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

Update prepared by
Climate Prediction Center / NCEP
January 19, 2010

Outline

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

Overview

- MJO activity continued during the past week with the enhanced convective phase now centered over the eastern Maritime continent.

- Based on the latest observations and MJO forecast tools, the MJO is expected to continue during the next 1-2 weeks with the enhanced phase located across the western Pacific.

- The MJO is expected to contribute to enhanced (suppressed) rainfall across the western Pacific (Indian Ocean / Maritime continent) and increase the chances for tropical cyclogenesis northeast of Australia during the period.

- The currently forecast phases of the MJO would tend to reinforce El Nino related impacts over the US as the enhanced convection continues to shift eastward.

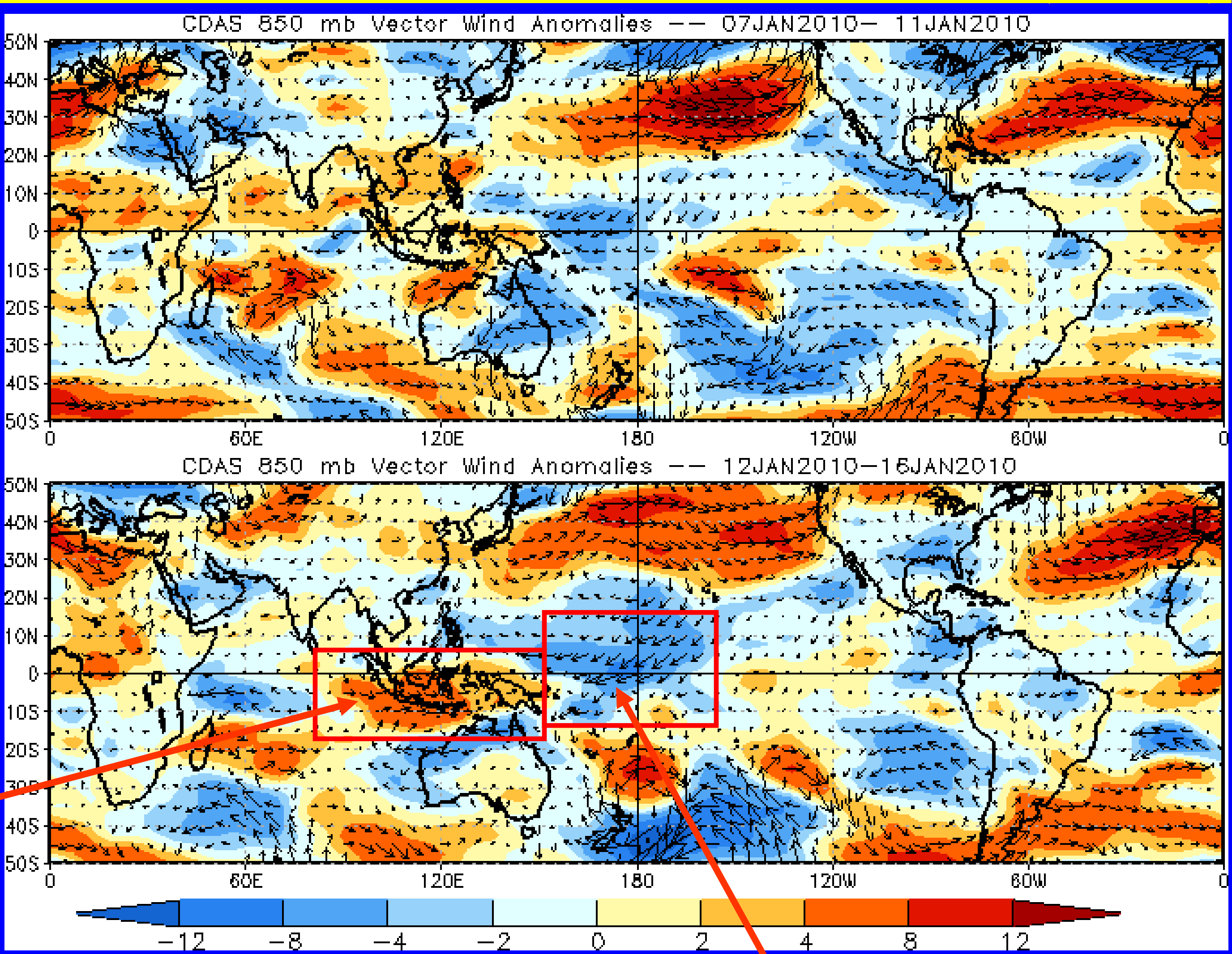
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/ghaz.shtml

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



Westerly anomalies increased over the central and southern portions of the Maritime continent.

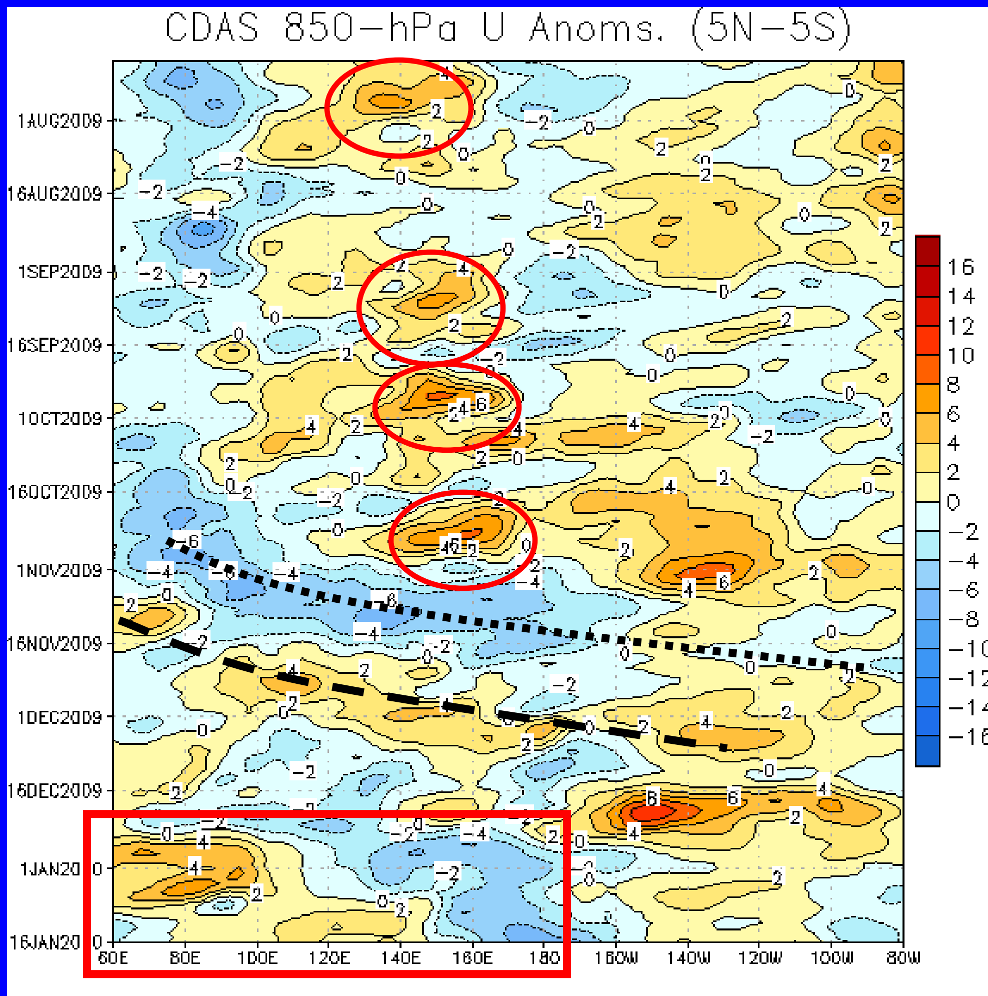
Easterly wind anomalies continue across the western Pacific during the last five days.

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



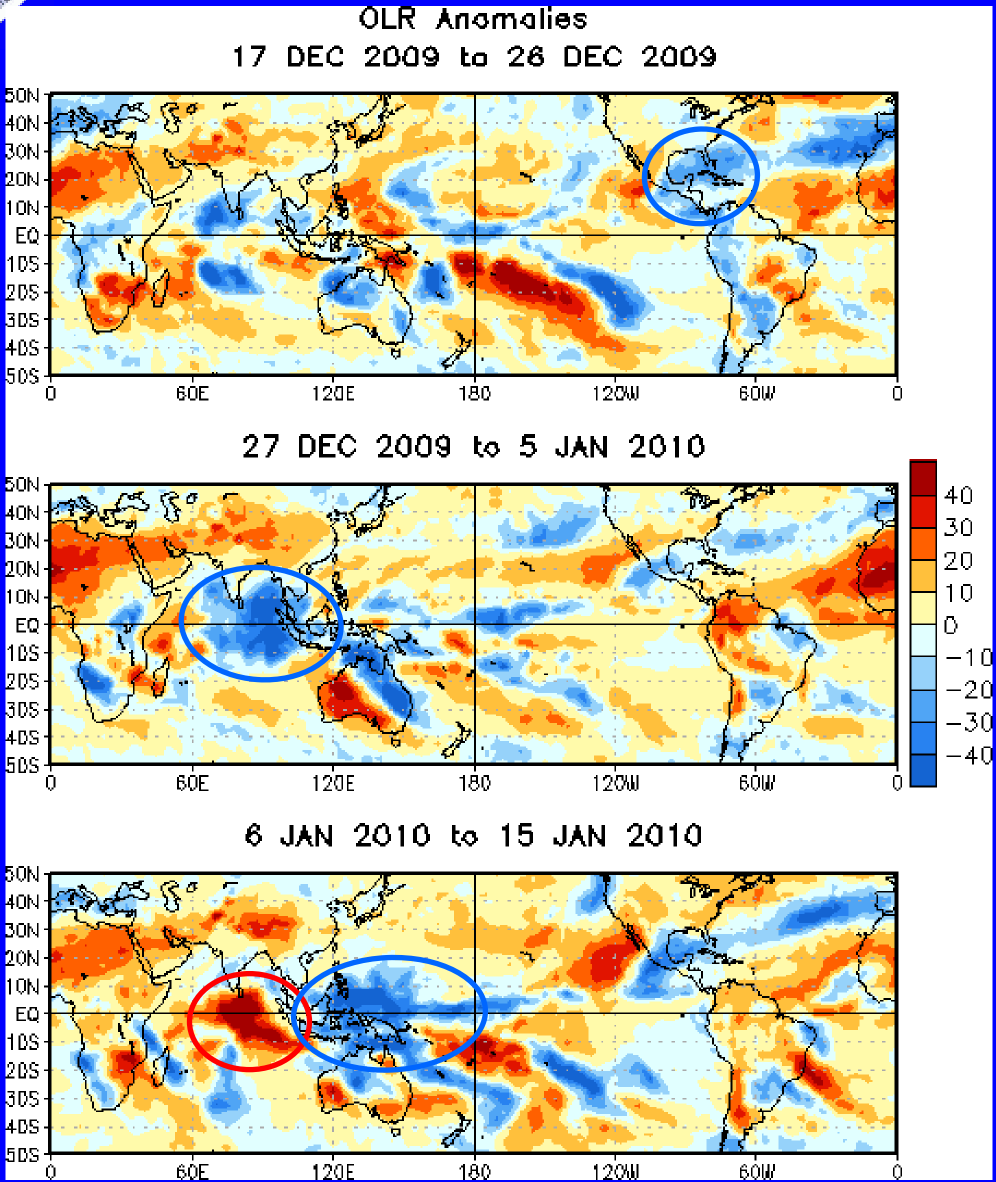
Longitude

Several westerly wind bursts (red circles) occurred during the July to October period. The westerly wind bursts became more frequent and stronger during September and October.

Easterly (dotted line) and westerly (dashed line) anomalies developed across the Indian Ocean and shifted eastward across the Date Line during late October and November associated with the MJO.

The westerly (easterly) anomalies (red box) evident in the Indian (western Pacific) Ocean during late December and early January have shifted eastward in mid-January.

OLR Anomalies: Last 30 days



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

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

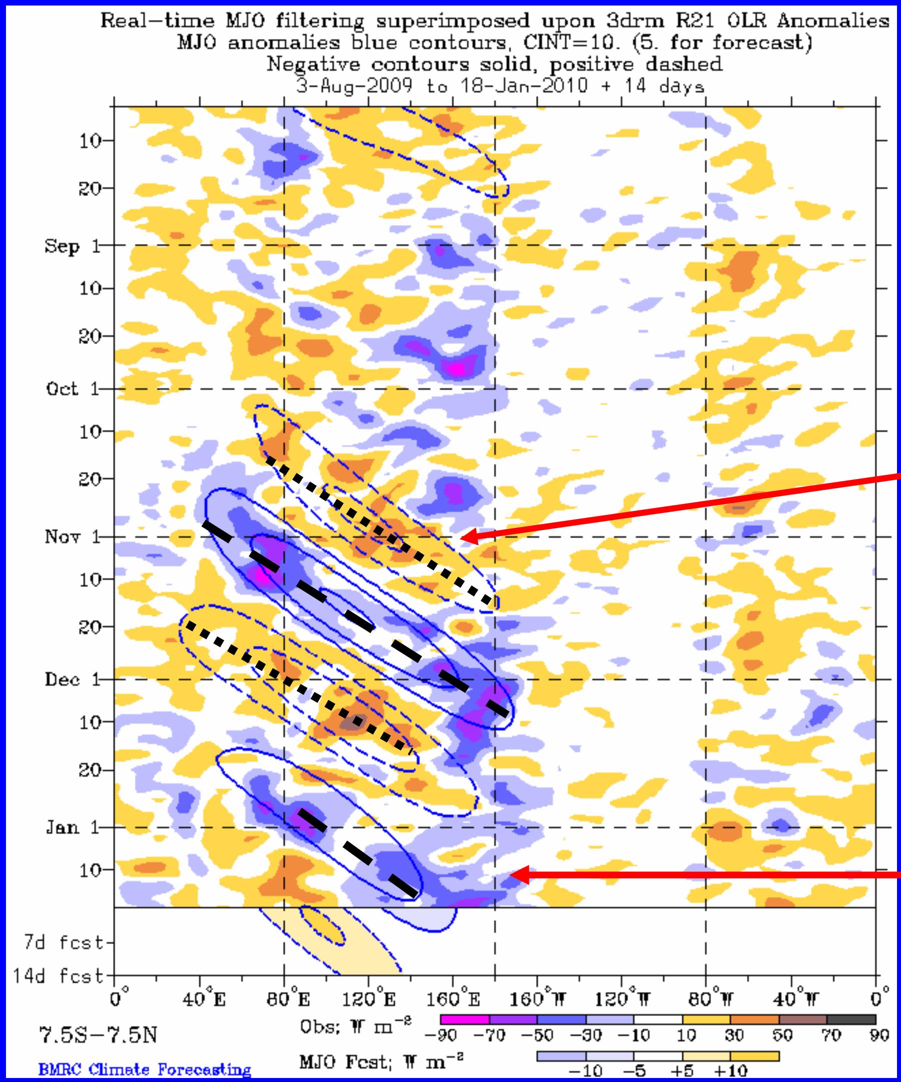
During mid-to-late December, convection became more mixed across the Maritime continent with enhanced convection evident across the Caribbean and Central America (blue oval).

During late December and early January, enhanced convection rapidly developed across the Indian Ocean.

In early-to-mid January, enhanced convection shifted eastward across the Maritime continent into the western Pacific while suppressed convection (red oval) developed across the equatorial Indian Ocean.

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

Time



Longitude

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 (BOM) - Australia)

Beginning in late October, suppressed (enhanced) convection (dotted and dashed lines) developed across the Maritime continent (Indian Ocean) and shifted eastward into the Pacific. Later, suppressed convection once again developed across the Indian Ocean and spread eastward during late November and early December.

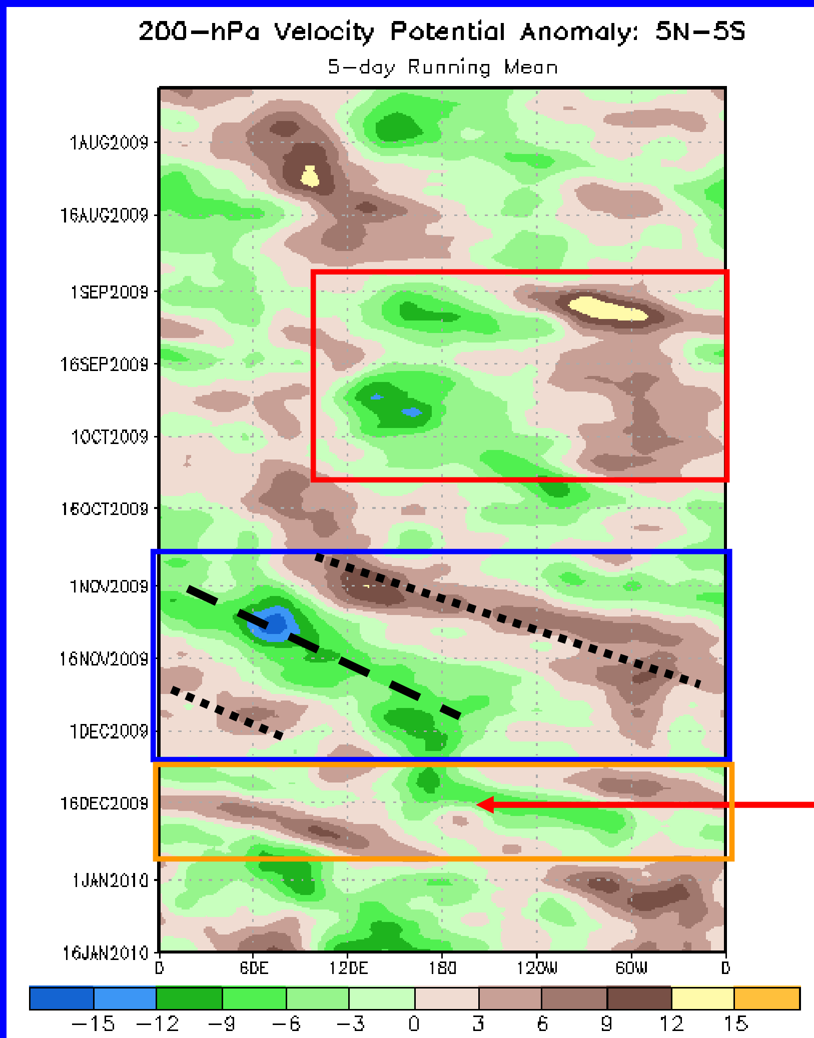
During late December and early January, enhanced convection developed in the Indian Ocean (60E – 100E) and shifted eastward to the western Pacific by mid-January.

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

Anomaly intensity varied during September and early October but the overall pattern remained generally persistent with upper-level divergence (convergence) across the western Pacific (parts of Western Hemisphere) (red box).

In late October and November, anomalies increased and eastward propagation was evident associated with MJO activity (blue box).

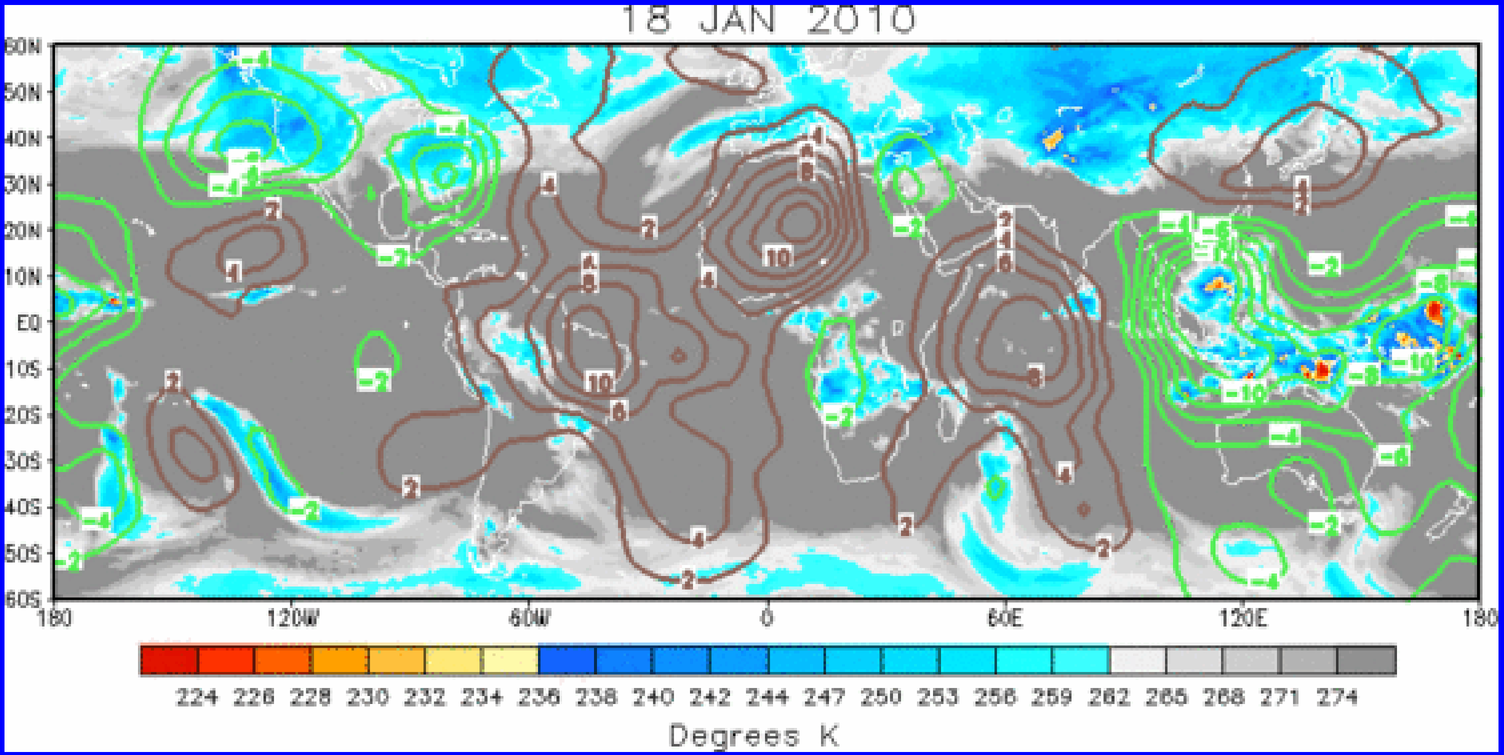
During early-to-mid December, the coherent MJO pattern weakened. Eastward propagation evident during the second half of December was related to higher frequency tropical variability and not large-scale coherent MJO activity (orange box).

By mid-January, the MJO again strengthened.

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



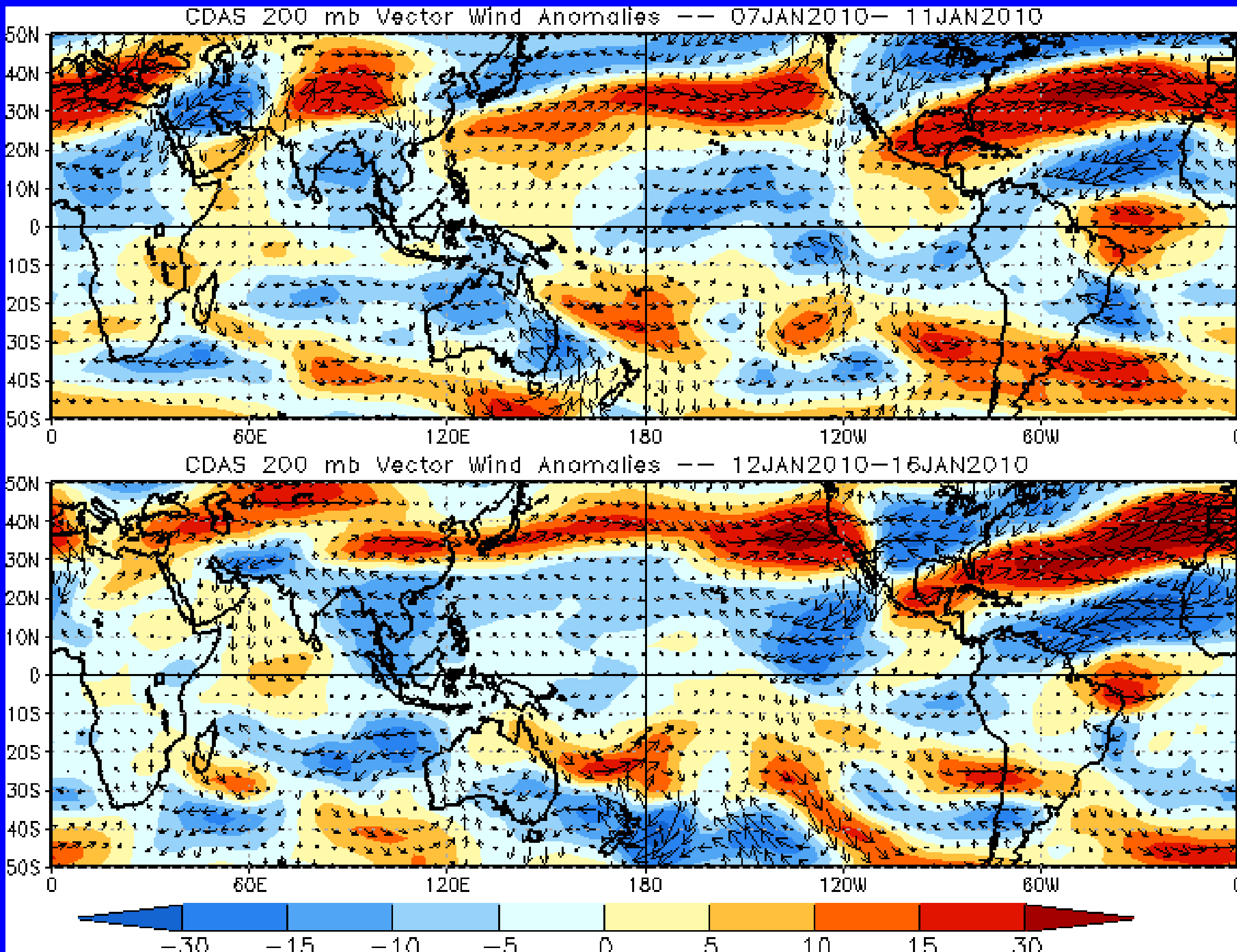
The anomalous velocity potential pattern indicates upper-level convergence over South America, the Atlantic, parts of Africa and now the Indian Ocean. The strongest upper-level divergence is evident across the Maritime continent and western Pacific.

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



During the last five to ten days, there has been little change in the tropical wind anomalies.

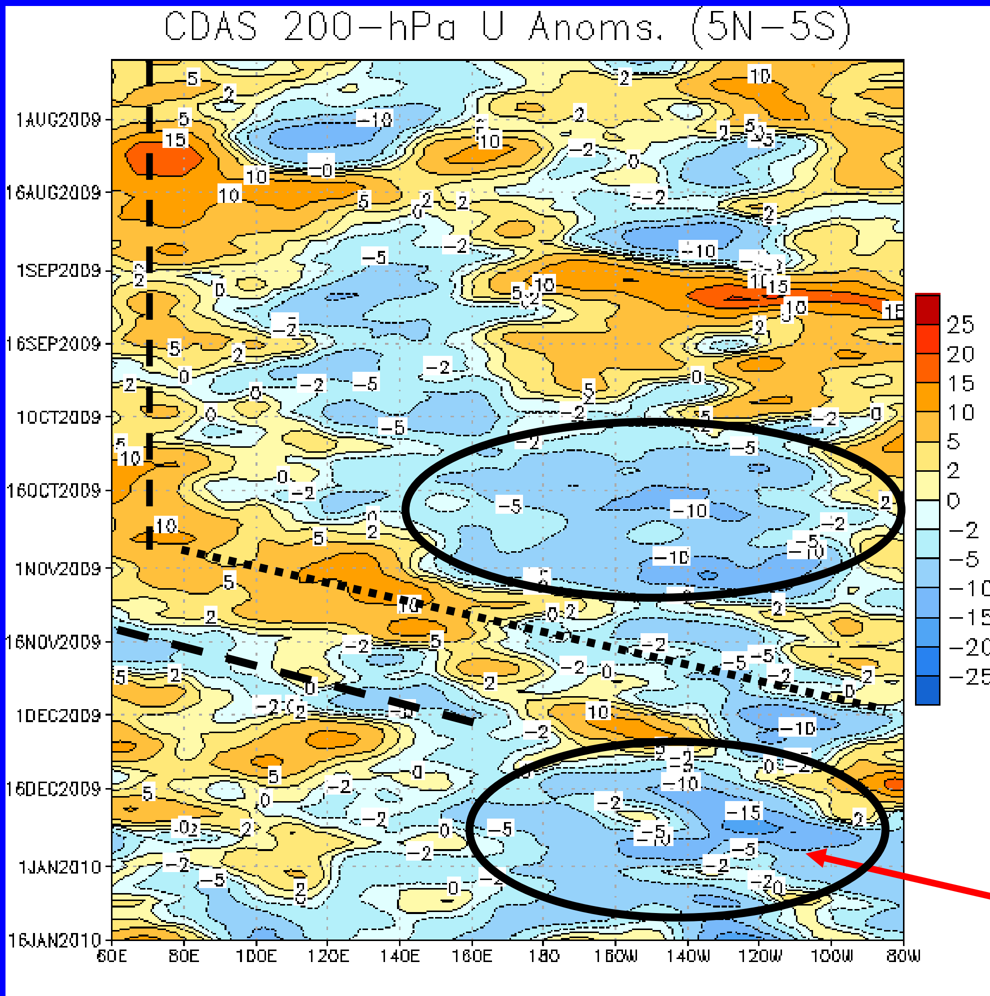
Strong westerly winds (red shades) continue across much of the subtropics of the Northern Hemisphere.

200-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

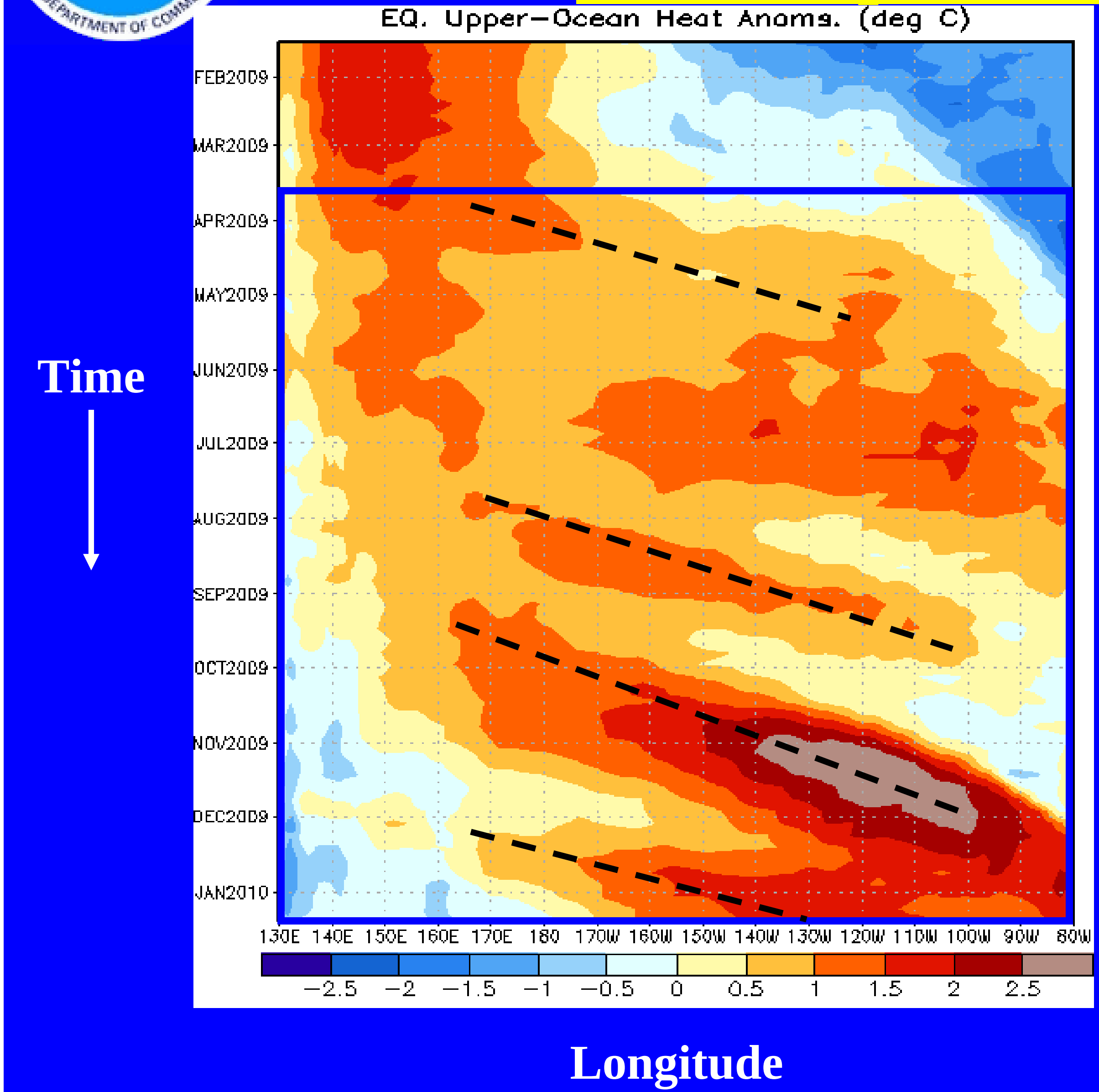
Westerly anomalies across the Indian Ocean had persisted for much of the period since July 2009 (vertical dashed black line).

In early October, easterly anomalies rapidly replaced westerly anomalies across much of the Pacific (black solid oval).

Westerly (easterly) anomalies (dotted and dashed lines) shifted eastward across the Maritime Continent during late October and November associated with the MJO.

Easterly anomalies have dominated much of the central and eastern Pacific during the second half of December and January.

Weekly Heat Content Evolution in the Equatorial Pacific



The negative anomalies associated with La Nina weakened during January-March 2009, with anomalies becoming positive since late March.

In April 2009, the combined effects of an oceanic Kelvin wave and weaker easterly trade winds contributed to an increase in the upper-ocean heat content anomalies across the Pacific Ocean.

Since April 2009, heat content anomalies have remained above-average (blue box).

Multiple Kelvin waves shifted eastward between August and December (last three dashed black lines).

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).**

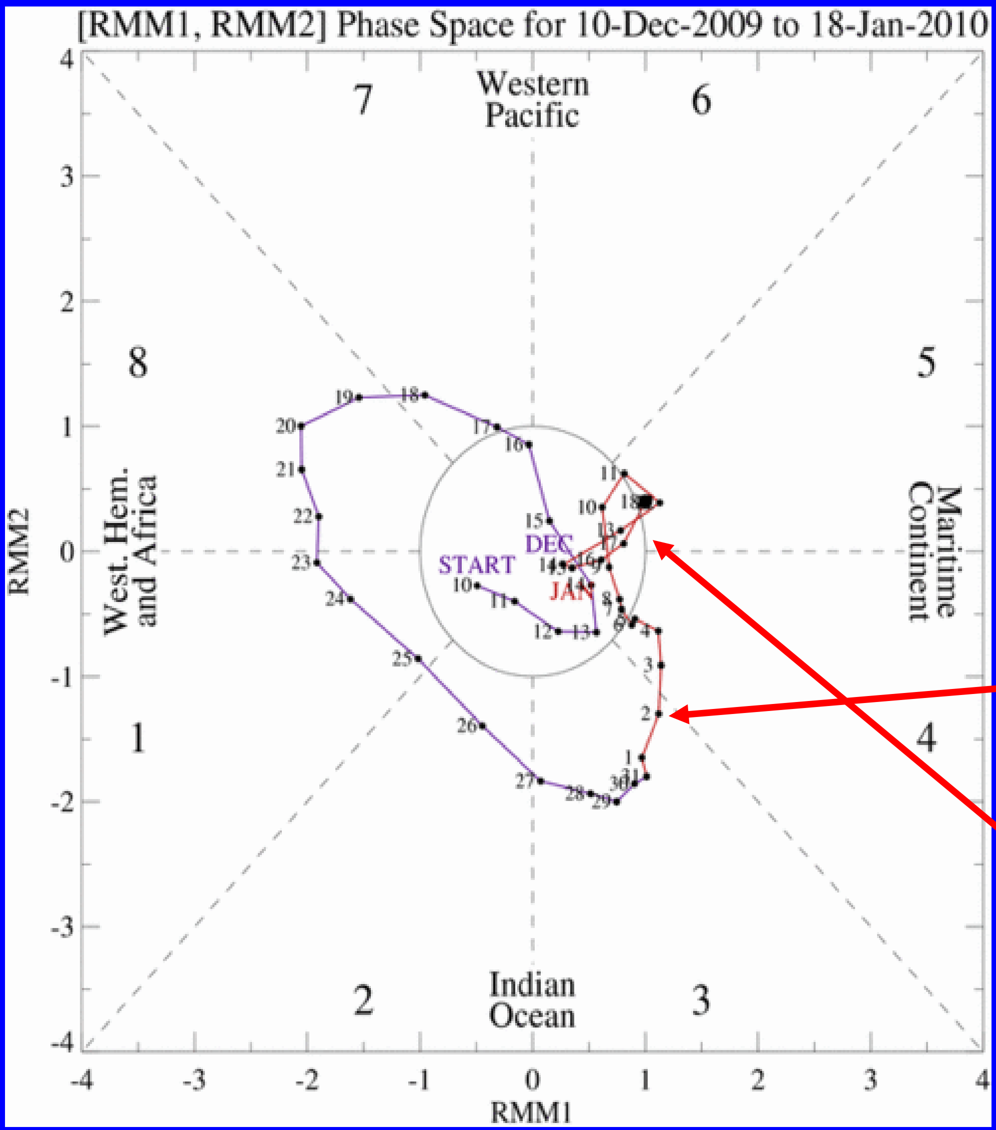
Wheeler M. and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction, *Monthly Weather Review*, 132, 1917-1932.

• **The methodology is 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 US CLIVAR MJO Working Group.**

Gottschalck et al. 2010: A Framework for Assessing Operational Model MJO Forecasts: A Project of the CLIVAR Madden-Julian Oscillation Working Group, *Bull. Amer. Met. Soc.*, Submitted.

• **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

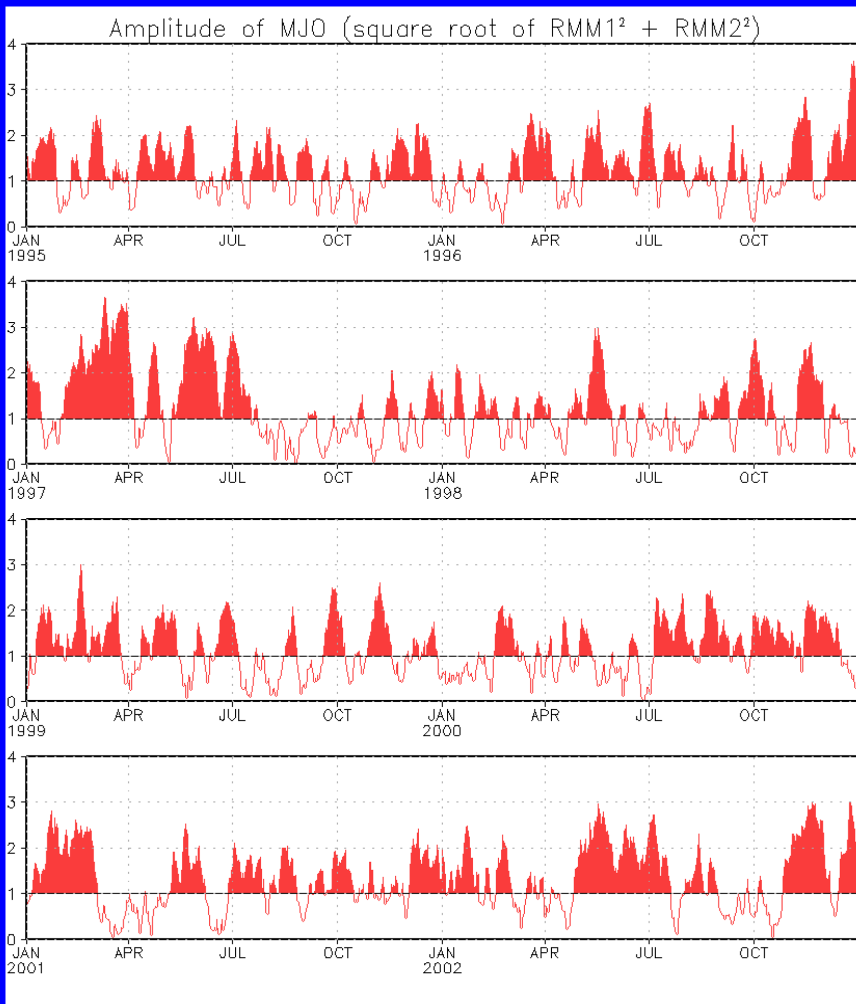


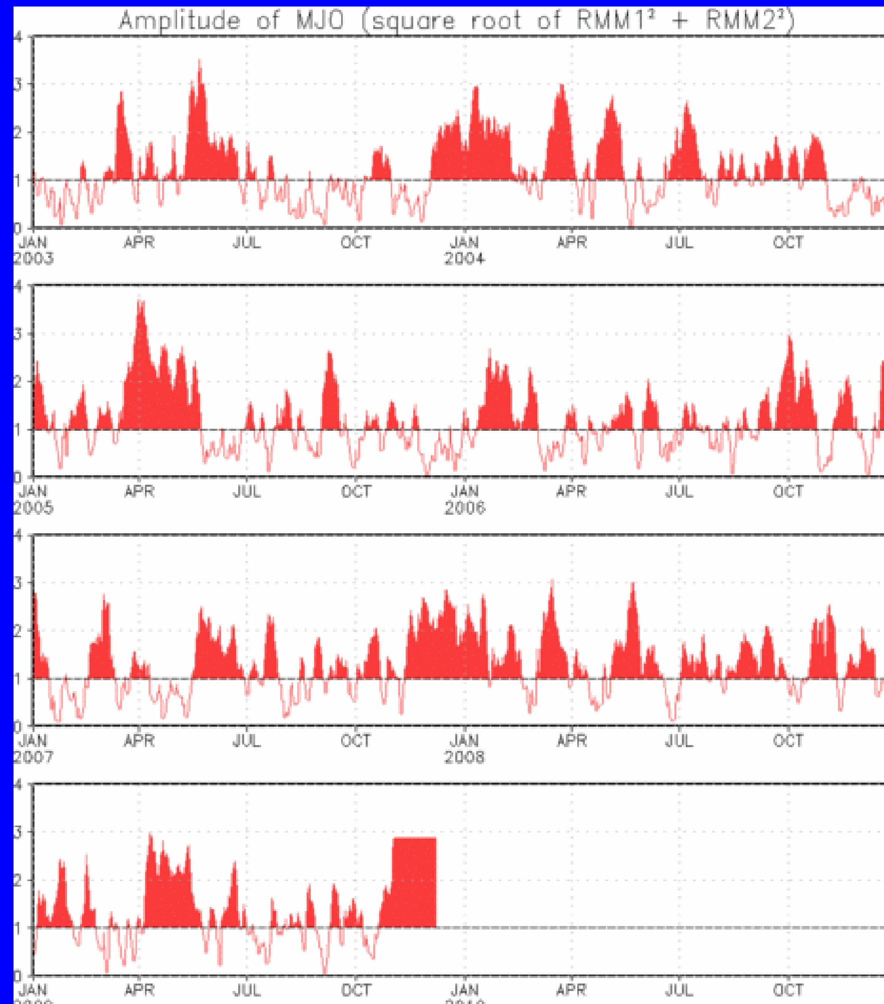
- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

During early January, the MJO index indicated eastward propagation that was more consistent with the MJO time scale although its amplitude decreased.

Over the past week, the index indicates eastward propagation slowed. This is most likely a result of other coherent tropical variability.

MJO Index – Historical Daily Time Series





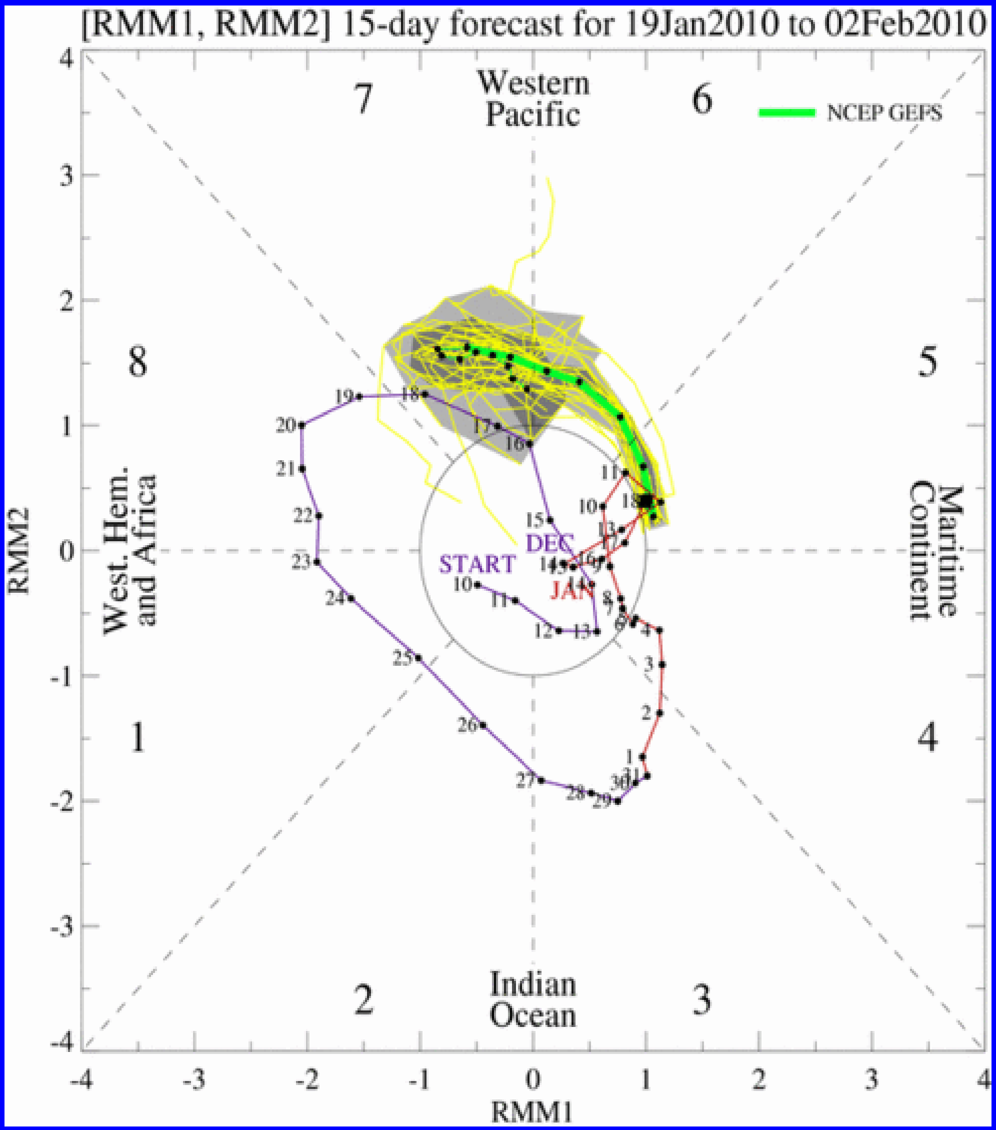
Time series of daily MJO index amplitude from 1995 to present. Plots put current MJO activity in historical context.

Ensemble GFS (GEFS) MJO Forecast

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



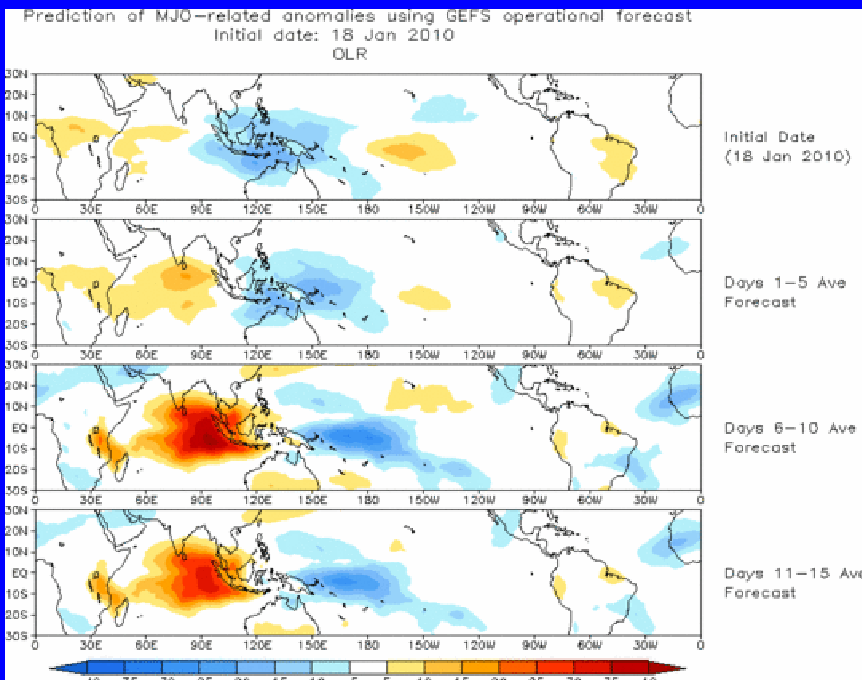
The GFS MJO index forecasts indicate eastward propagation during the next two weeks. The signal slows during Week-2 across the western Pacific.

There is high confidence during Week-1 as indicated by the small ensemble spread.

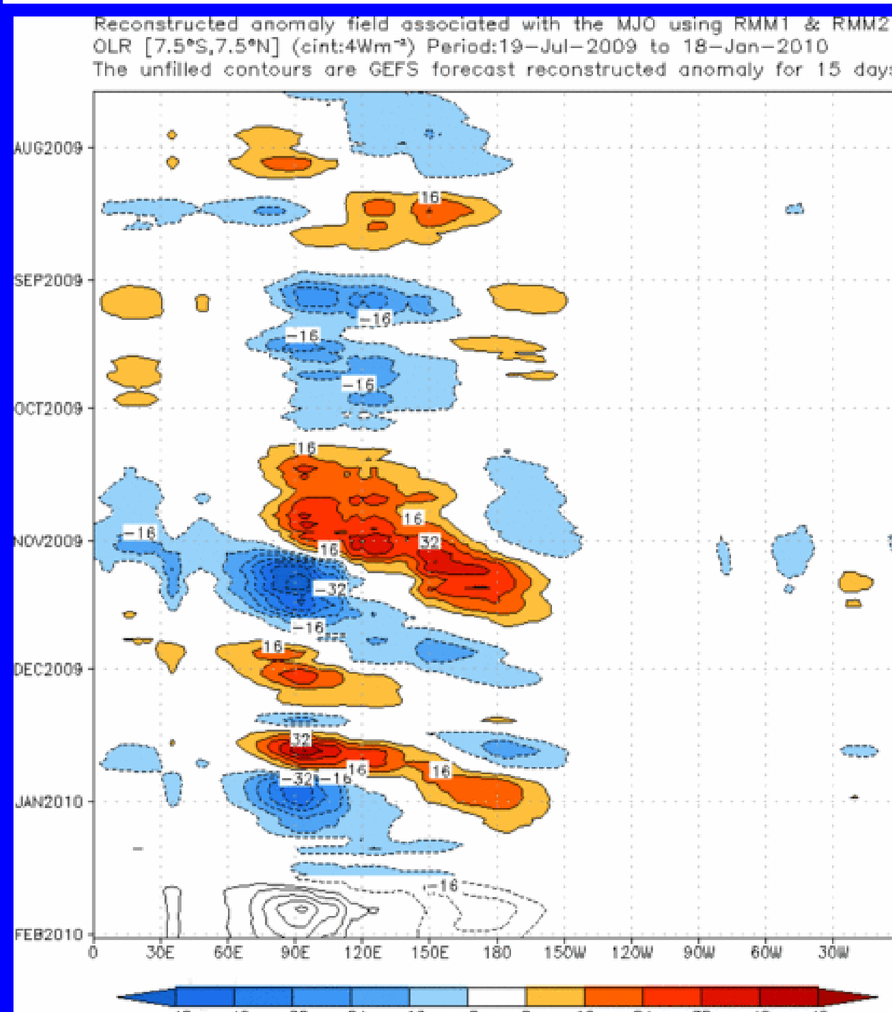
Ensemble Mean GFS MJO Forecast

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 ensemble mean forecast indicates enhanced convection (blue shades) across the Maritime continent early then shifting into the western Pacific. Suppressed convection intensifies across the Indian Ocean during Week-2.

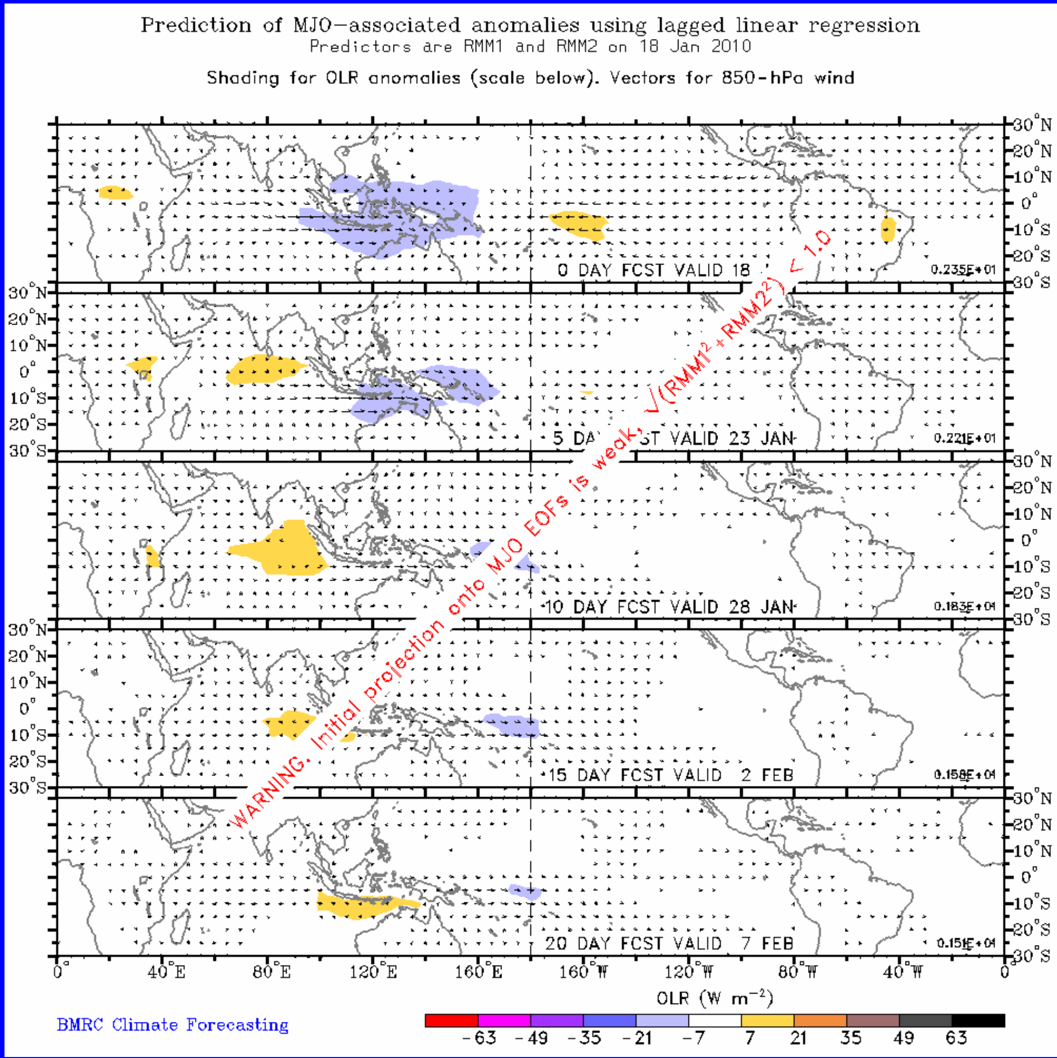
Statistical MJO Forecast

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 vectors for the next 20 days

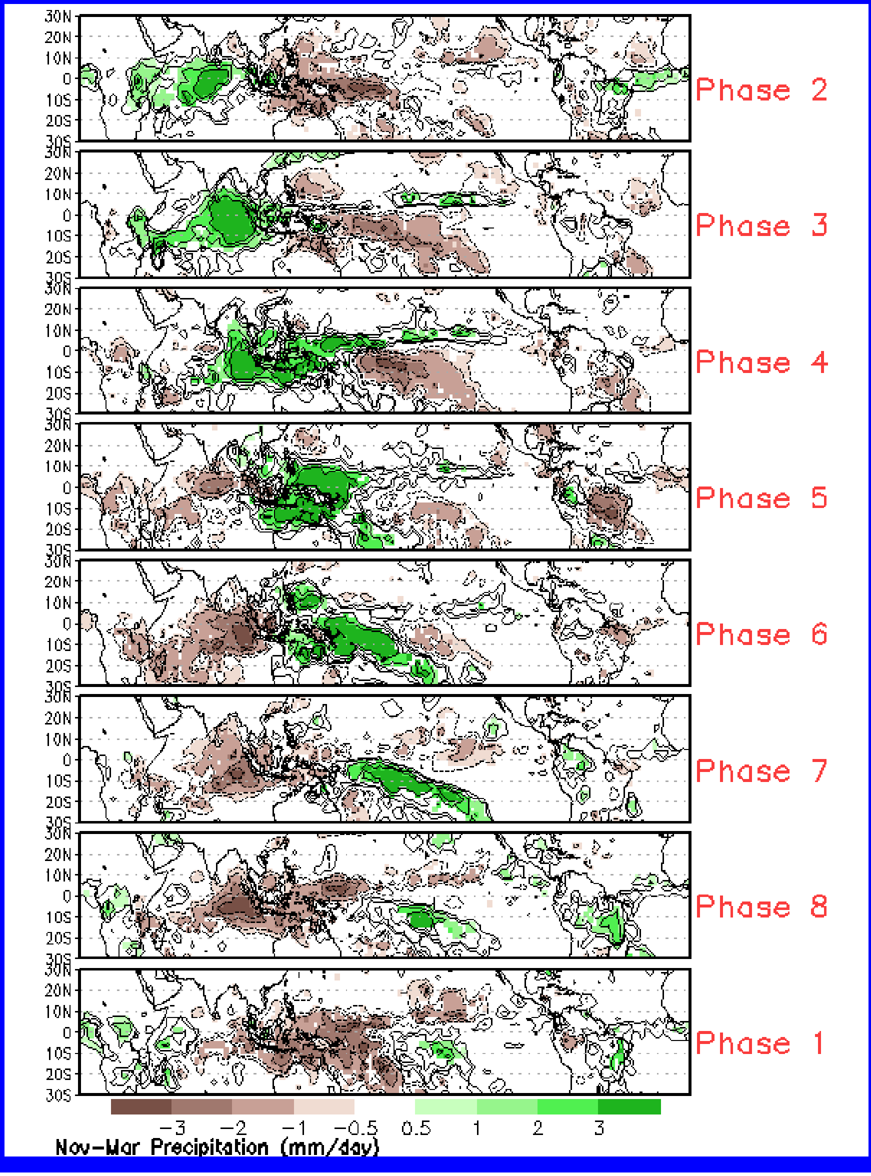
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

The statistical forecast indicates a weak signal during the period.



MJO Composites – Global Tropics

Precipitation Anomalies (Nov-Mar)



850-hPa Wind Anomalies (Nov-Mar)