



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

**Update prepared by
Climate Prediction Center / NCEP
March 05, 2012**



Outline

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



Overview

- **The MJO remained active during the past week with the enhanced phase shifting across the eastern Indian Ocean.**
- **Dynamical model MJO index forecasts show a moderate strength MJO signal continuing through the period. There is some spread amongst the models about the magnitude and phase by the end of Week-2, but most favor the enhanced phase moving across the Maritime Continent during the period. The MJO is forecast to remain active during the upcoming 1-2 weeks.**
- **The MJO is forecast to contribute to enhanced convection across the Maritime Continent and parts of the western Pacific during the next two weeks. Suppressed convection is favored for the parts of Brazil, Africa, and the Indian Ocean (Weeks 1-2) during the period.**
- **The current and upcoming phases of the MJO favor constructive interference with La Nina conditions for the majority of the period as enhanced convection related to the MJO increases over the Maritime continent.**
- **Above-average temperatures are favored for the eastern U.S. as the MJO enhanced phase shifts across the Maritime continent into the western Pacific. The MJO and La Nina favor enhanced moisture across parts of the Pacific Northwest, the northern tier of the contiguous U.S, Great Lakes and Ohio Valley.**

Additional potential impacts across the global tropics are available at:
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

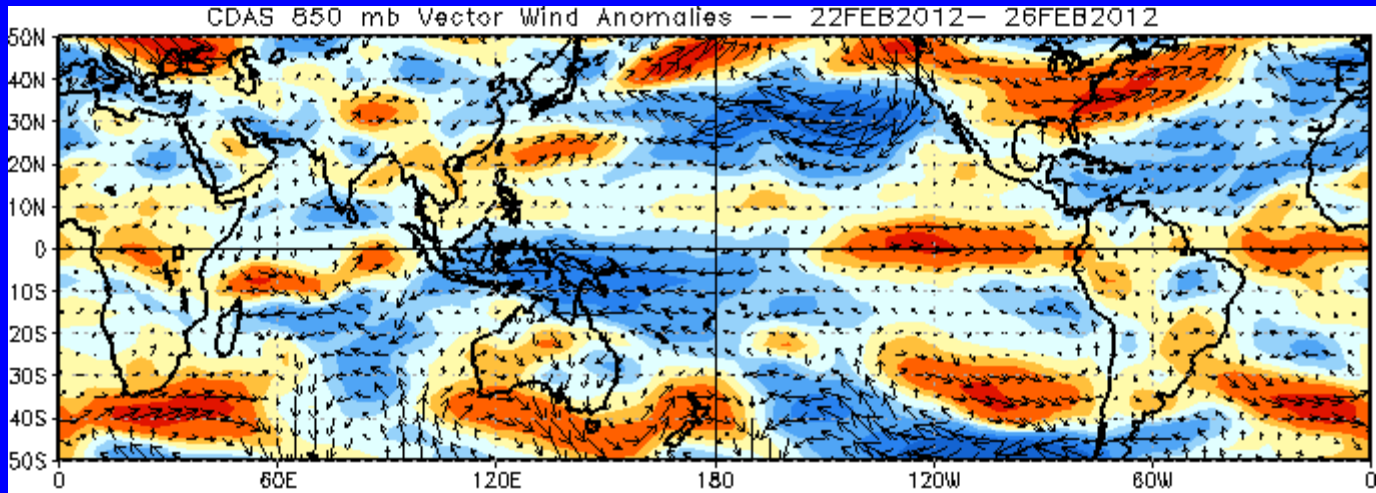


850-hPa Vector Wind Anomalies (m s^{-1})

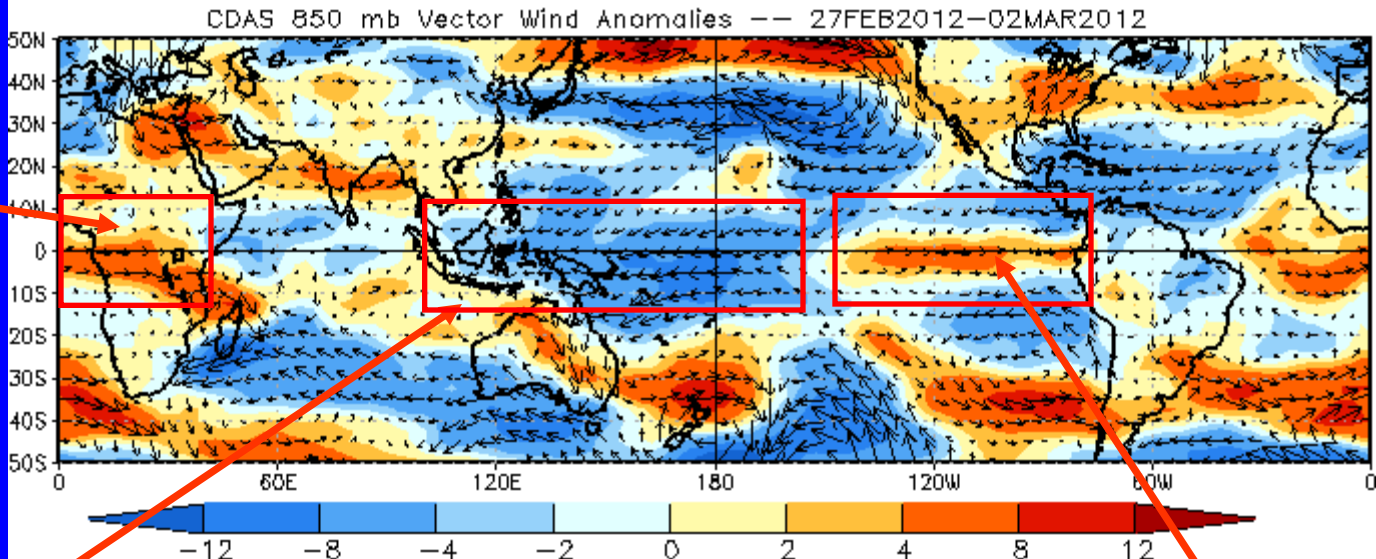
Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



Westerly anomalies over the Atlantic Ocean and Africa expanded eastward and increased during the past five days.



Easterly anomalies persisted over the Maritime Continent and expanded over the Central Pacific during the past five days.

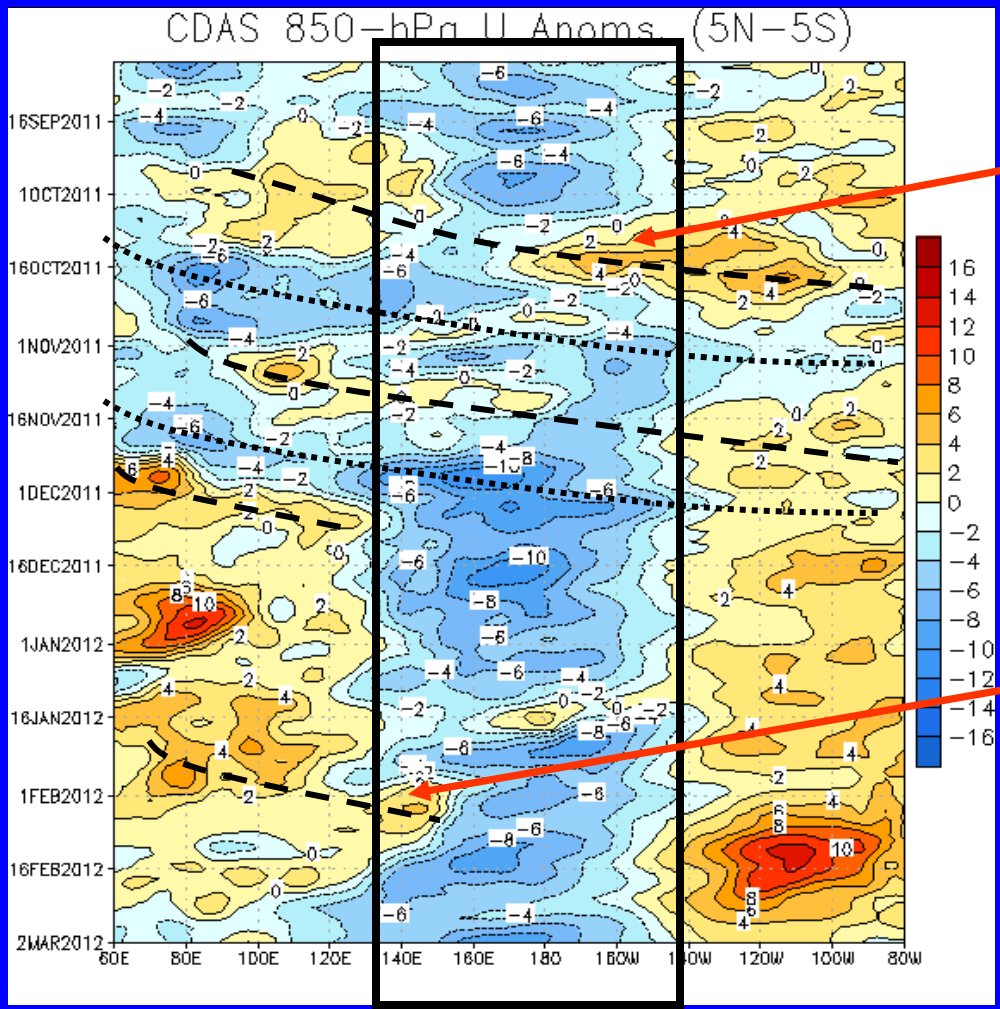
Westerly wind anomalies over the eastern Pacific Ocean persisted during the last five days.



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

In early October, MJO activity weakened the persistent easterly anomalies across the central Pacific (first dashed line).

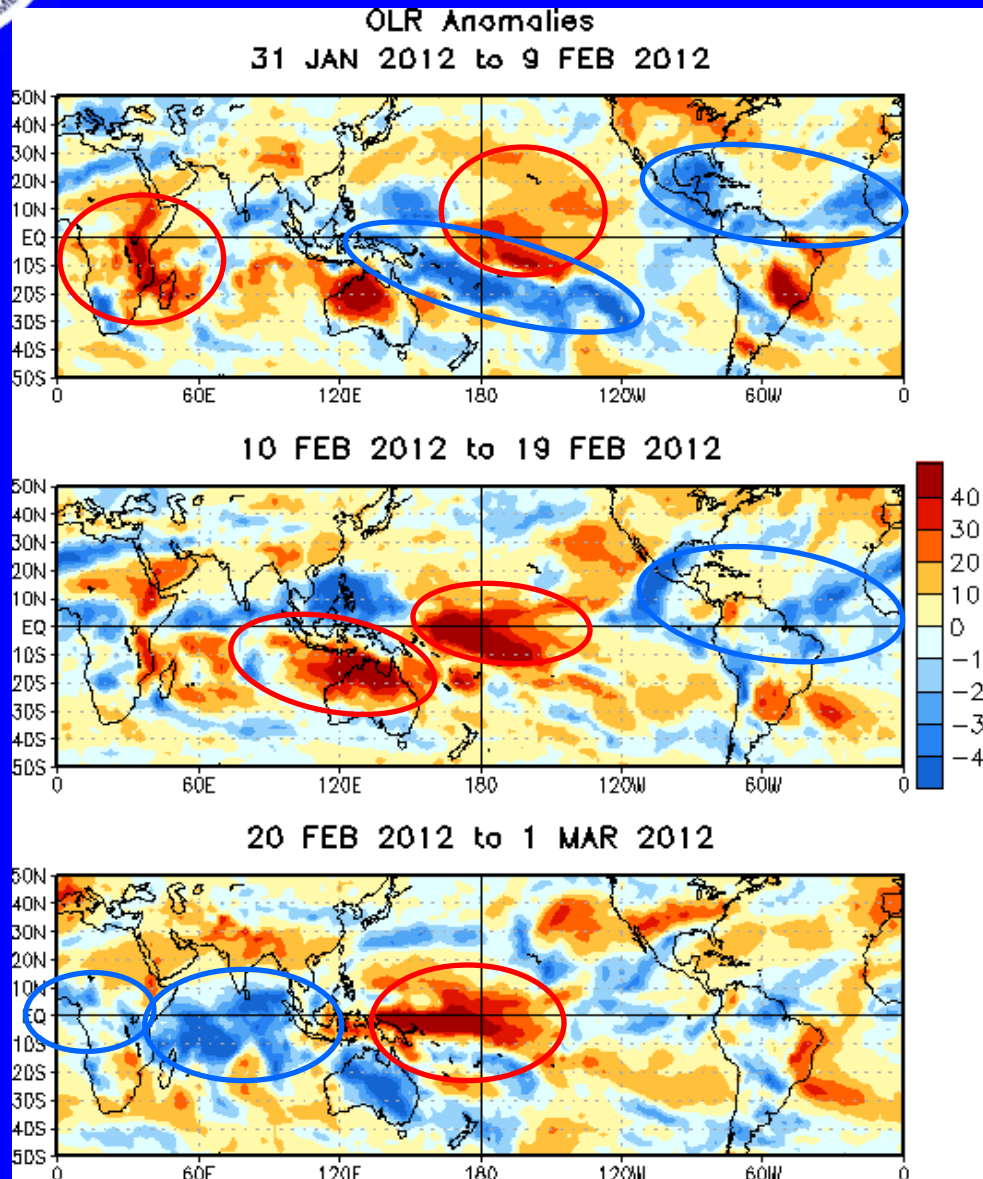
MJO activity continued into December (altering dashed and dotted lines), but then westerly (easterly) wind anomalies across the Indian Ocean (western Pacific) became more stationary.

In early February, westerly anomalies extended to 140E and were associated with the current MJO activity.

Recently, easterly anomalies expanded westward over the Maritime Continent and Western Pacific while westerly anomalies persisted over the eastern Pacific.



OLR Anomalies – Past 30 days



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

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

During late January and early February, suppressed convection was observed in the central Pacific, Africa and the western Indian Ocean. Enhanced convection covered the area from the eastern Maritime continent to the southwest Pacific.

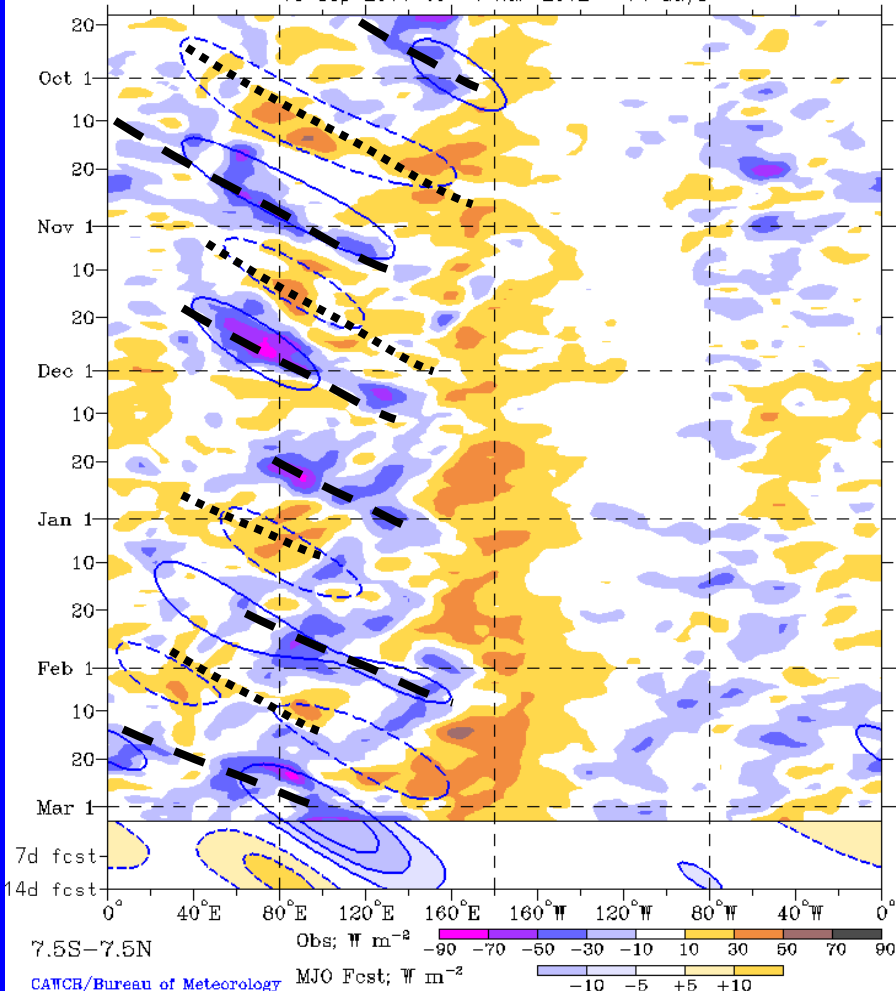
The MJO contributed to enhanced convection across the Americas and the Atlantic during early-to-mid February. Suppressed convection was observed for the eastern Indian Ocean and northern Australia.

During late February, the MJO contributed to enhanced (suppressed) convection across Africa and the Indian Ocean (western Pacific).



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

Real-time MJO filtering superimposed upon 3drmm R21 OLR Anomalies
MJO anomalies blue contours, CINT=10. (5. for forecast)
Negative contours solid, positive dashed
18-Sep-2011 to 4-Mar-2012 + 14 days



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

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

(Courtesy of CAWCR Australia Bureau of Meteorology)

Beginning in mid-September, enhanced convection shifted from southern Asia to the western Pacific while suppressed convection developed during late September across India and also shifted eastward to the western Pacific.

MJO activity continued into early December, then OLR anomalies decreased and eastward propagation was not as clear.

Enhanced convection (dashed lines) propagated eastward across the Indian Ocean and Maritime Continent during January as the MJO strengthened. MJO activity has continued into March. Other modes of coherent subseasonal tropical variability (Equatorial Rossby Wave) is also evident during February between 80E and 140E.

Longitude

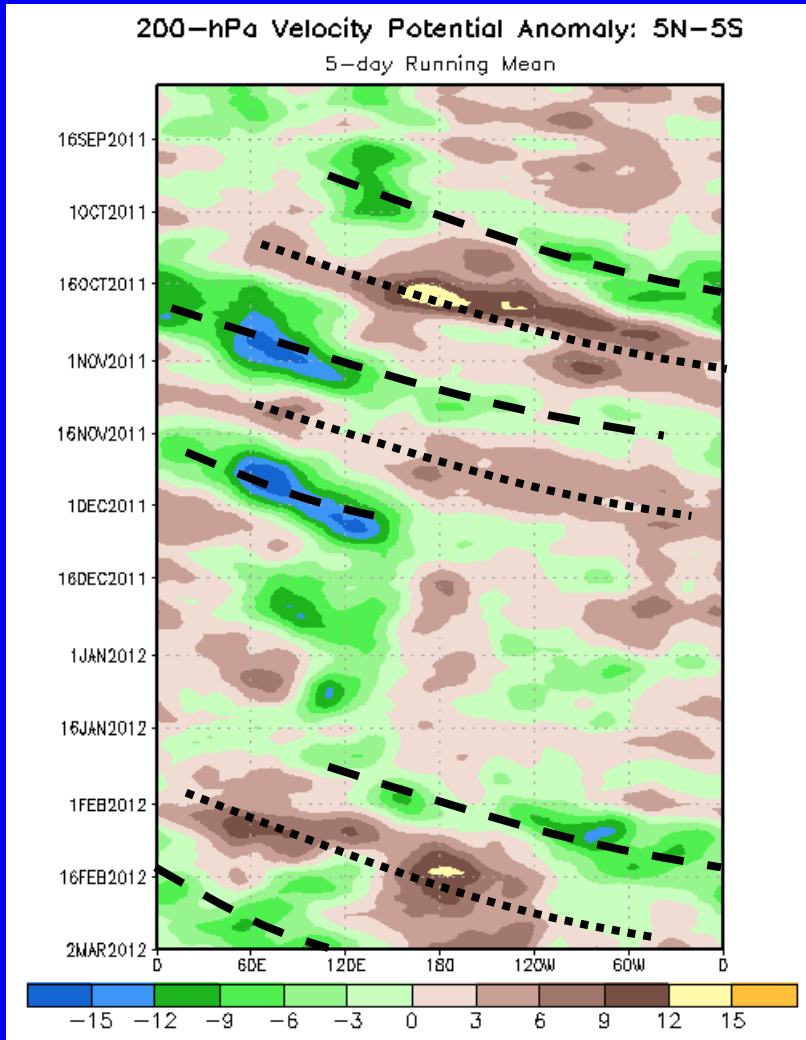


200-hPa Velocity Potential Anomalies (5°S-5°N)

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

Negative anomalies (green shading) indicate favorable conditions for precipitation

Time



Longitude

Beginning in the second half of September into December, alternating negative (dashed lines) and positive (dotted lines) anomalies were evident and associated with MJO activity during the period.

Eastward propagation of anomalies became less coherent during late December and early January and anomalies weakened.

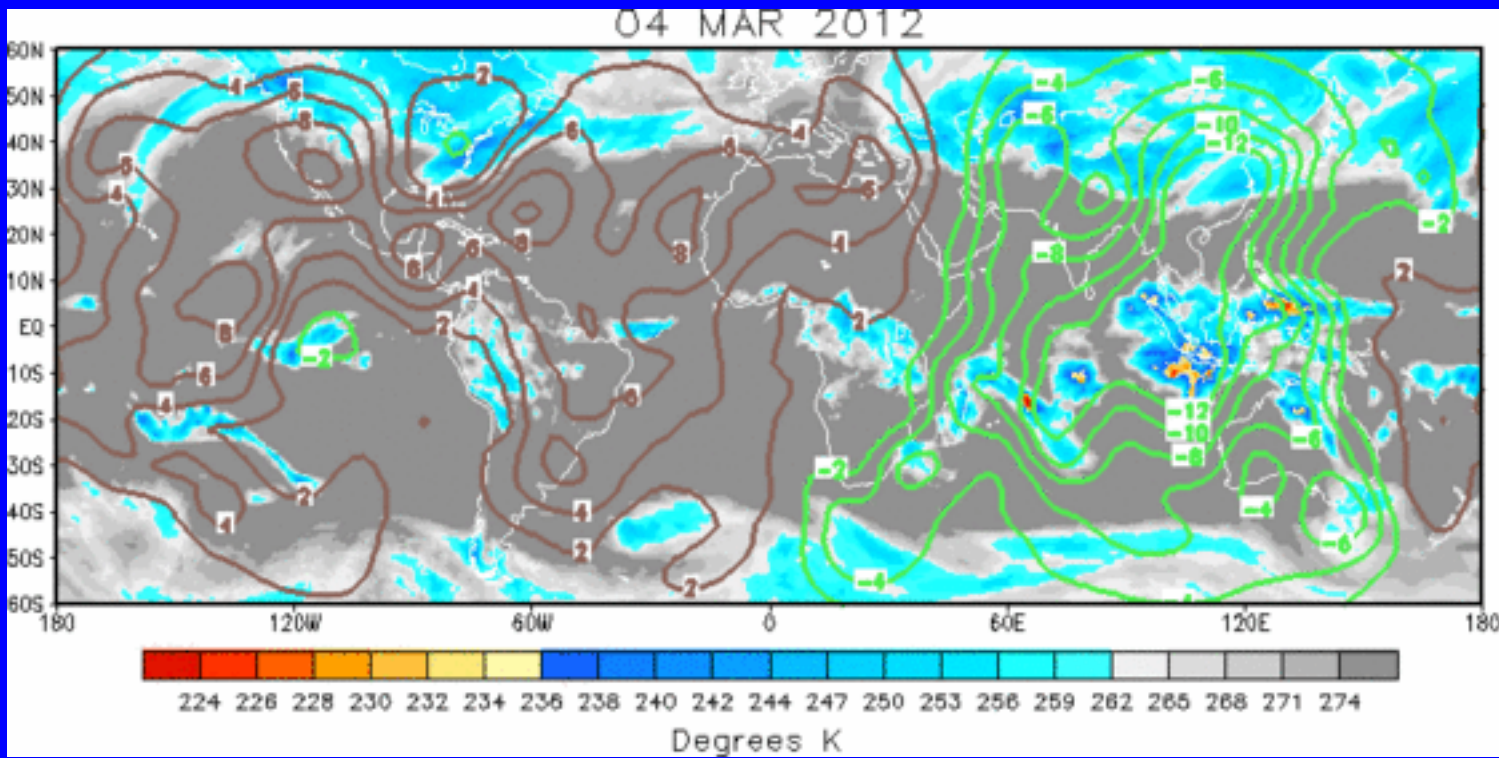
Eastward propagation again became evident in late January and continued to mid February, during which anomalies became nearly stationary. In the most recent couple of days, eastward propagation is once again more evident.



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 velocity potential pattern generally exhibits a wave-1 structure with upper-level divergence across the Indian Ocean and Maritime Continent, with upper-level convergence from the central Pacific to western Africa. Other modes of subseasonal tropical variability and mid-latitude influences are also affecting the pattern.

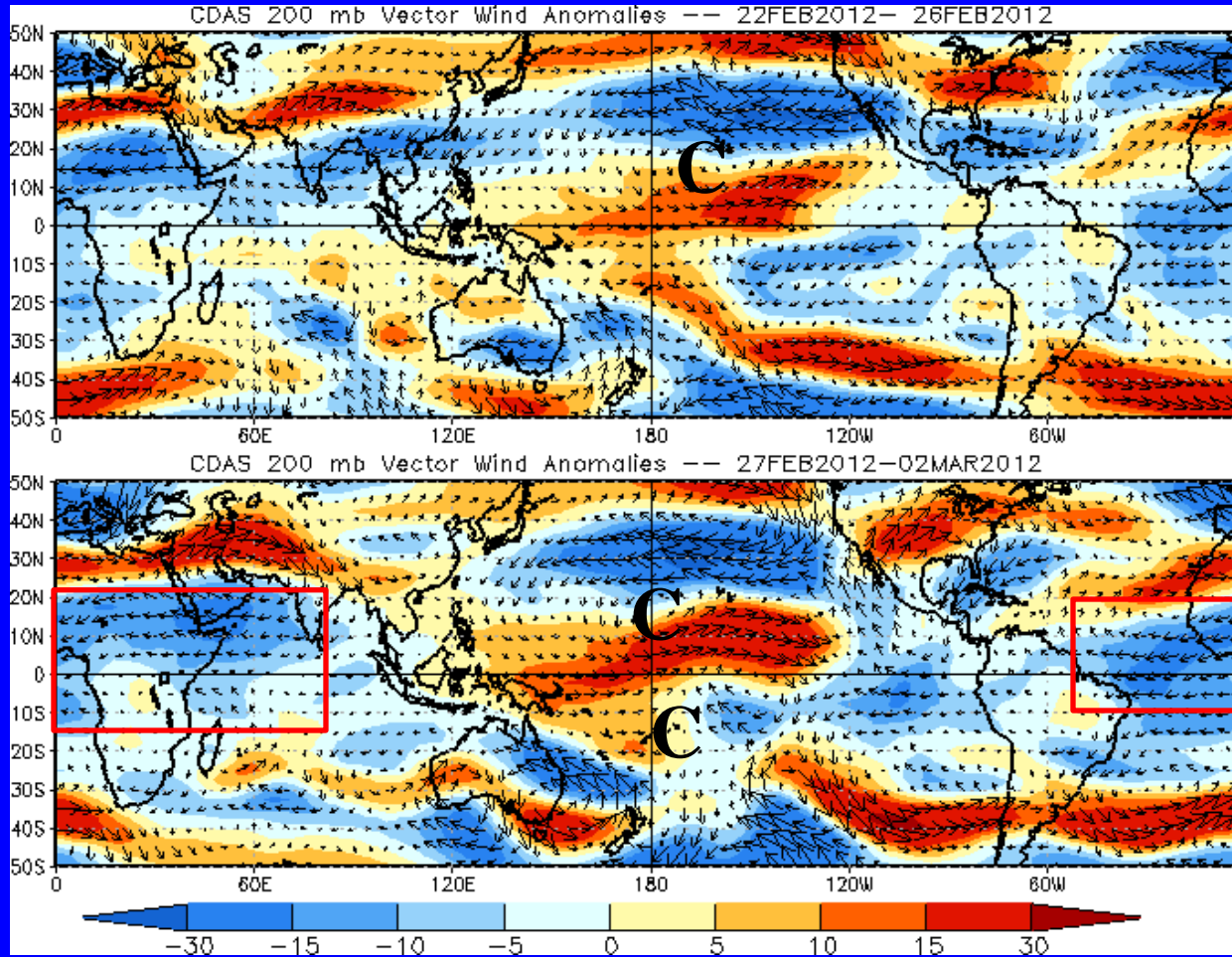


200-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



A large scale cyclonic circulation is evident north of the equator east of the Date Line with a more elongated trough south of the equator.

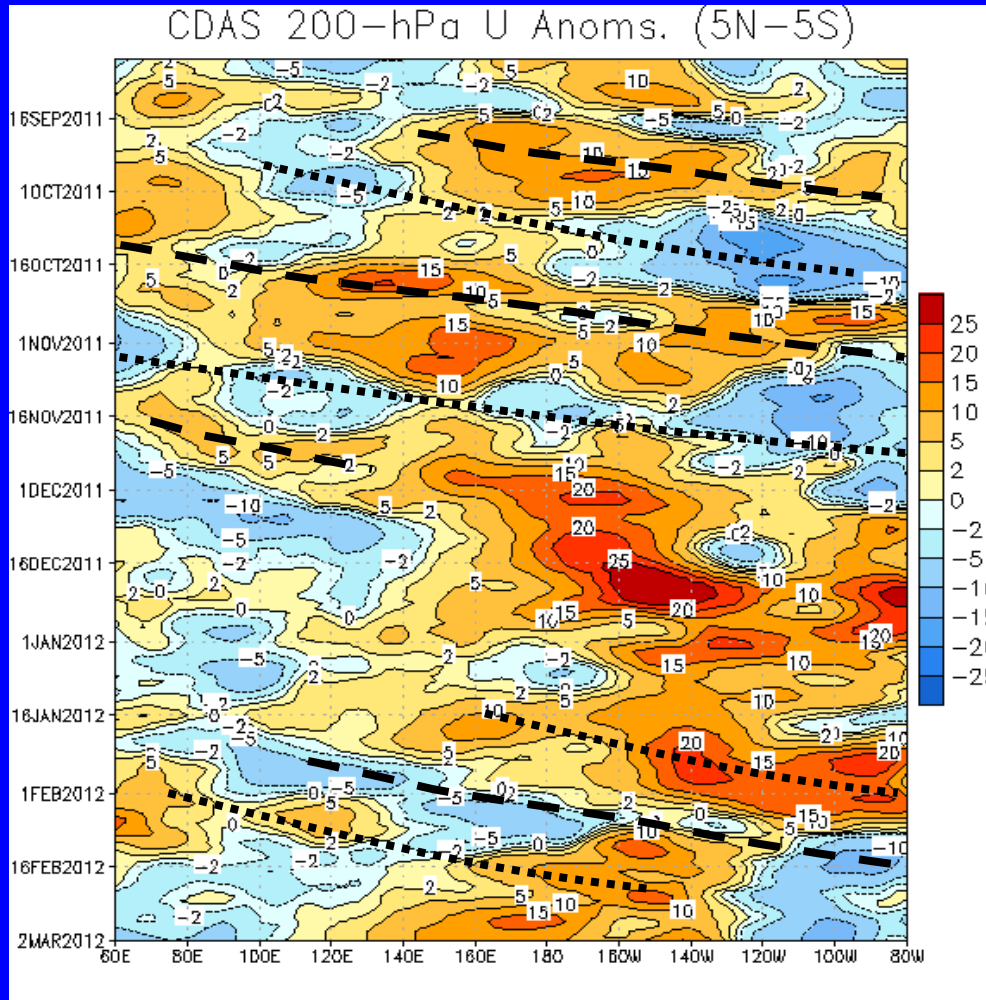
During the most recent five days, westerly anomalies over the western and central Pacific have increased in coverage and magnitude while easterly anomalies have spread over equatorial Africa. The entire upper-level pattern over the Pacific has shifted slowly westward.



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



Alternating westerly (dashed lines) and easterly (dotted lines) anomalies are evident from mid-September into December associated with the MJO.

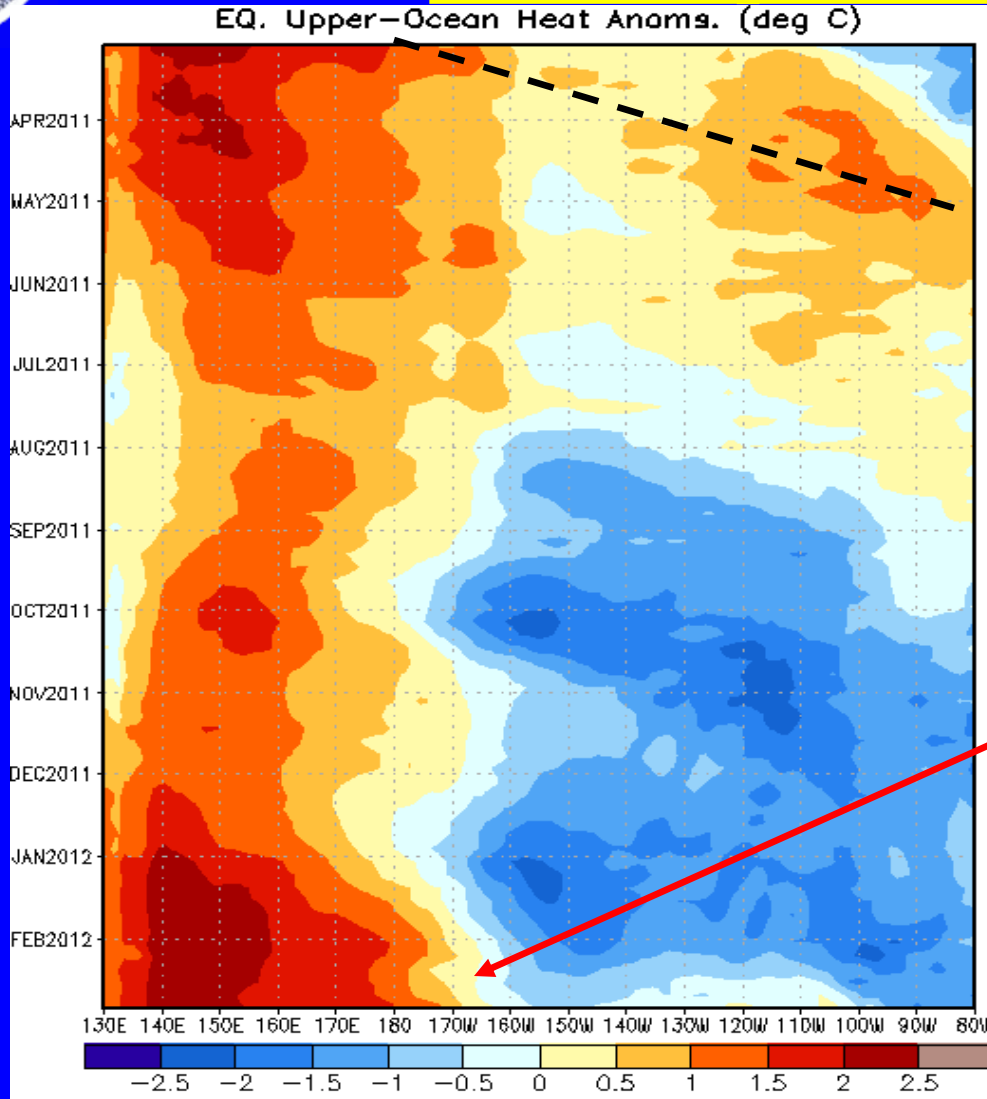
In December, westerly anomalies strengthened over the Pacific.

In January these westerly anomalies have shown some eastward propagation and easterly anomalies have also shifted eastward into the Pacific.

During February, westerly anomalies have moved slowly westward and are now located over the Maritime Continent and the Western Pacific.



Weekly Heat Content Evolution in the Equatorial Pacific



An oceanic Kelvin wave (dashed line) shifted eastward during February and March 2011.

Since late July, negative heat content anomalies are evident across the equatorial central and eastern Pacific.

In January and February 2012, negative heat content anomalies have weakened in the central and eastern equatorial Pacific.



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 U.S. CLIVAR MJO Working Group.

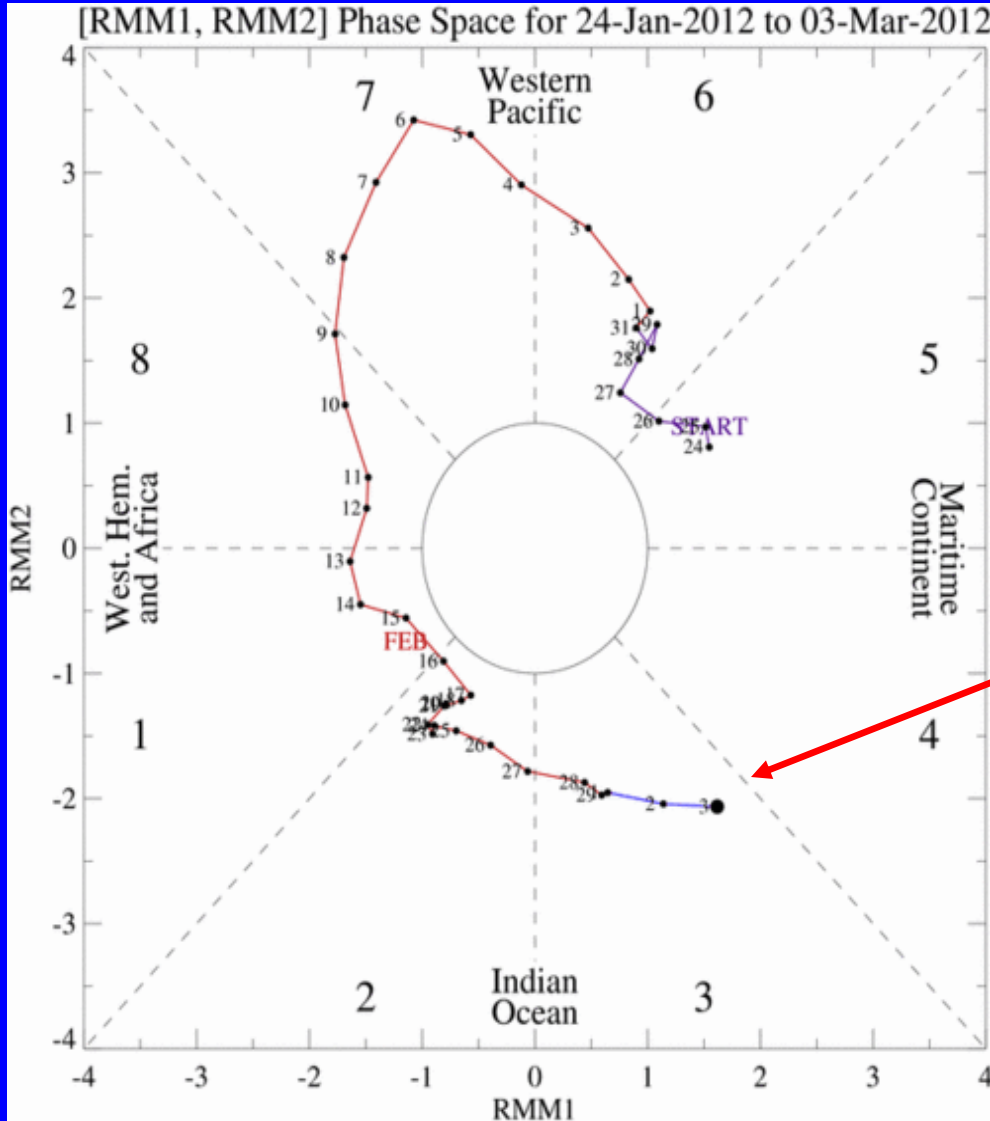
Gottschalck et al. 2010: A Framework for Assessing Operational Madden-Julian Oscillation Forecasts: A CLIVAR MJO Working Group Project, *Bull. Amer. Met. Soc.*, 91, 1247-1258.

- 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

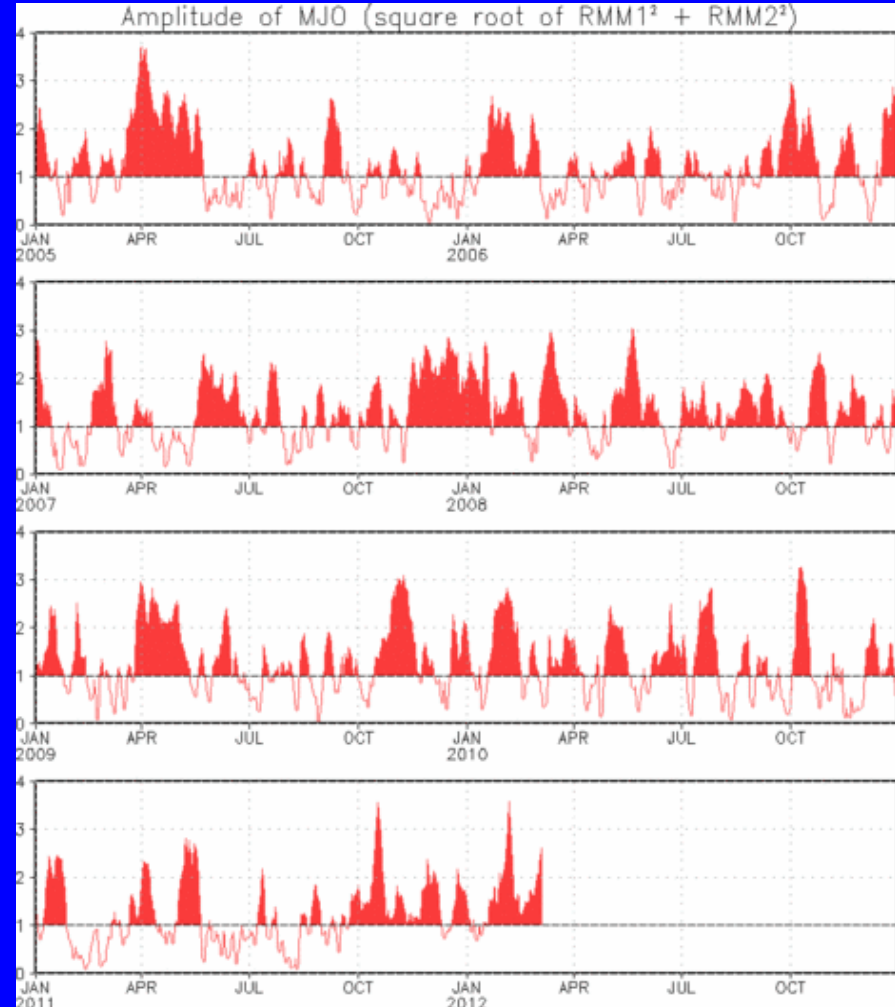
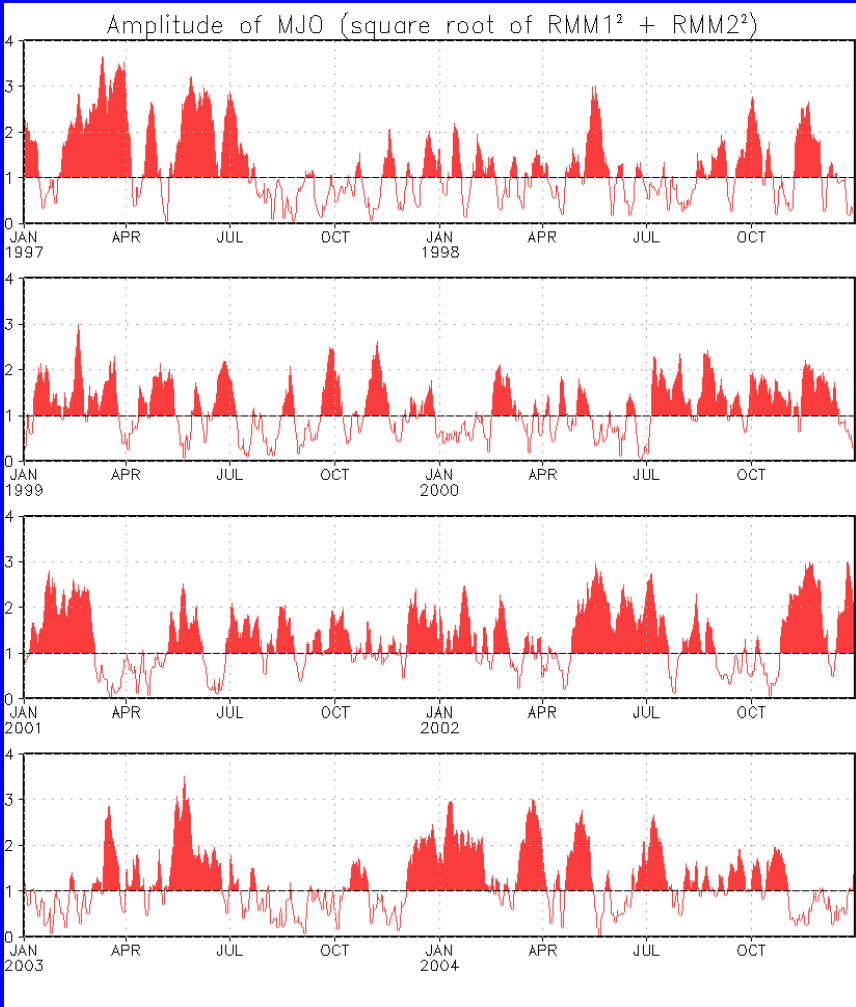
- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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



The MJO index shows continued MJO activity during the past week. The eastward propagation has returned to speeds consistent with coherent MJO activity.



MJO Index – Historical Daily Time Series



Time series of daily MJO index amplitude from 1997 to present. Plots put current MJO activity in historical context.



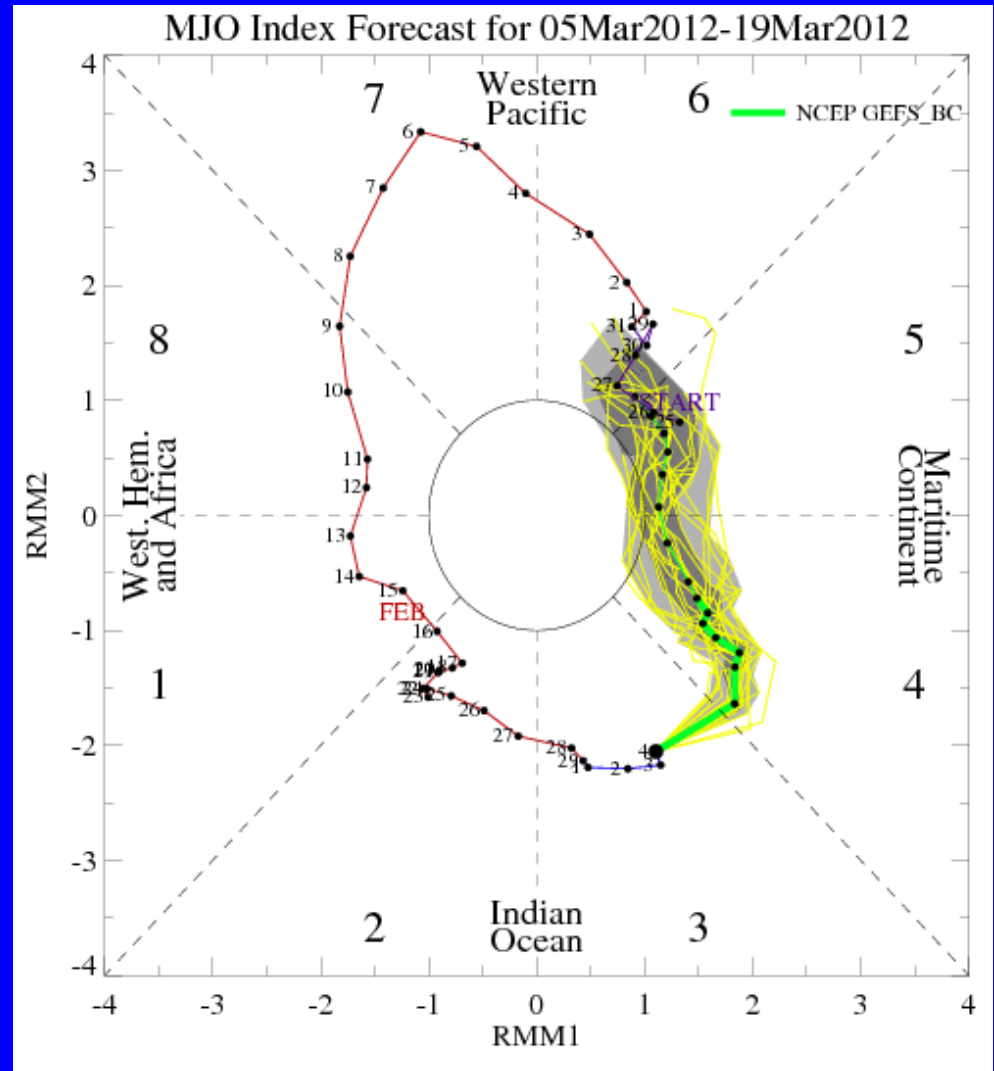
Ensemble GFS (GEFS) MJO Forecast

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 ensemble GFS forecasts the MJO signal to continue propagating eastward over the next two weeks with the enhanced phase over the Maritime Continent during Week-1 and potentially entering the Western Pacific by the end of Week-2.



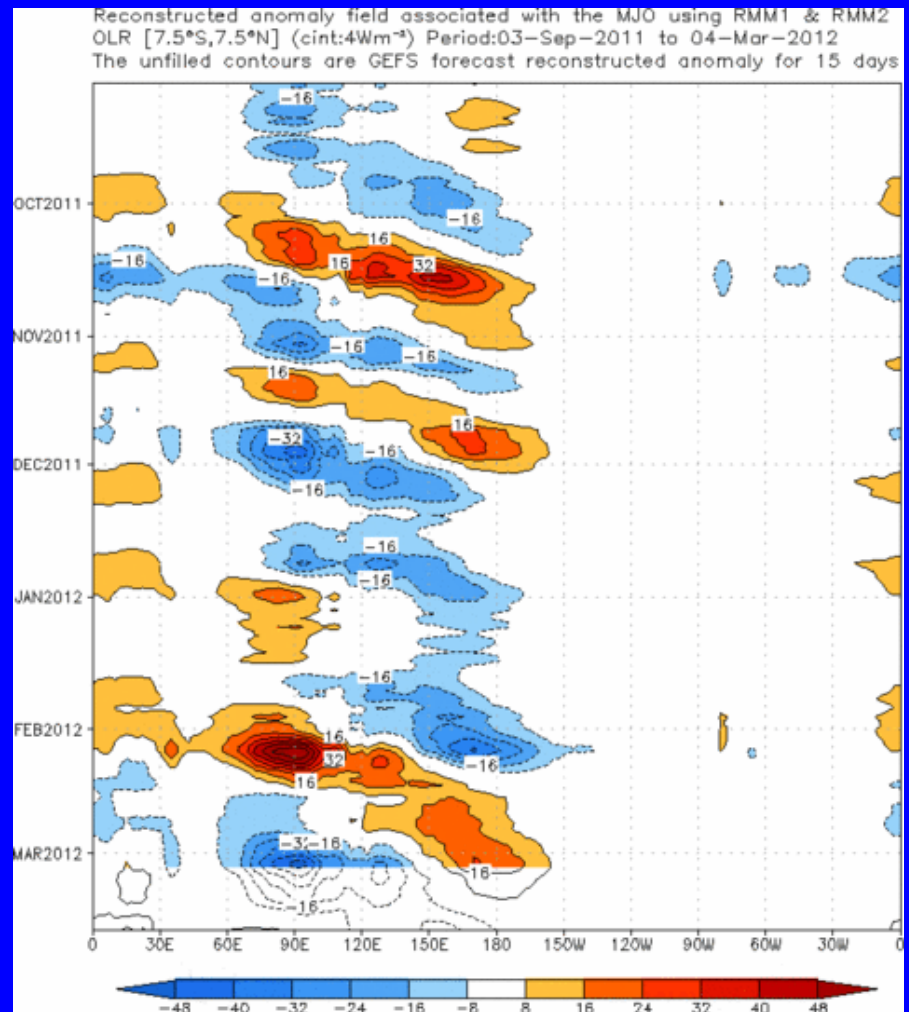
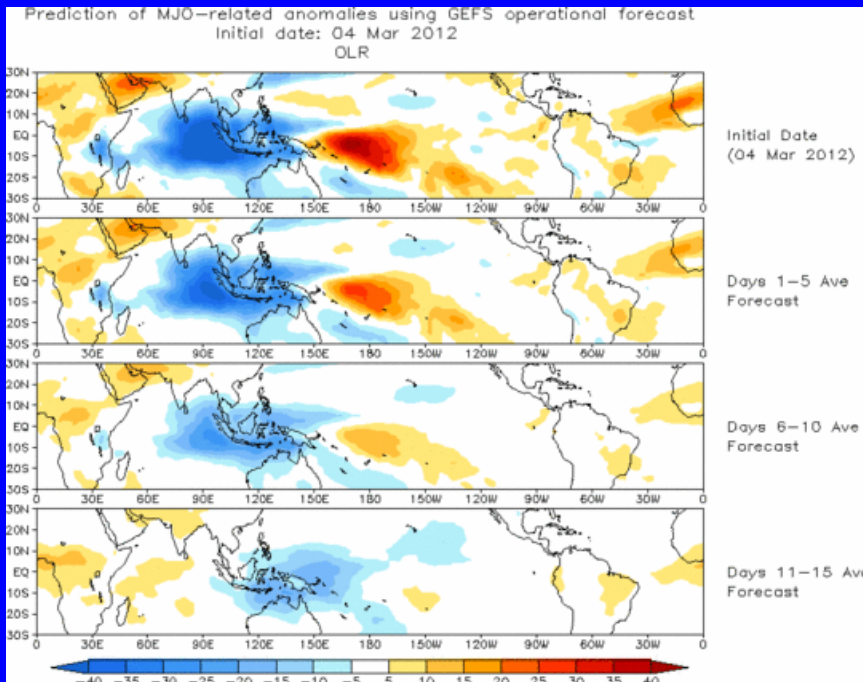


Ensemble Mean GFS MJO Forecast

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, etc.)

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 ensemble mean GFS forecast indicates enhanced convection across the Indian Ocean and Maritime Continent during Week-1 with some eastward propagation into the western Pacific by the end of Week-2. Suppressed convection is forecast across the central equatorial Pacific and the lower latitudes of the Americas during the period.

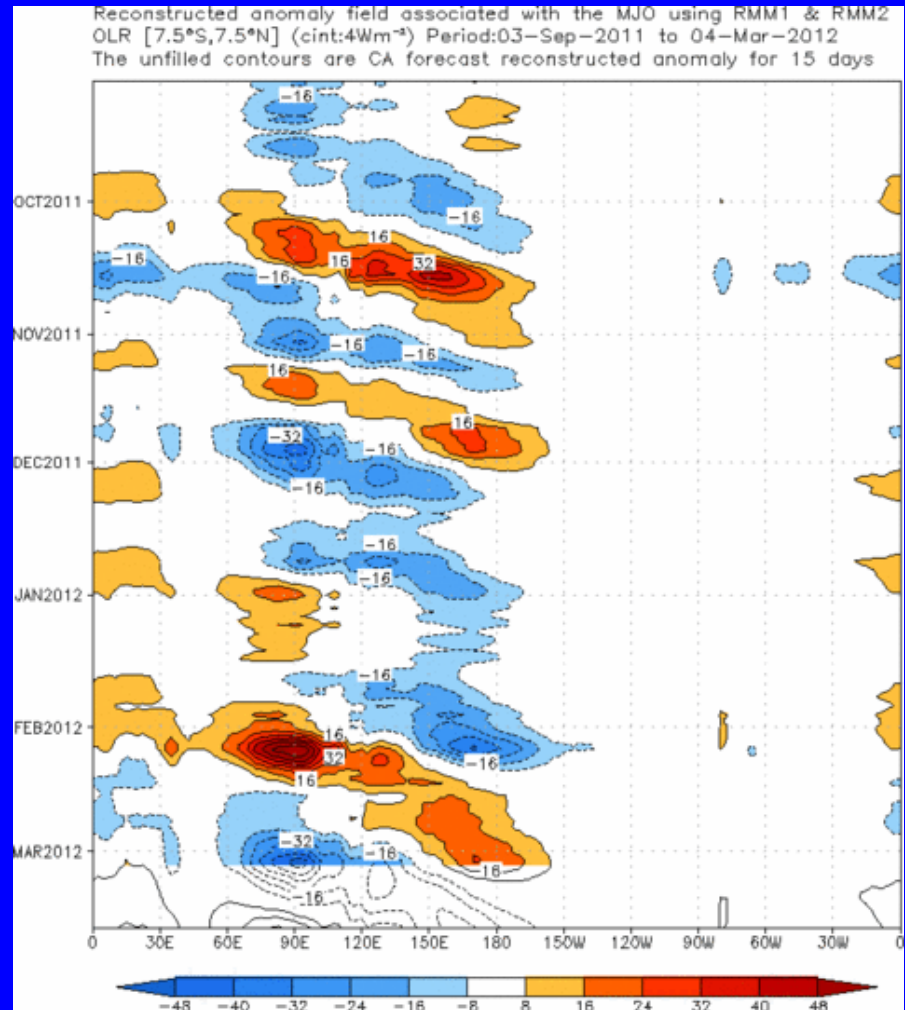
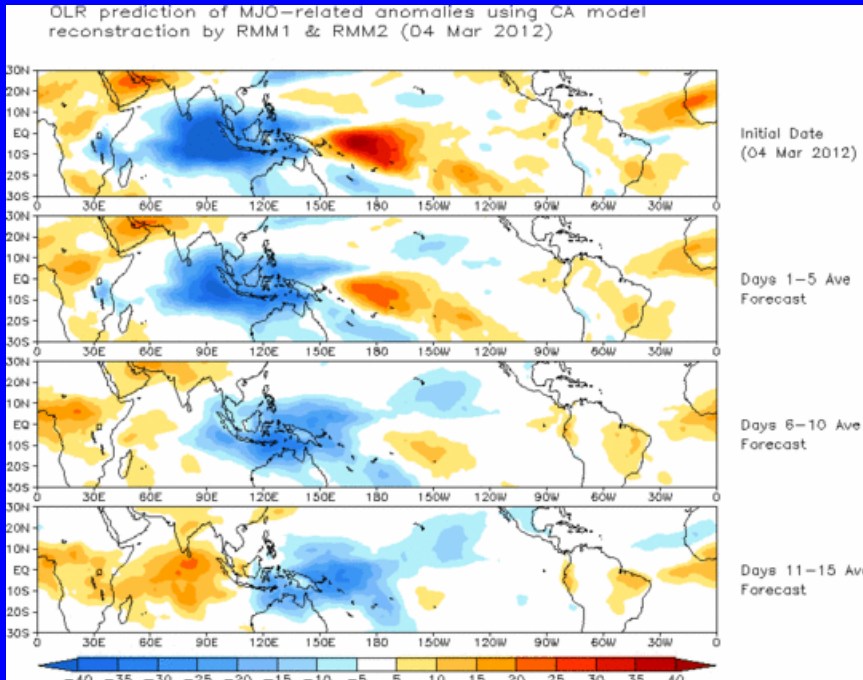


Constructed Analog (CA) MJO Forecast

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, etc.)

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

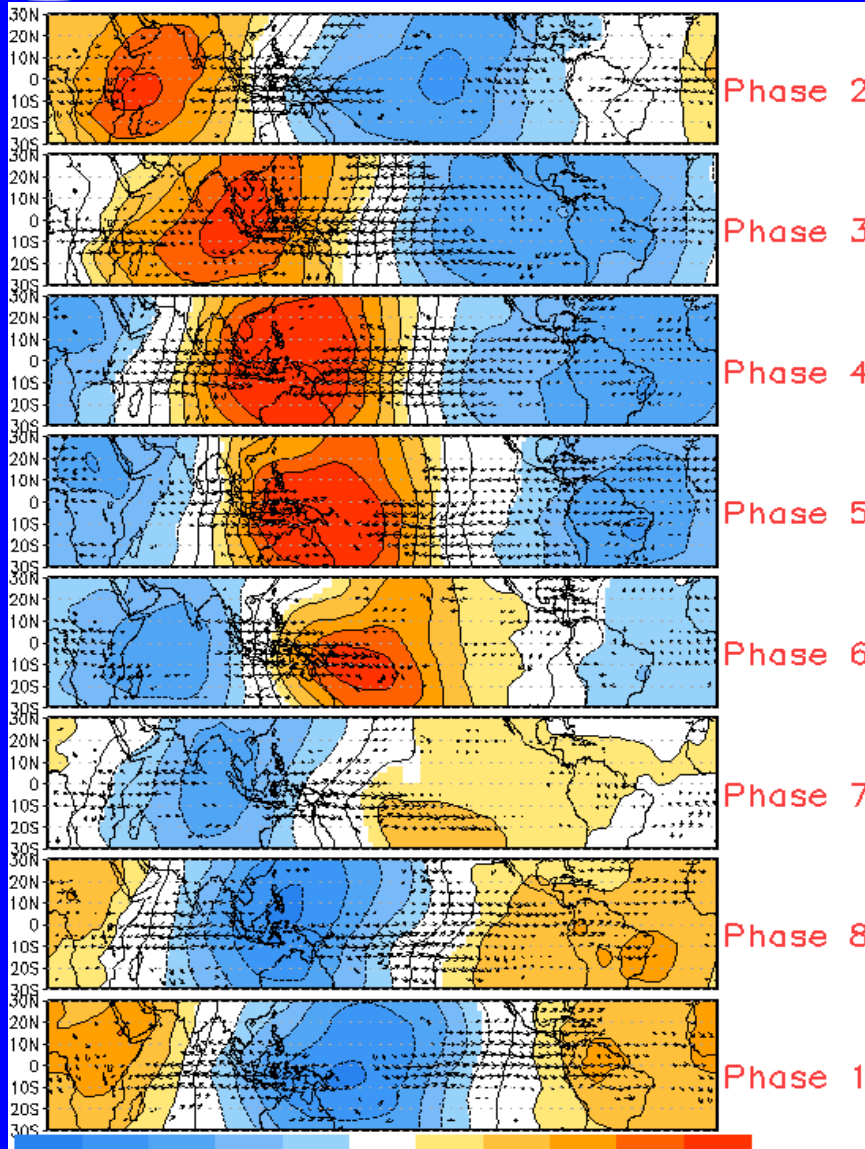


The CA forecast shows enhanced convection stretching from the Indian Ocean to the Maritime Continent during Week-1, and later the western Pacific during Week-2. A return to drier than average conditions across Africa and the Indian Ocean is forecast during Week-2.

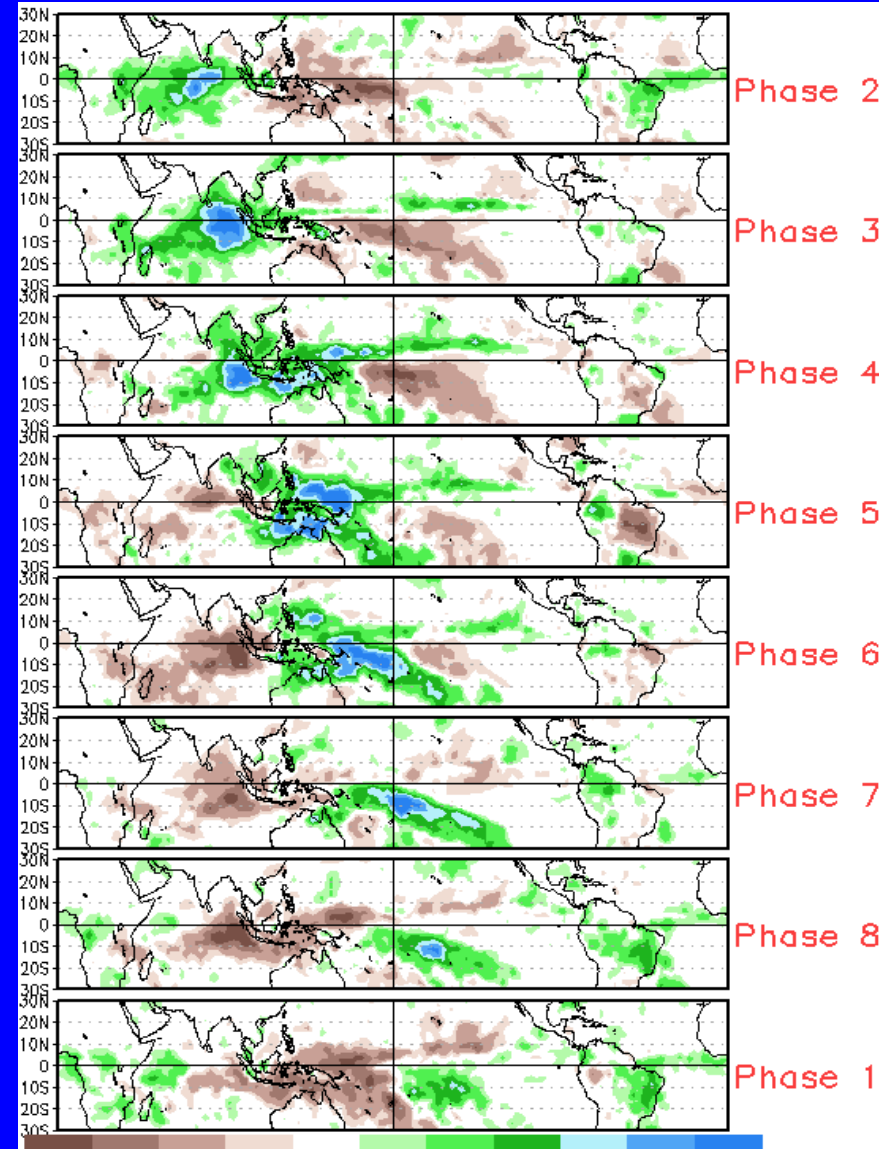


MJO Composites – Global Tropics

850-hPa Wind Anomalies (Nov-Mar)



Precipitation Anomalies (Nov-Mar)

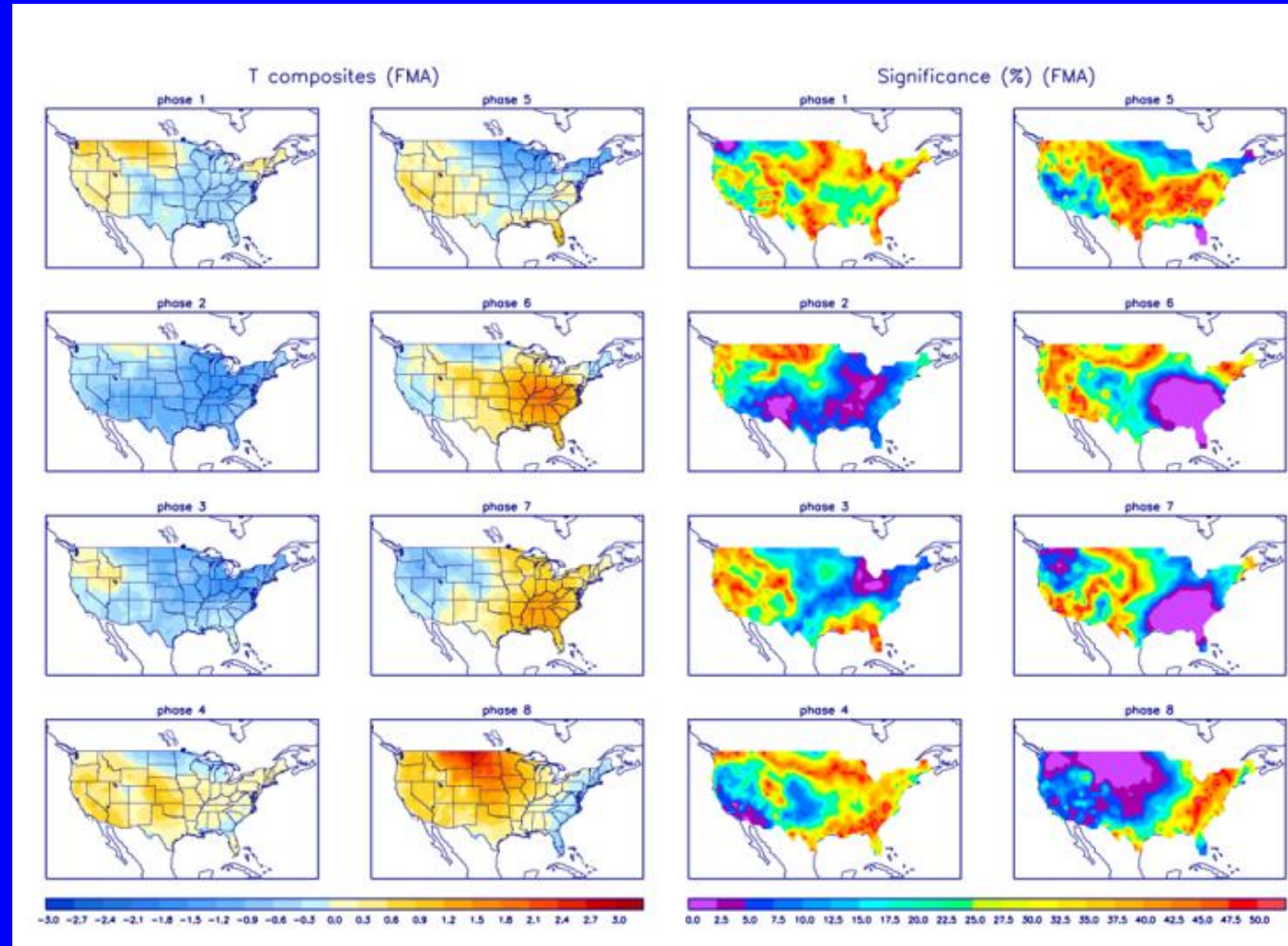




U.S. MJO Composites – Temperature

Left hand side plots show temperature anomalies by MJO phase for MJO events that have occurred over the three month period in the historical record. Blue (orange) shades show negative (positive) anomalies respectively.

Right hand side plots show a measure of significance for the left hand side anomalies. Dark blue and purple shades indicate areas in which the anomalies are significant at the 95% or better confidence level.



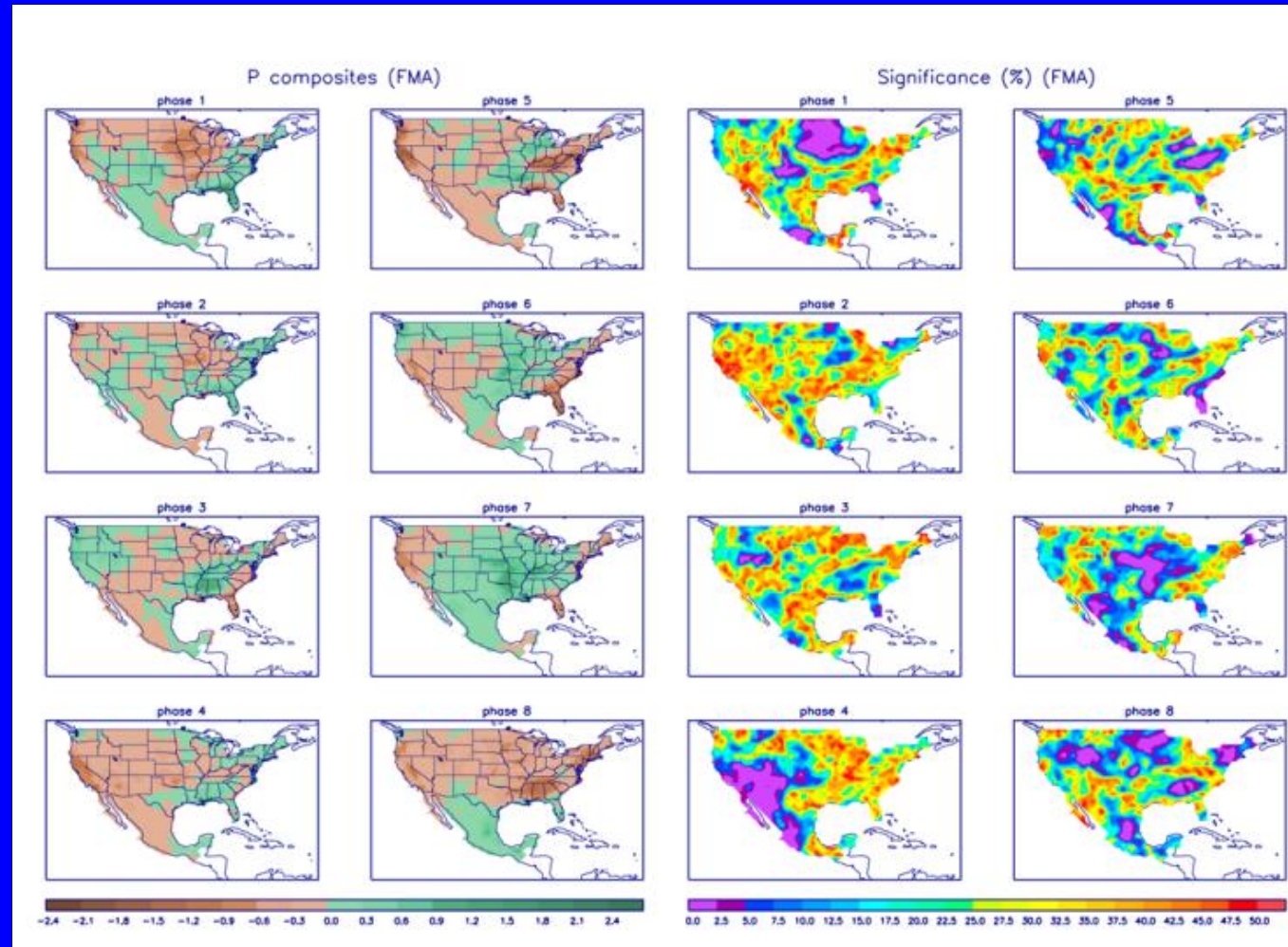
Zhou et al. (2011): A composite study of the MJO influence on the surface air temperature and precipitation over the Continental United States, *Climate Dynamics*, 1-13, doi: 10.1007/s00382-011-1001-9

<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml>



U.S. MJO Composites – Precipitation

- Left hand side plots show precipitation anomalies by MJO phase for MJO events that have occurred over the three month period in the historical record. Brown (green) shades show negative (positive) anomalies respectively.
- Right hand side plots show a measure of significance for the left hand side anomalies. Dark blue and purple shades indicate areas in which the anomalies are significant at the 95% or better confidence level.



Zhou et al. (2011): A composite study of the MJO influence on the surface air temperature and precipitation over the Continental United States, *Climate Dynamics*, 1-13, doi: 10.1007/s00382-011-1001-9

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