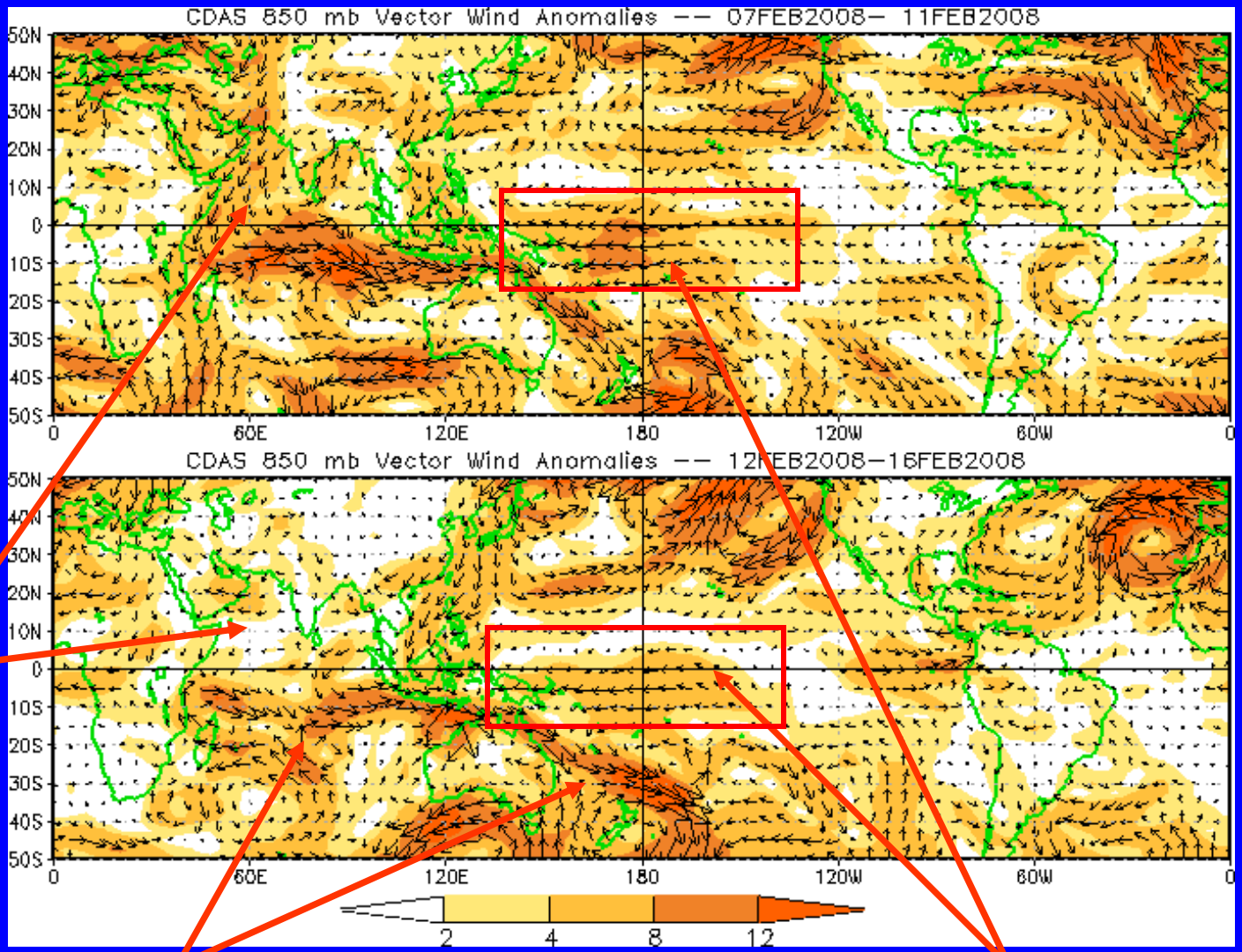
- The MJO is expected to continue at moderate strength during the next 1-2 weeks with the enhanced convective phase entering the Indian Ocean by the end of the period.

- The MJO activity is expected to enhance (suppress) rainfall across parts of northwest South America (equatorial Indian Ocean) during week 1. Wet conditions are expected to impact central Africa during week 2. Tropical cyclogenesis remains favored for waters near Australia.

- During the period, frequent storminess is expected for the US west coast and potentially the southern tier of the US as a result of the recent evolution of the MJO along with the existing extratropical circulation.

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

Note that shading denotes the magnitude of anomalous wind vectors



Strong northerly flow has ended across the Arabian Sea.

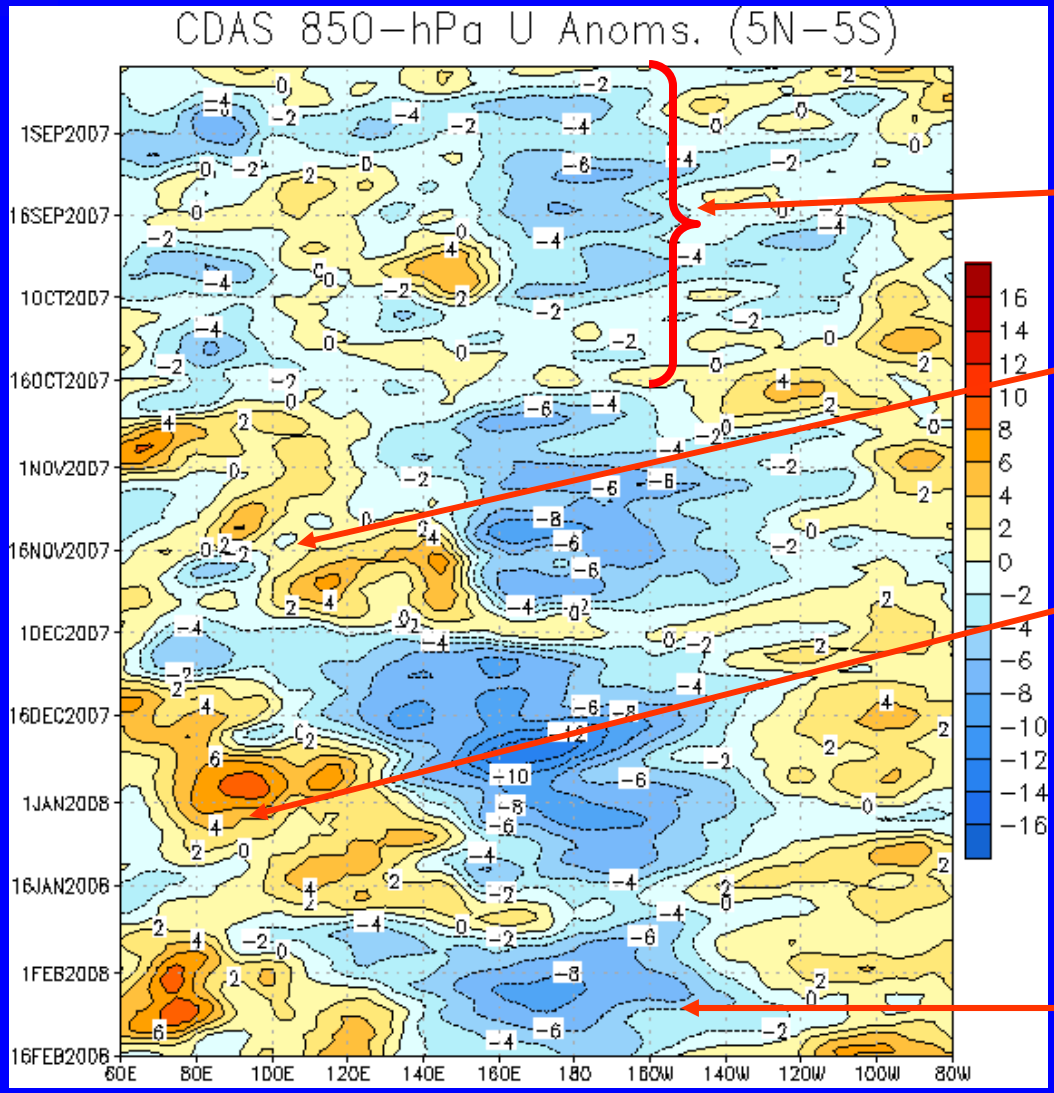
Westerly anomalies stretch from the Indian Ocean to the southwest Pacific Ocean.

Easterly anomalies have decreased across the western 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



Time

Longitude

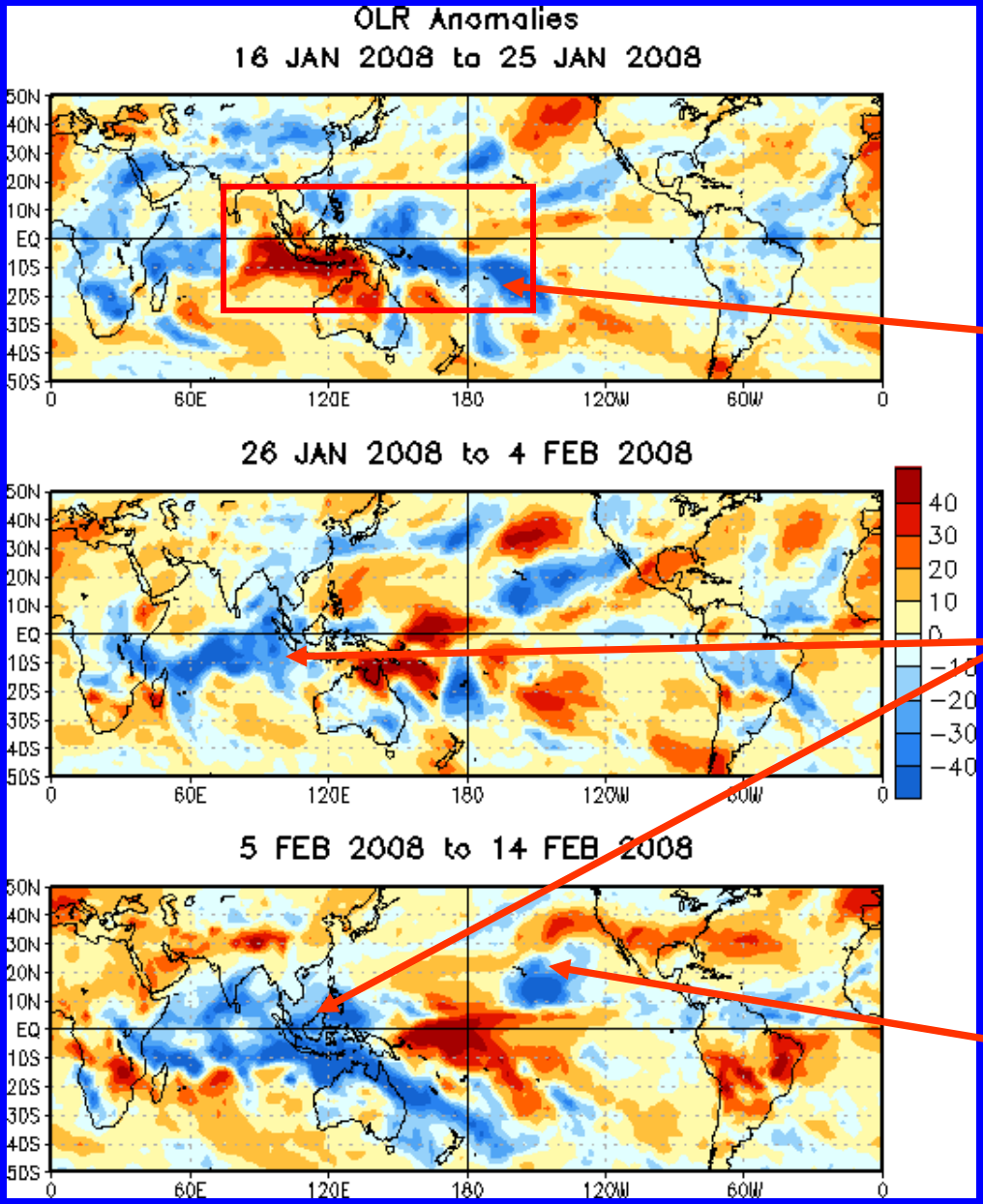
Weak intraseasonal activity was evident from August to October.

Westerly anomalies shifted eastward from the Indian Ocean to the Date Line in November during the first cycle of the recent MJO activity.

During December, the second MJO cycle is evident as westerly anomalies again developed across the Indian Ocean and shifted eastward while easterly anomalies strengthened in the western and central Pacific.

The next MJO cycle is evident as westerly anomalies have propagated eastward from the Indian Ocean to Indonesia with renewed easterly anomalies just west of the Date Line.

OLR Anomalies: Last 30 days



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

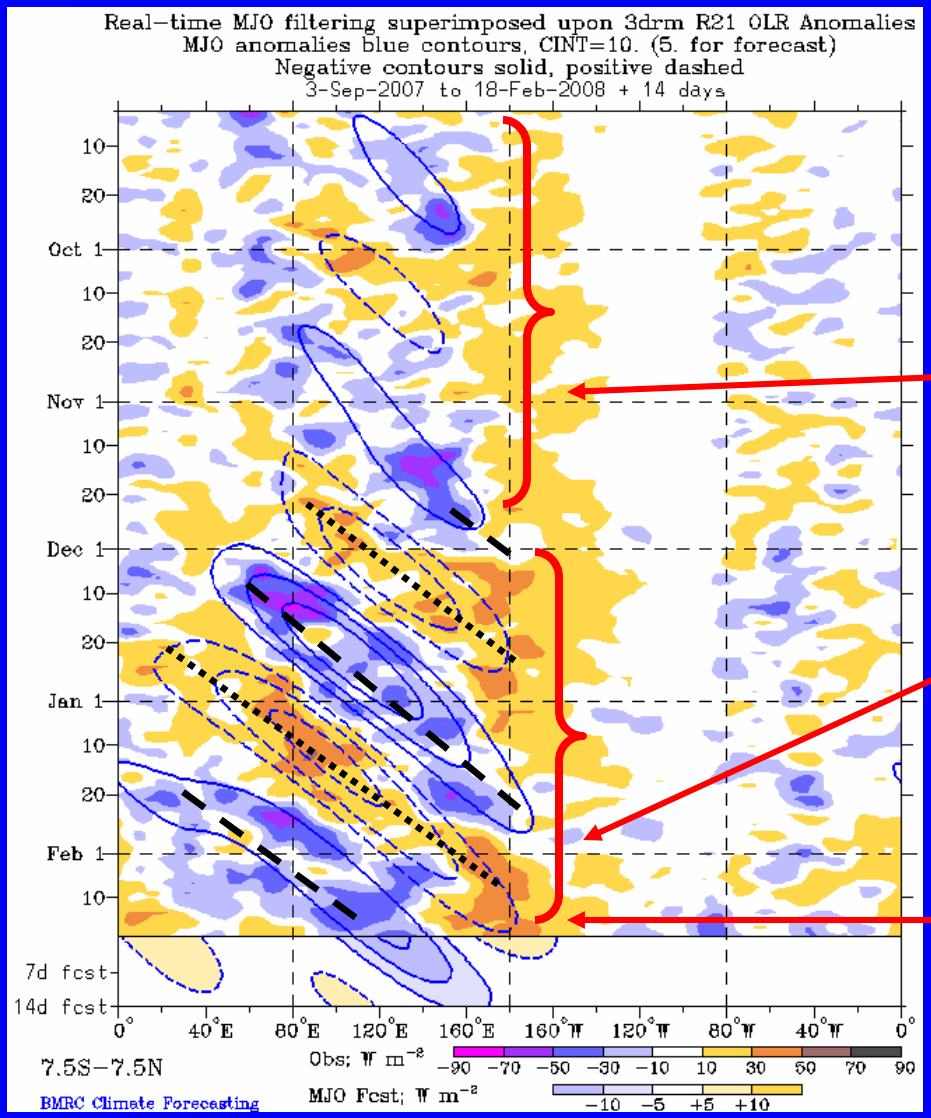
Wetter-than-normal conditions, negative OLR anomalies (blue shading)

Wet (dry) conditions were observed across the western Pacific (Indian Ocean/western Maritime continent) during mid January.

As the MJO propagated eastwards, enhanced rainfall once again developed across the Indian Ocean and later Indonesia by early February. Dry conditions shifted across the Maritime continent to the western Pacific over the period.

Enhanced convection is evident near Hawaii during early-mid February.

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)

Intraseasonal variability was evident during September and October but was less coherent and had a longer period then the current MJO activity.

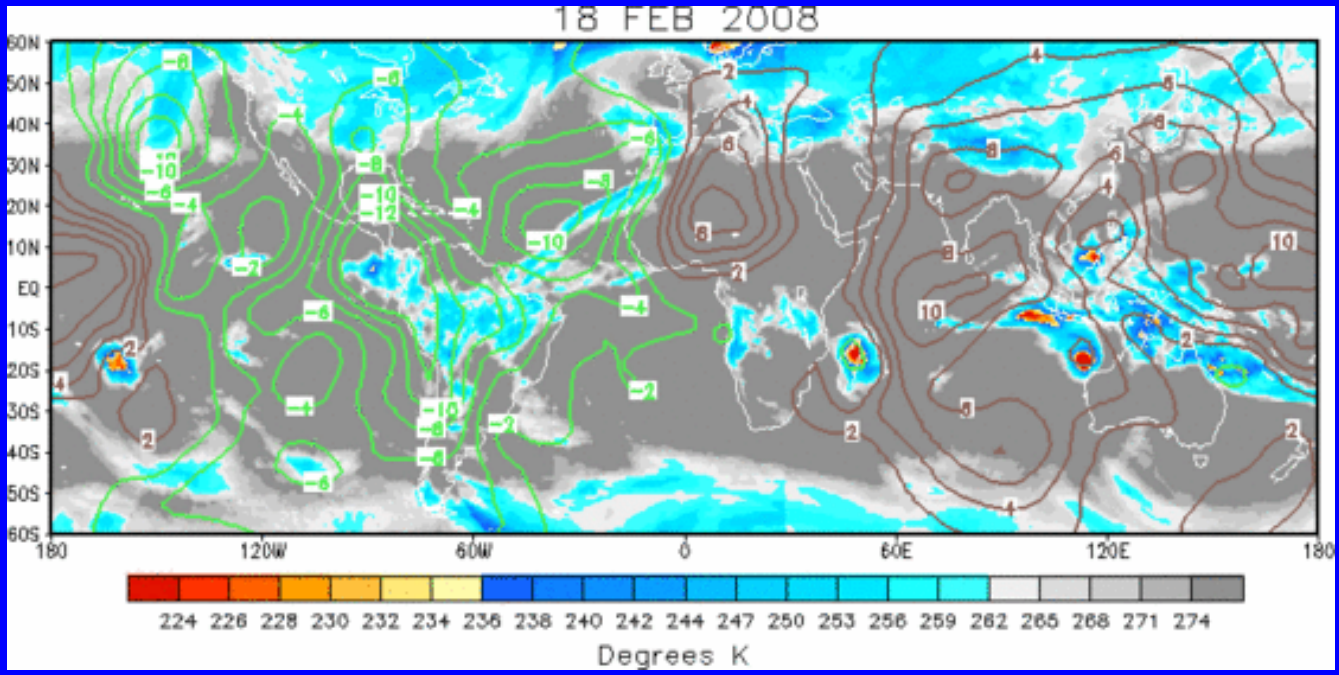
Moderate-to-strong MJO activity has been evident since mid-November. Enhanced convection shifted from the Indian Ocean to the southwest Pacific during December and January while suppressed convection shifted from Africa to the Pacific.

Equatorial anomalous enhanced (suppressed) convection is evident across the Maritime continent (Date Line).

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

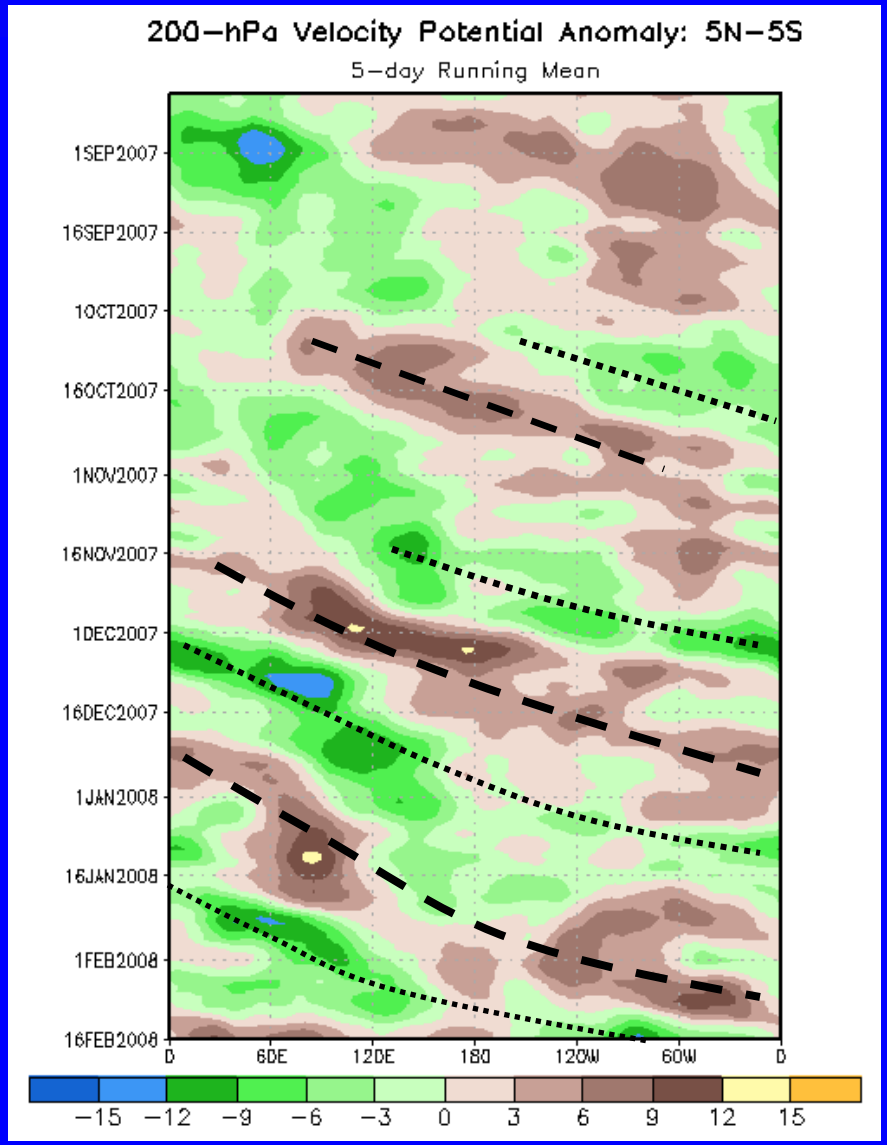


The global velocity potential indicates a coherent pattern with large-scale upper-level divergence (convergence) generally across the western (eastern) hemisphere.

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

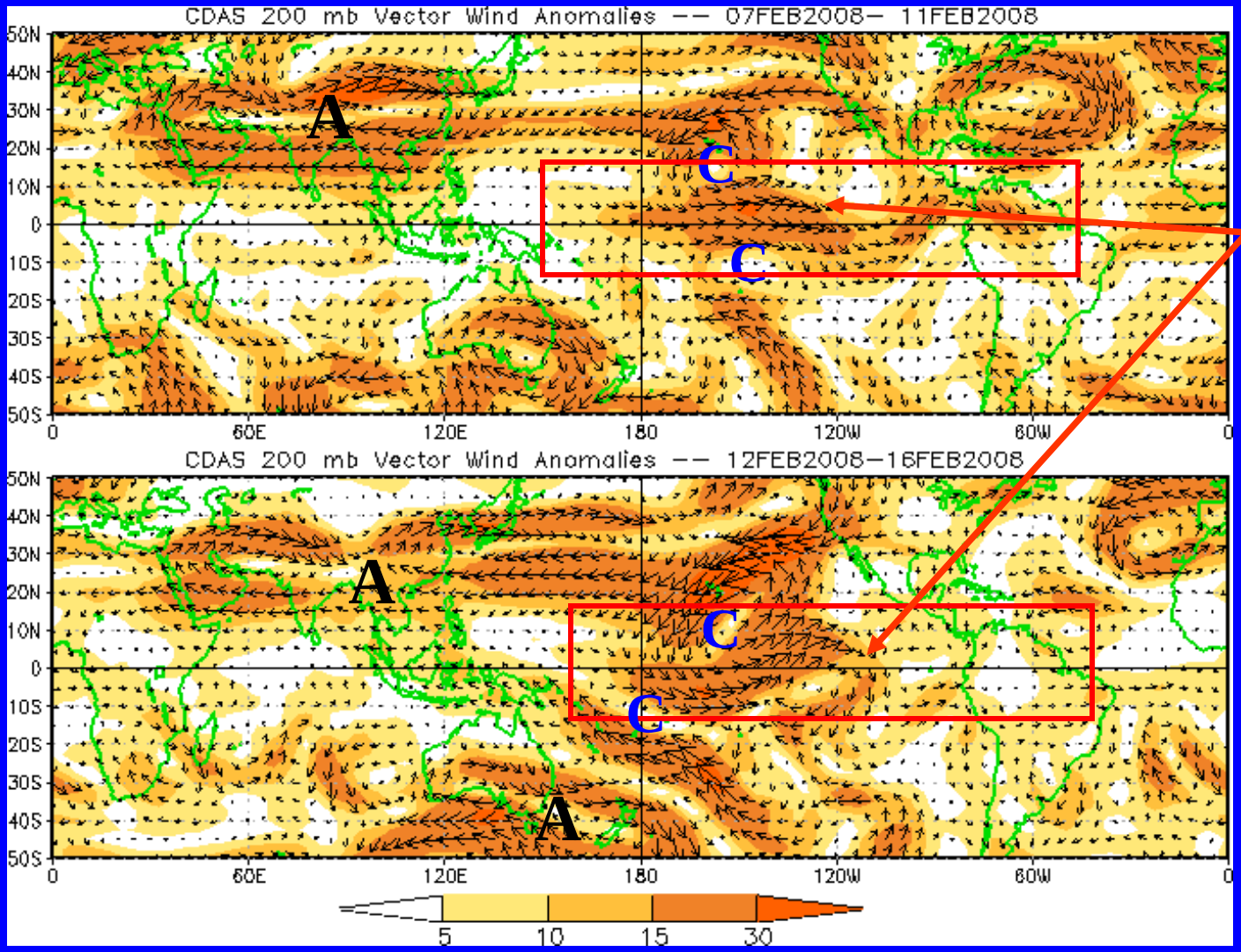
The MJO was weak or incoherent during much of August and September.

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 did weaken somewhat in early January as velocity potential anomalies became less coherent but the MJO has become better organized during the second half of January and February.

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

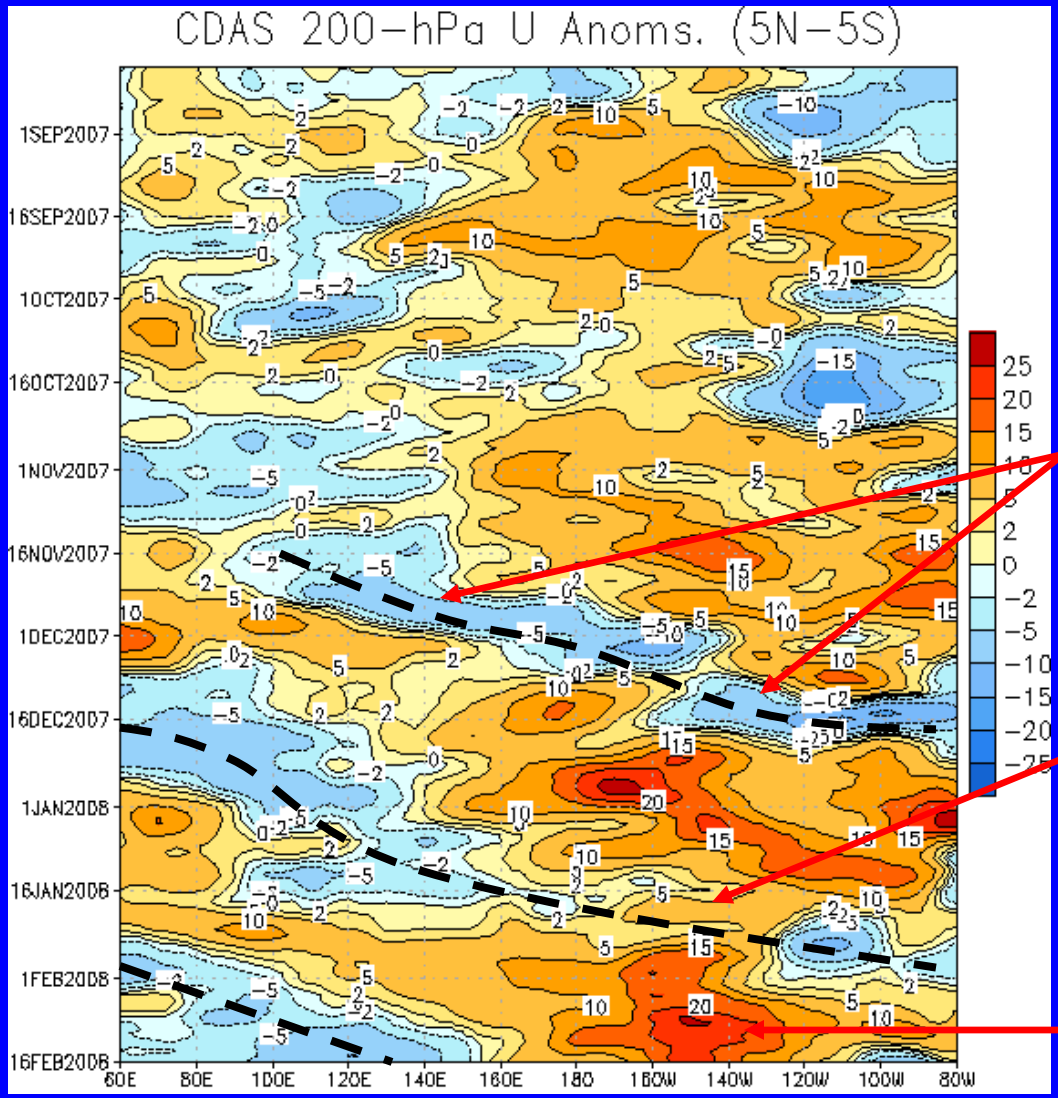


Note that shading denotes the magnitude of anomalous wind vectors

Westerly anomalies continue across the Pacific Ocean.

Well-defined anti-cyclonic (A) and cyclonic (C) circulations are evident throughout the period.

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



Time

Longitude

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

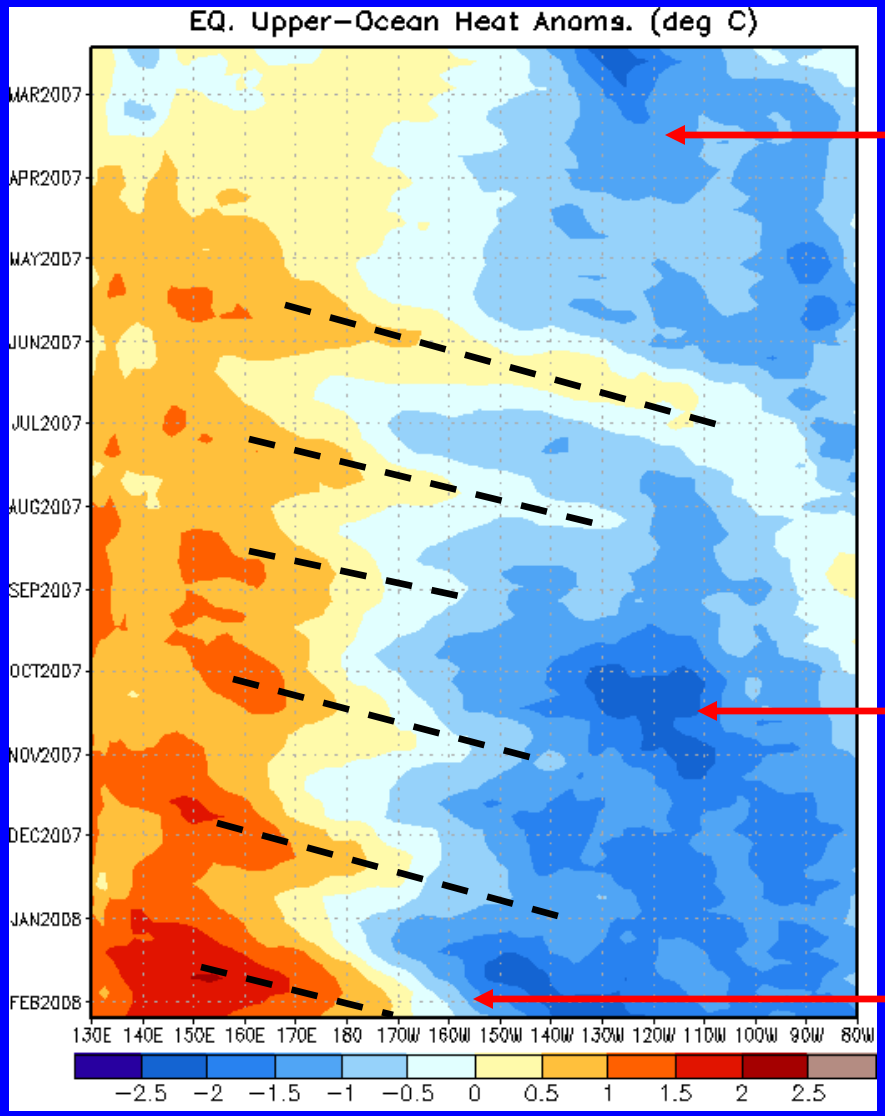
Easterly anomalies (blue shading) represent anomalous east-to-west flow

Cycle 1 of the ongoing MJO activity is most clearly 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.

Recently, both the MJO and La Nina are contributing to strong westerly anomalies between 160°W – 130°W as easterly anomalies continue to shift eastward across Indonesia.

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 levels 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

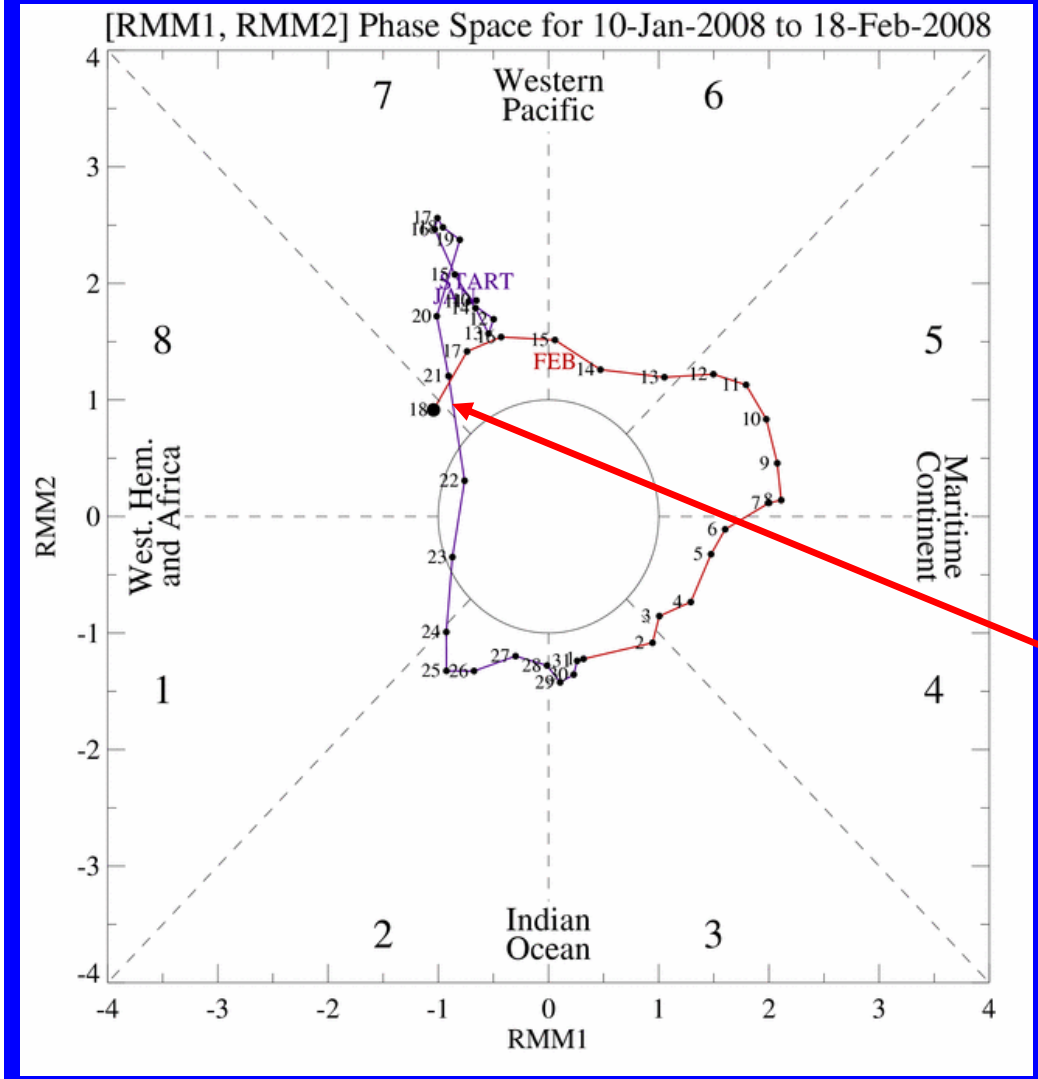
- **The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).**

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).**

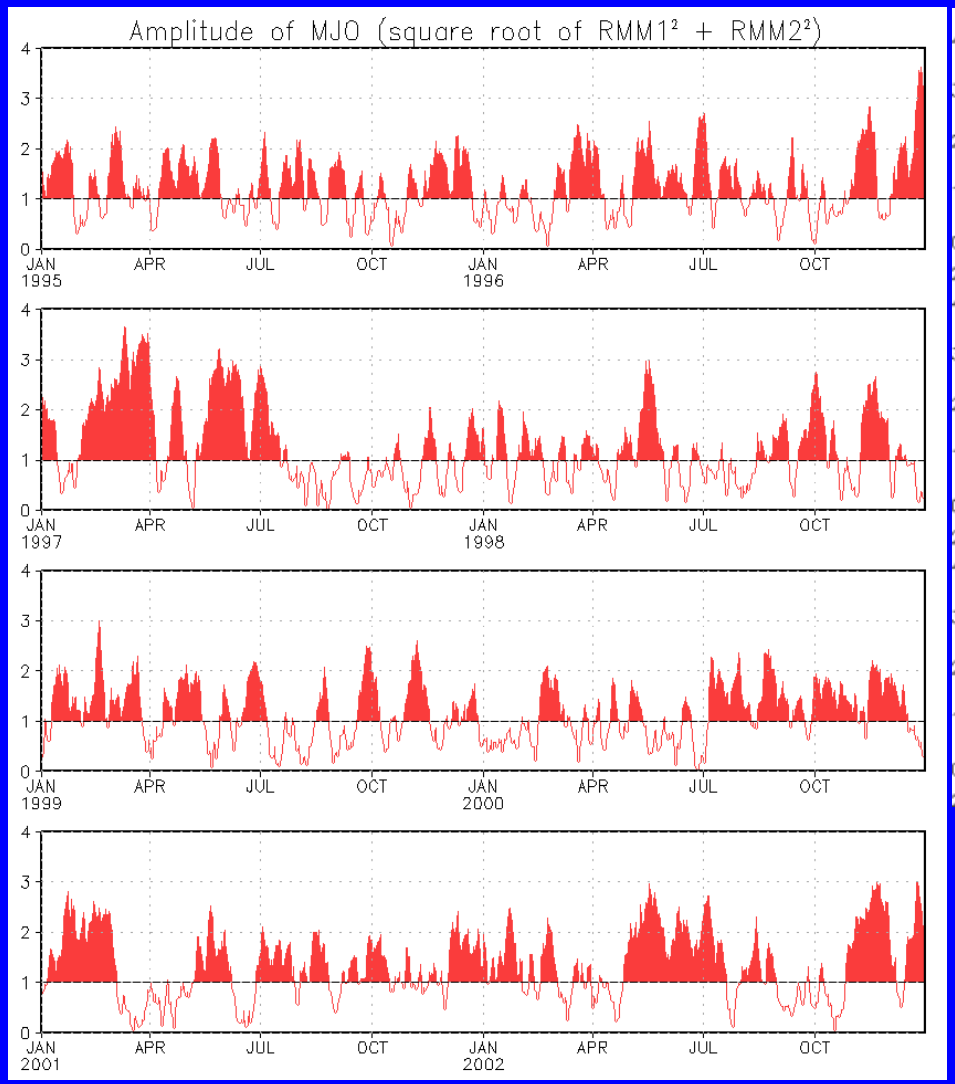
MJO Index -- Recent Evolution

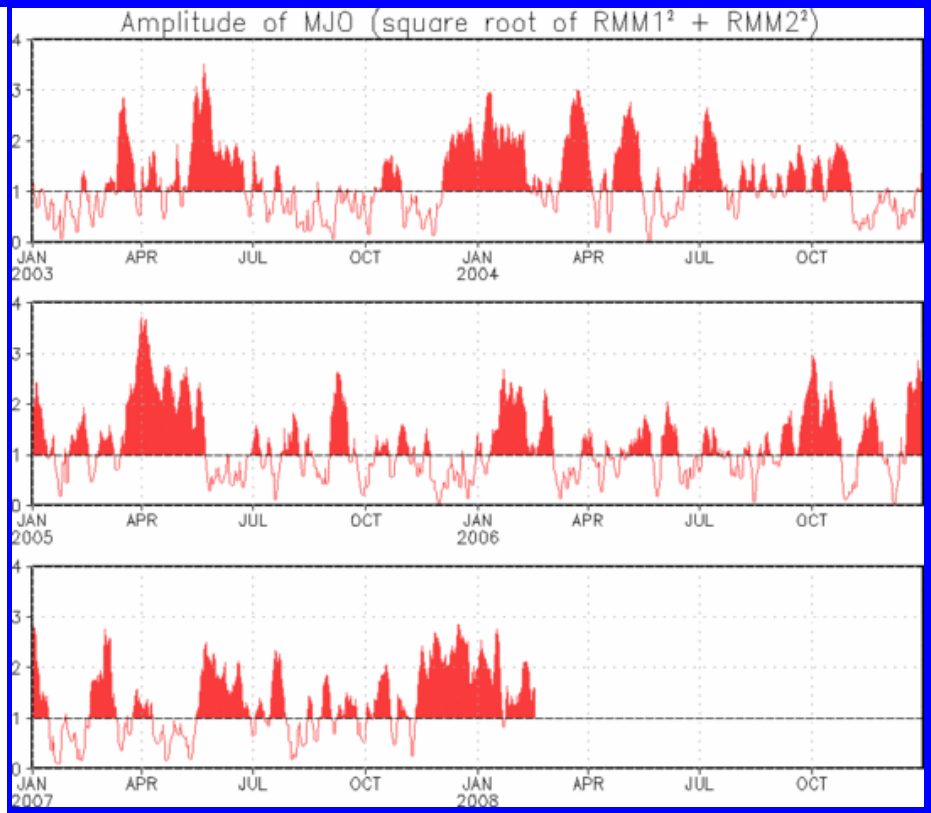


- **The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes**
- **The triangular areas indicate the location of the enhanced phase of the MJO**
- **Counter-clockwise motion is indicative of eastward propagation**
- **Distance from the origin is proportional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

The MJO index indicates the MJO signal is entering the western hemisphere and is continuing to shift east.

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

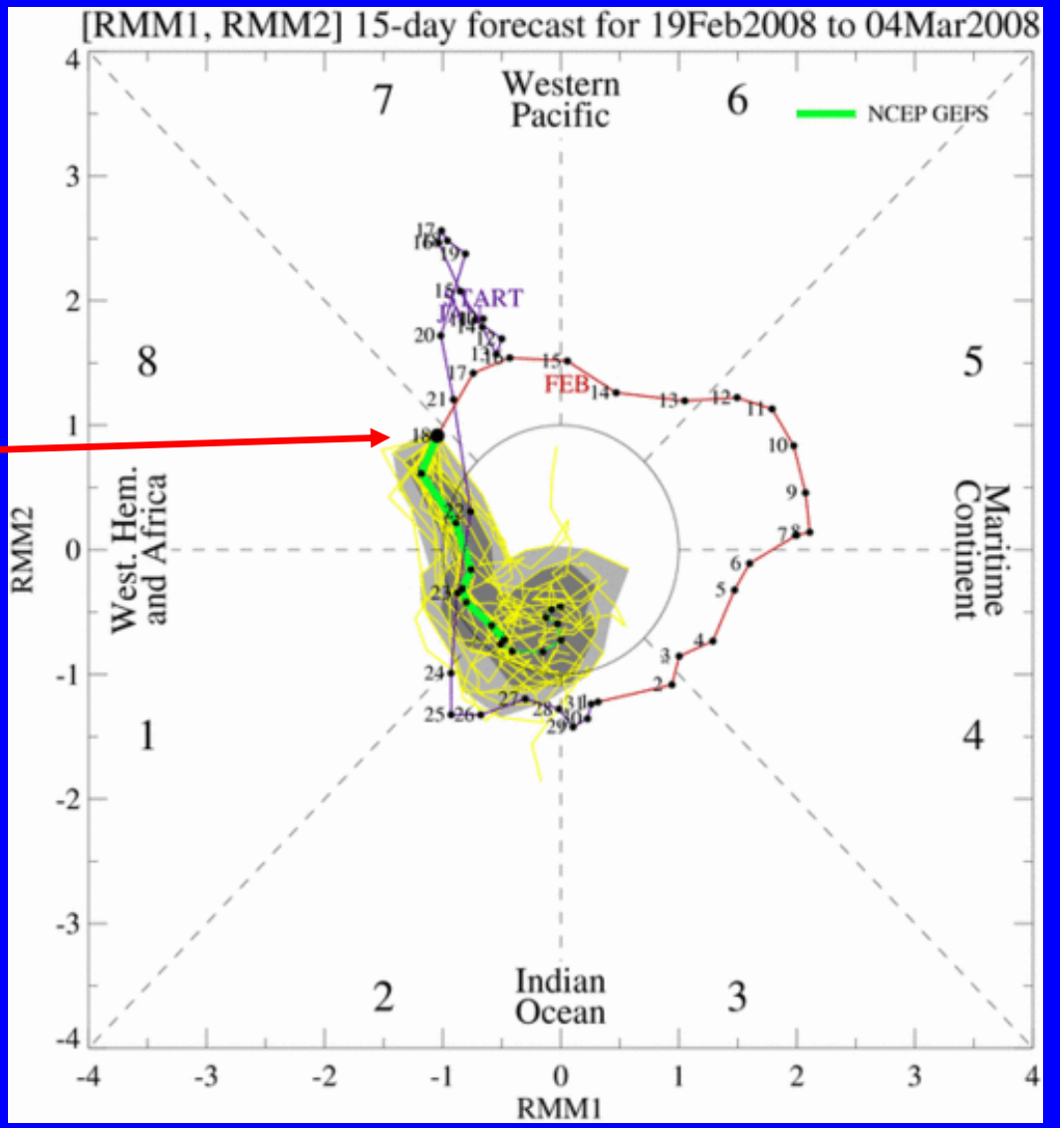
Yellow Lines – 20 Individual Members
Green Line – Ensemble Mean

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 continued eastward propagation during the next 1-2 weeks but with a decrease in amplitude.

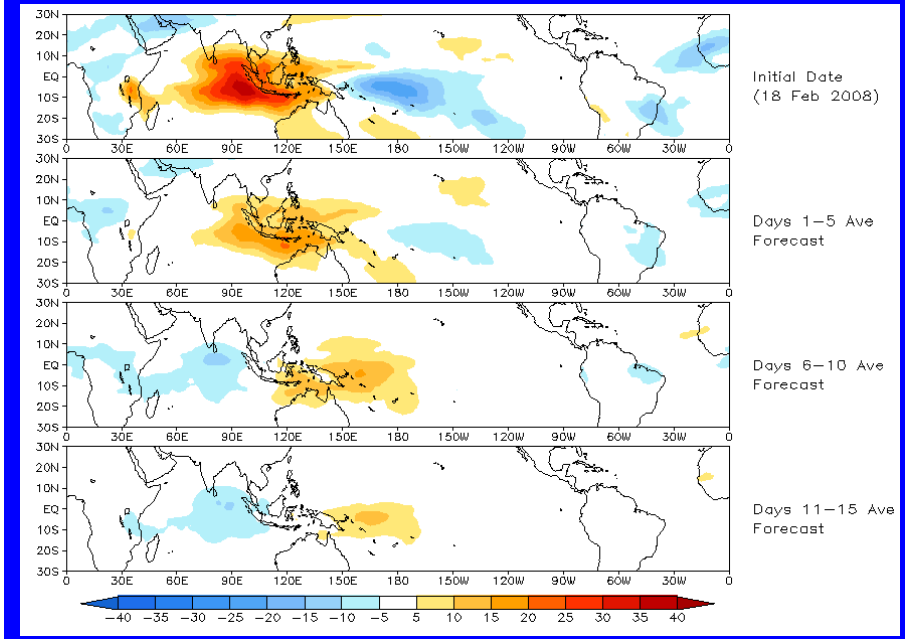
Confidence is reasonably high during the first week as most ensemble members predict similar evolution.



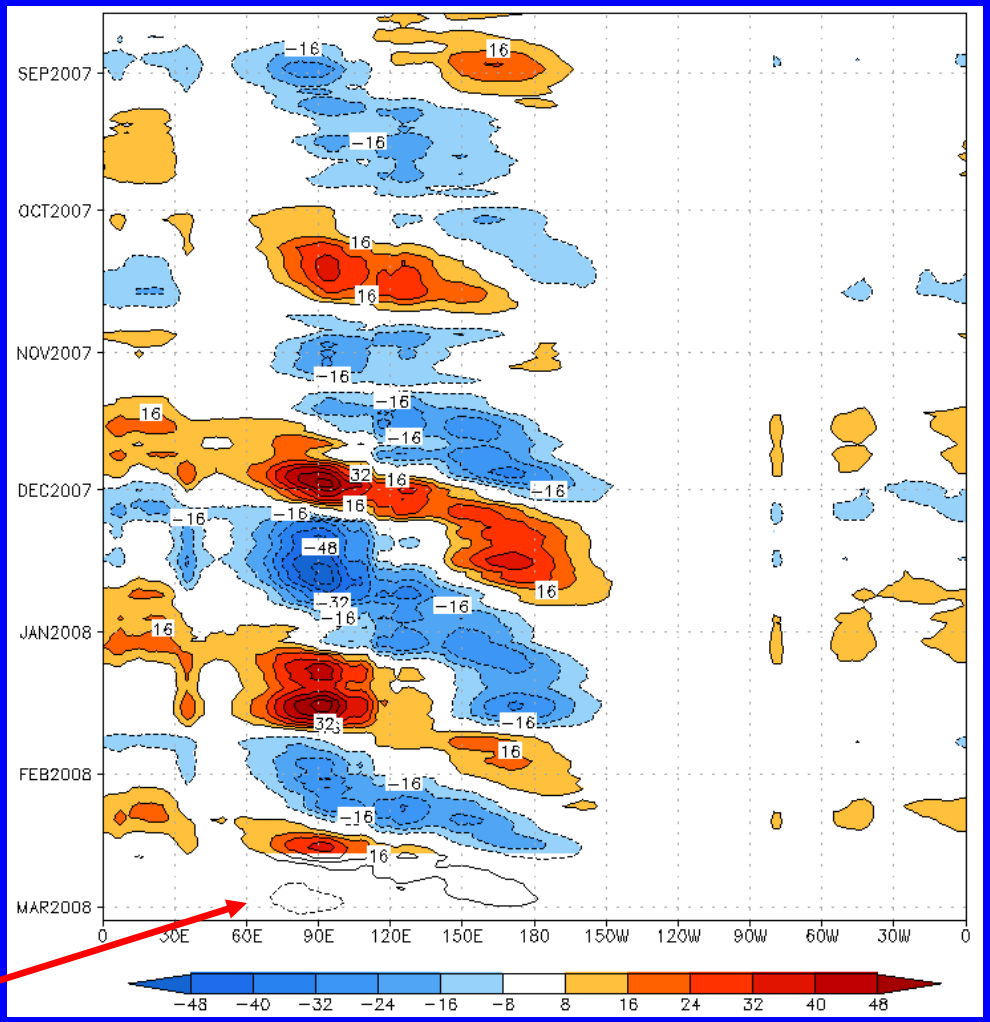
Ensemble Mean GFS MJO Forecast

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 GEFS forecasts a moderate MJO signal early with a decrease in amplitude by week 2. The contribution from the MJO is expected to suppressed rainfall across Indonesia and act to oppose La Nina.

Wet conditions are anticipated across the Indian Ocean during week 2.

Eastward propagation is expected during the period.

Statistical MJO Forecast

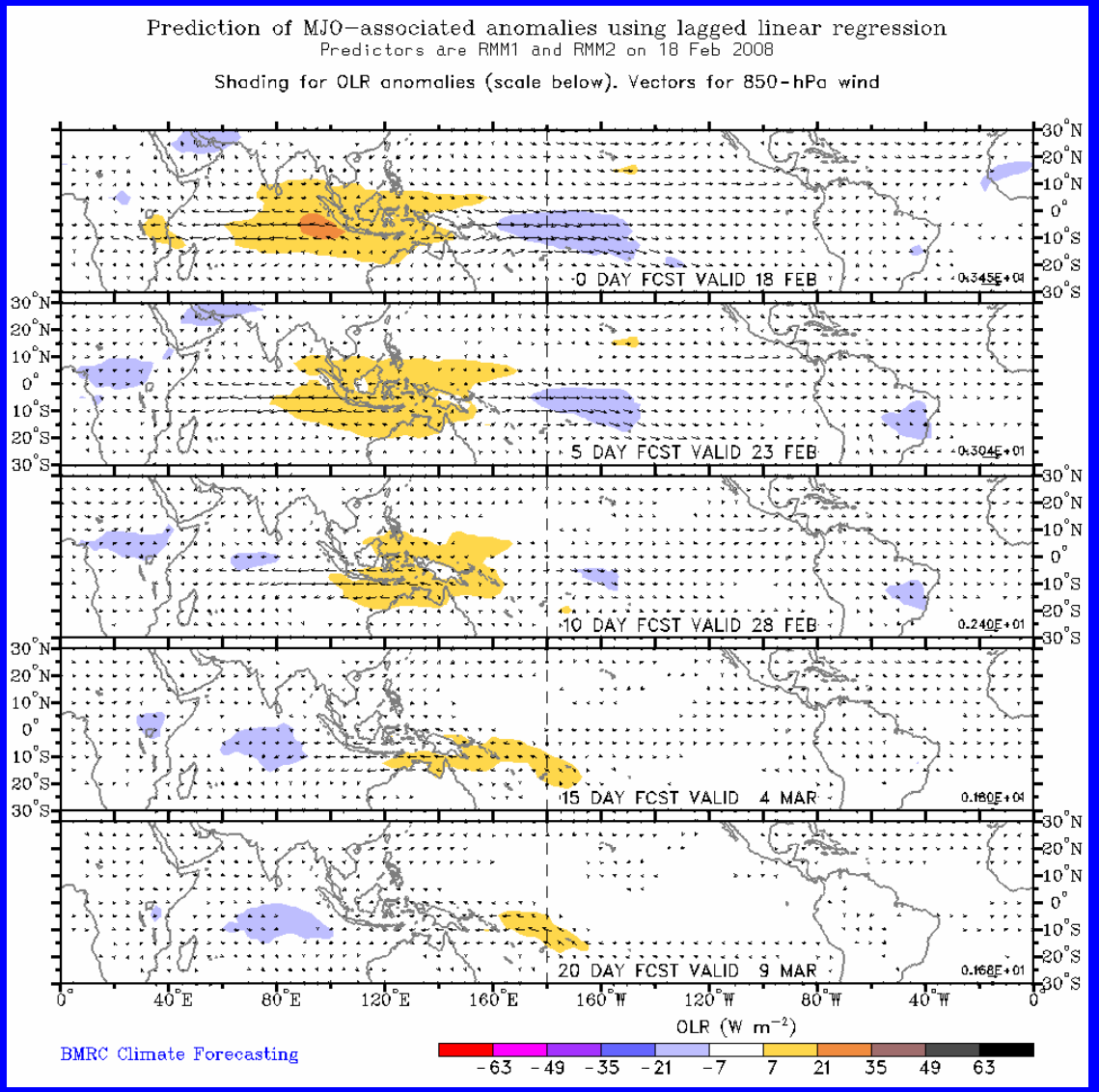
Figure below shows MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

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

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

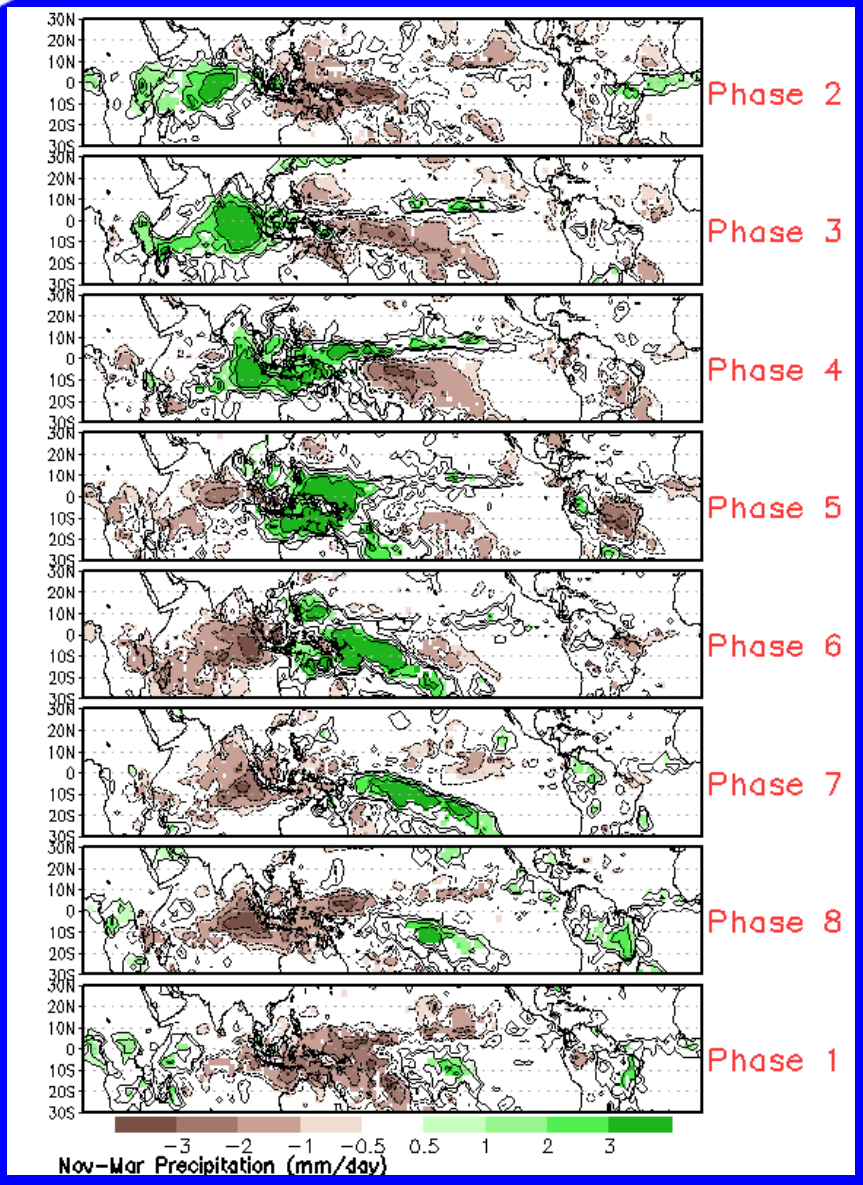
The statistical MJO forecast indicates moderate MJO activity during the upcoming 1-2 week period.

The MJO contribution is forecast to suppressed rainfall across the Maritime continent and act to oppose La Nina.



MJO Composites – Global Tropics

Precipitation Anomalies



850-hPa Wind Anomalies