



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

Update prepared by
Climate Prediction Center / NCEP
December 12, 2011



Outline

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



Overview

- The MJO has weakened during the past week as several observational indicators have become less coherent. Also, other subseasonal tropical variability is affecting the pattern of tropical convection.
- The majority of dynamical model MJO index forecasts indicate an incoherent MJO signal in Week-1 with some models indicating potential re-strengthening during Week-2.
- Based on the latest observations and some MJO forecasts, the MJO is forecast to remain weak through the first part of the assessment period, but it is too early to indicate an end to the recent MJO activity.
- The MJO is expected to contribute less to patterns of tropical rainfall variability during the period as compared to recent weeks.

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

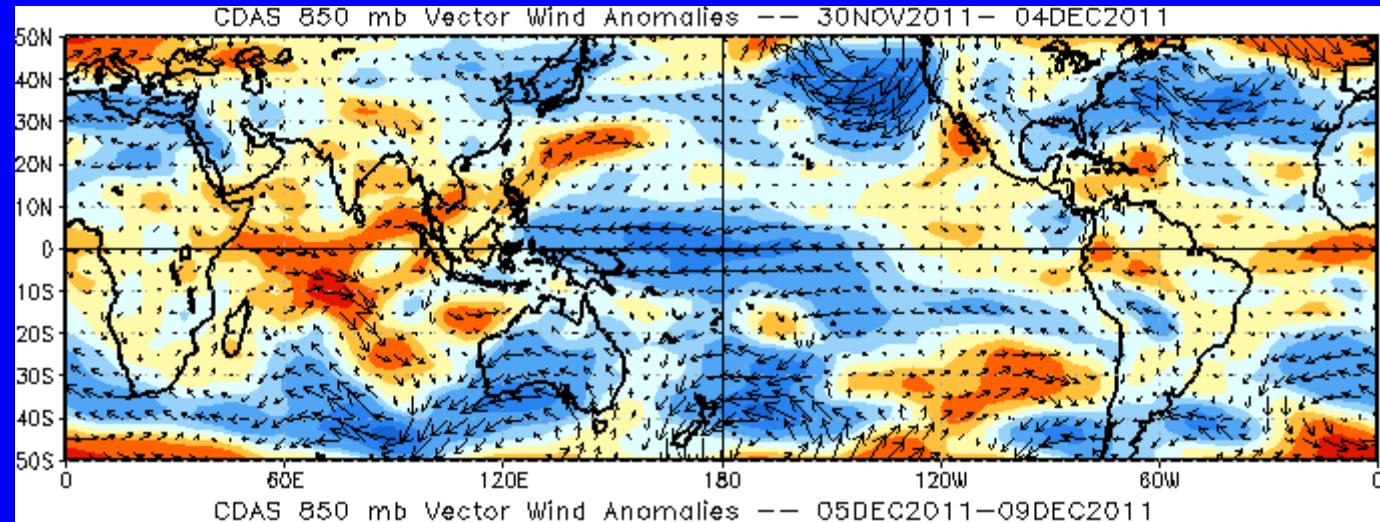


850-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies

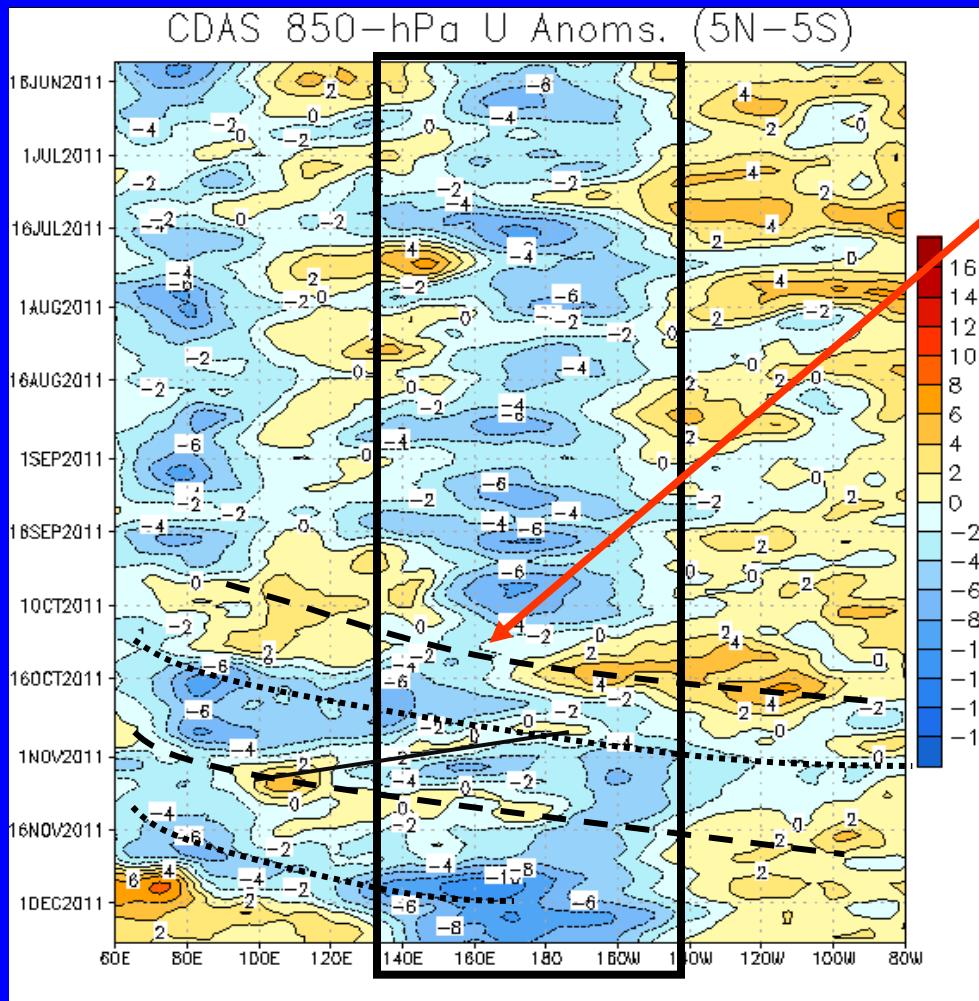


Westerly wind anomalies have strengthened over the Southern Indian Ocean.

Easterly anomalies persisted over the west 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

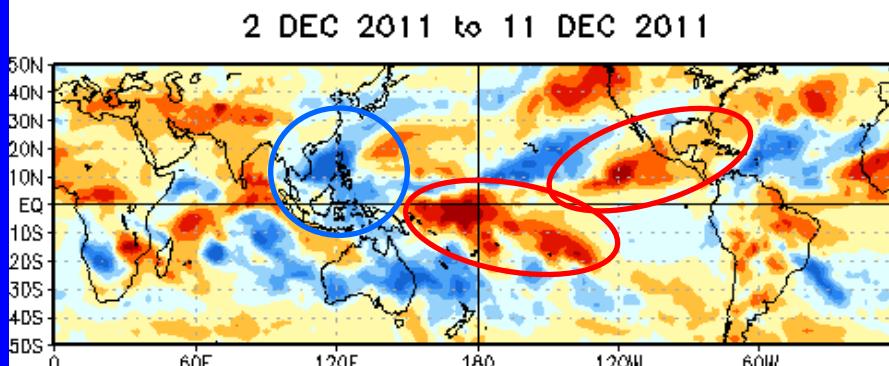
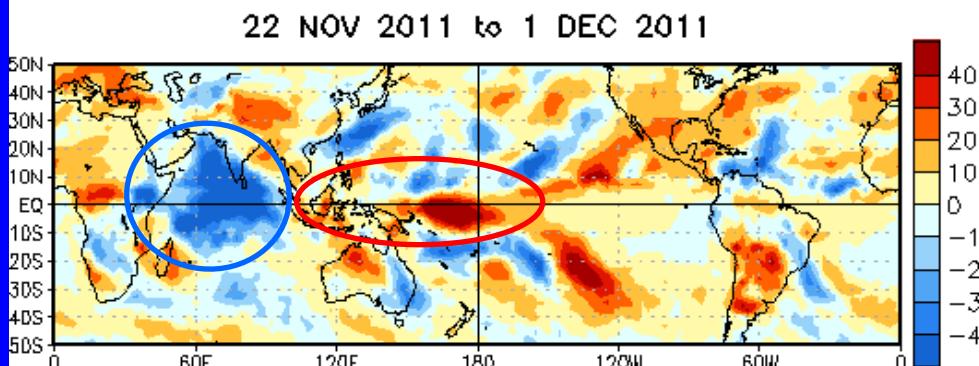
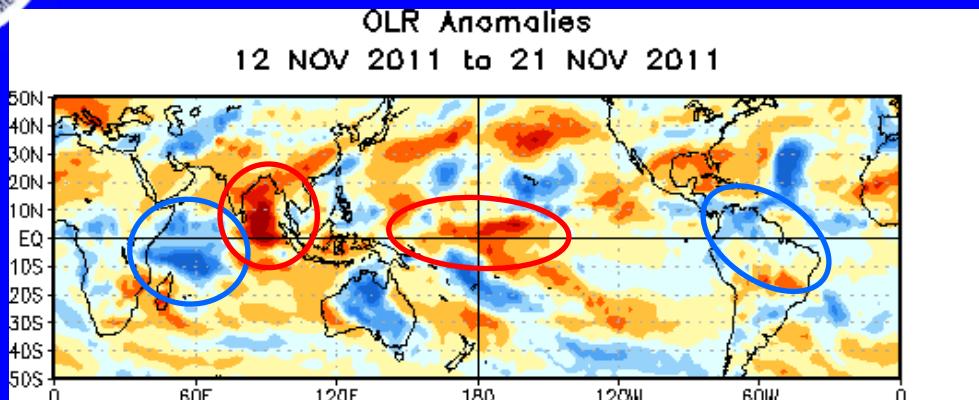
In early October, MJO activity weakened the persistent easterly anomalies across the central Pacific (first dashed line).

An equatorial Rossby wave imparted westerly anomalies across parts of the western Pacific and Maritime continent during late October and early November (thin solid line).

MJO activity has continued into December (altering dashed and dotted lines) and most recently westerly anomalies across the Maritime Continent and easterly anomalies across the Pacific Ocean are evident.



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 mid November suppressed convection (red circle) was observed across the Western Pacific and the Bay of Bengal, while enhanced convection (blue circle) covered portions of the Americas, Africa, and the western Indian Ocean.

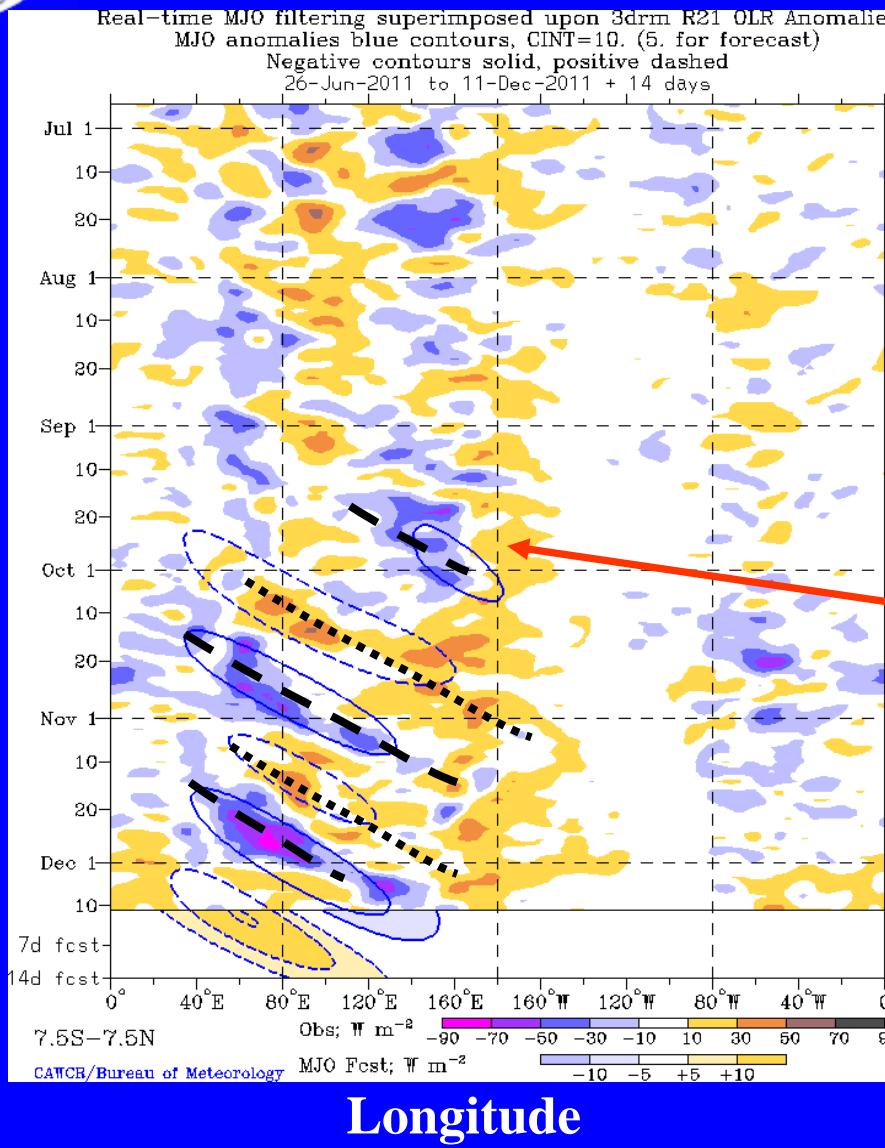
During late November enhanced convection strengthened over the Indian Ocean, consistent with MJO activity at that time. Suppressed convection strengthened over the Western Pacific near the Date Line.

During early December, suppressed convection developed over parts of the eastern Pacific and Central America while enhanced convection shifted over the Maritime Continent.



Outgoing Longwave Radiation (OLR)

Anomalies (7.5°S-7.5°N)



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)

Little MJO activity was observed during June, July and August.

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.

A second cycle of enhanced and suppressed convection was evident during the second half of October and first half of November.

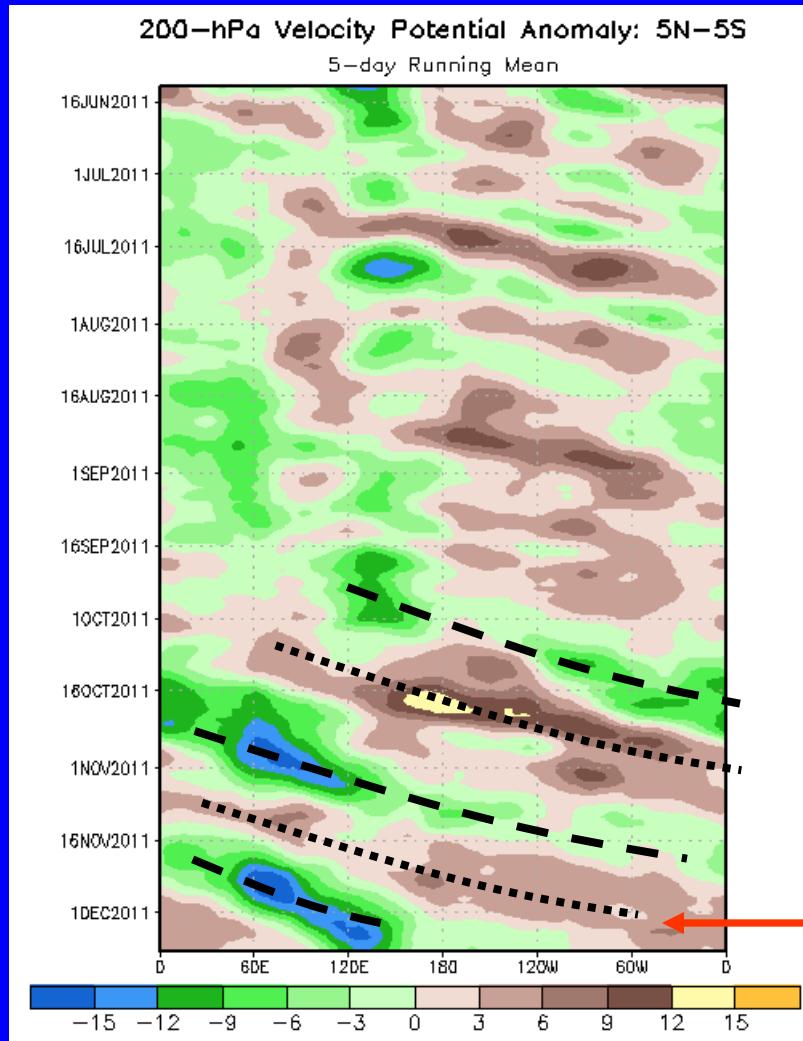
Most recently, enhanced convection is shifted across the Maritime Continent with suppressed convection over the Indian and central Pacific Oceans.



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
↓



During parts of June, July and August very fast eastward propagation was evident at times and mainly associated with higher frequency sub-seasonal coherent tropical variability not associated with MJO activity.

During the second half of September negative anomalies developed across the Western Pacific, with positive anomalies in the Indian Ocean, consistent with MJO genesis and subsequent circumglobal propagation.

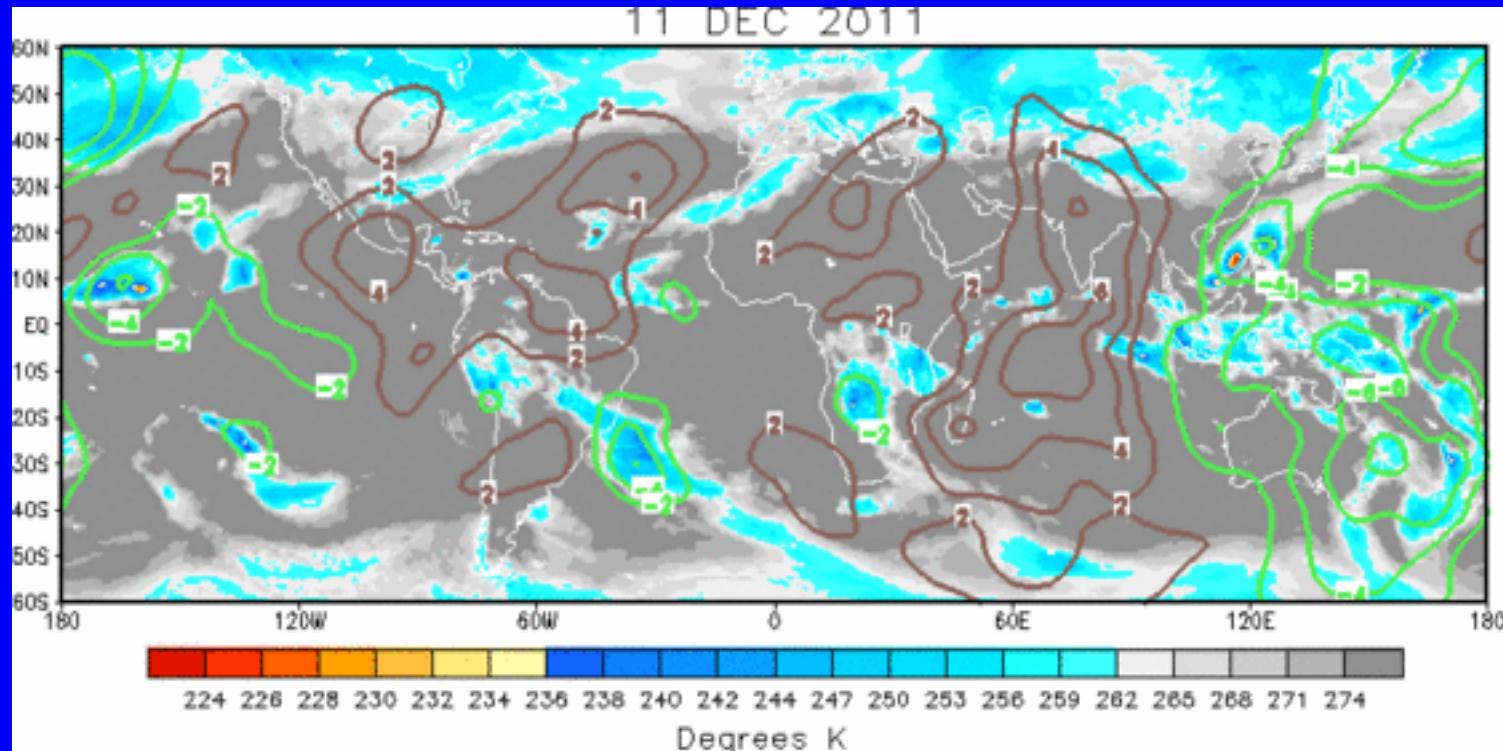
Recently, negative anomalies have moved through the Maritime Continent and are weaker over the central Pacific, with positive anomalies across the Americas, Africa, and the western Indian Ocean.



IR Temperatures (K) / 200-hPa

Velocity Potential Anomalies

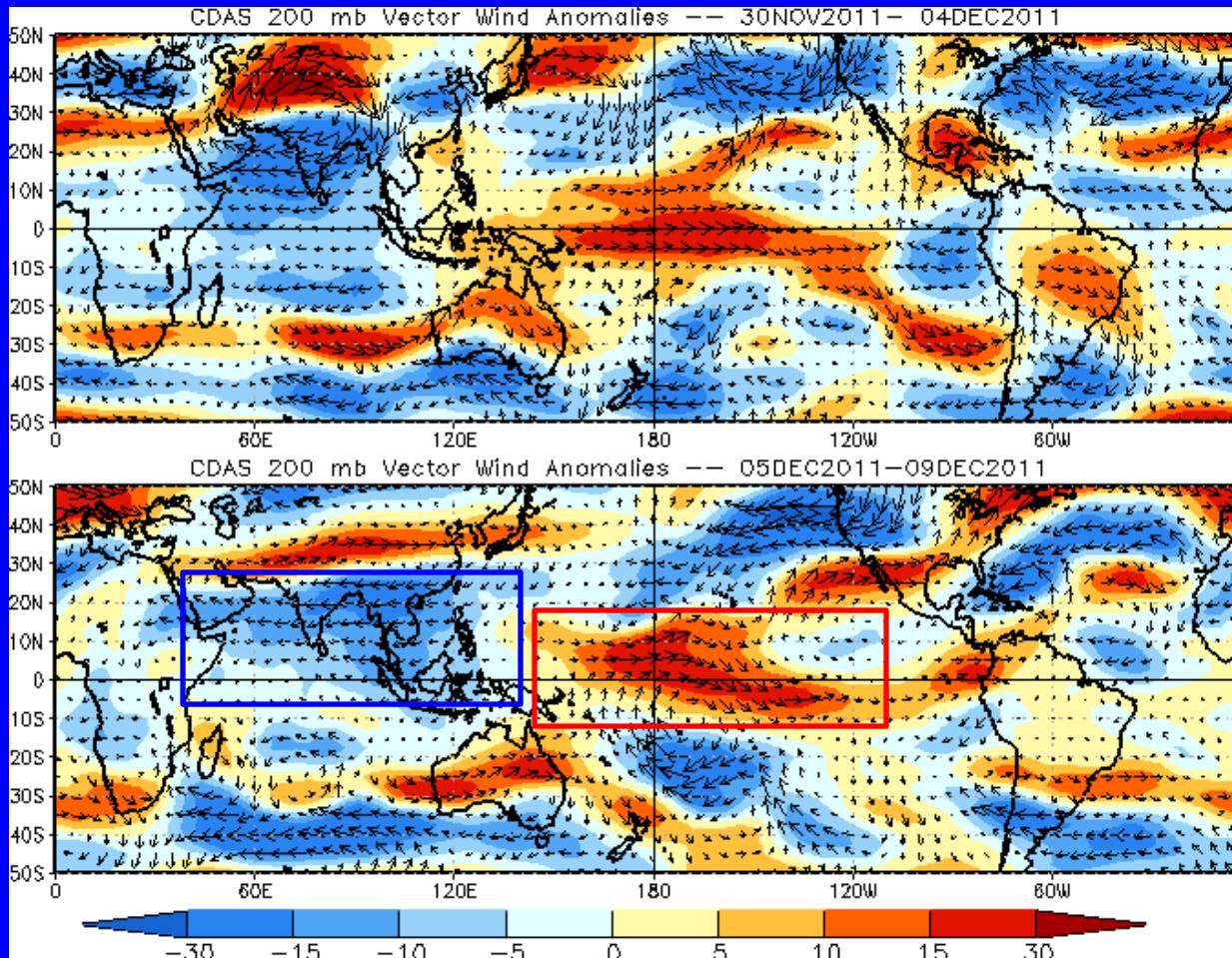
Positive anomalies (brown contours) indicate unfavorable conditions for precipitation
Negative anomalies (green contours) indicate favorable conditions for precipitation



The large scale velocity potential pattern exhibits vestiges of a wave-1 structure, however, it is considerably less coherent than previous weeks. Weak anomalous upper-level divergence is centered across the Maritime Continent with weak anomalous upper-level convergence across the western Hemisphere, Africa, and the Indian Ocean.



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



Note that shading denotes the zonal wind anomaly

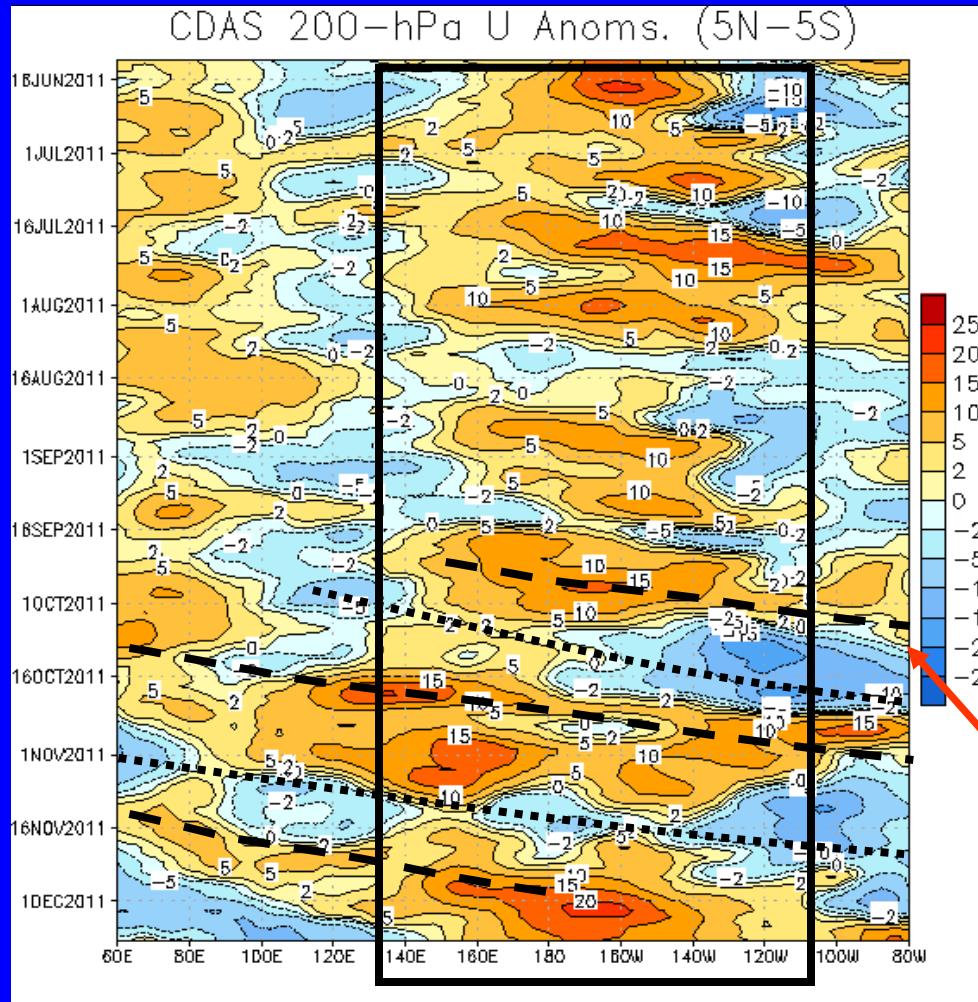
Blue shades: Easterly anomalies

Red shades: Westerly anomalies

Upper-level westerly wind anomalies remain over the west-central Pacific Ocean with easterly anomalies entrenched over southern Asia.



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



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

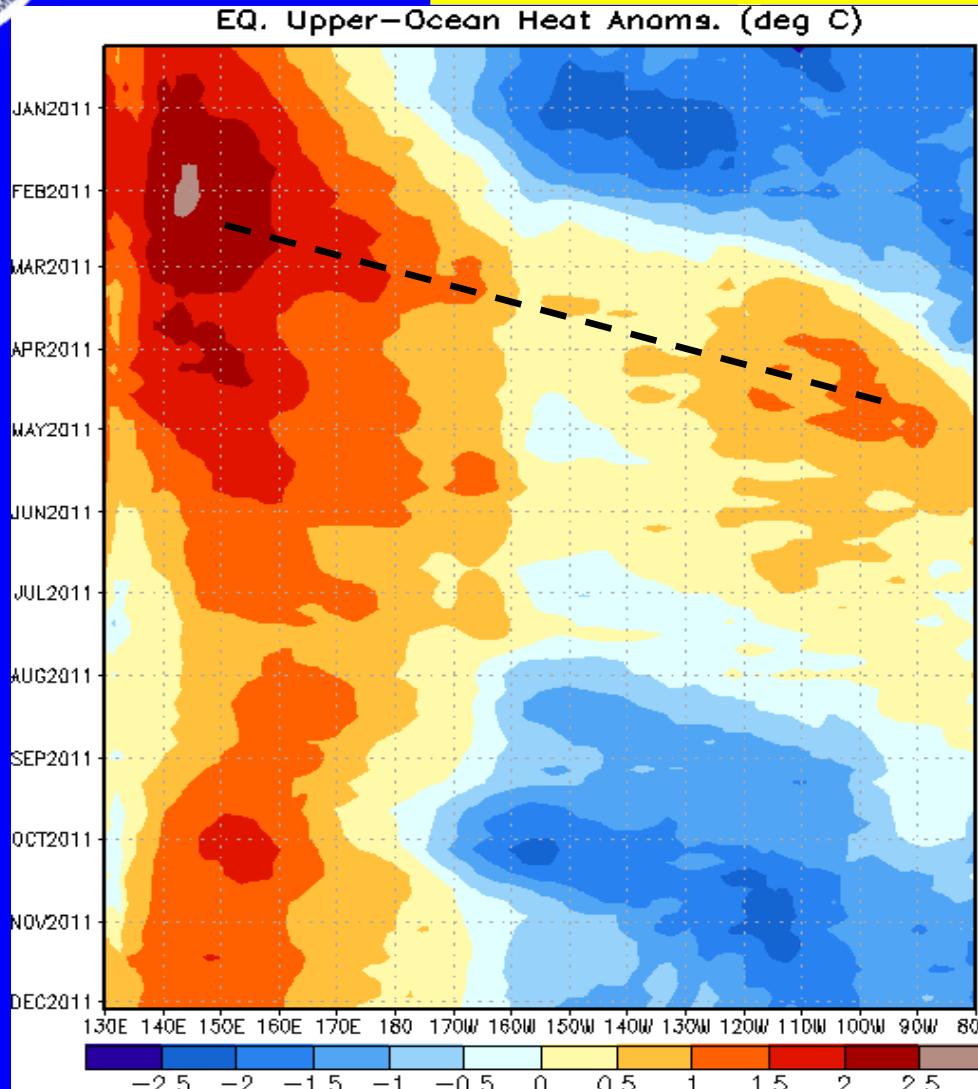
Easterly anomalies (blue shading) represent anomalous east-to-west flow

Westerly anomalies persisted across a large area from the Maritime Continent to the central Pacific (black solid box) since June.

Westerly anomalies over the Pacific strengthened during late September and have shifted eastward during October and November associated with the MJO.



Weekly Heat Content Evolution in the Equatorial Pacific



Since the beginning of January 2011, positive heat content anomalies shifted eastward, while negative heat content anomalies weakened and then became positive across much of the Pacific basin.

An oceanic Kelvin wave (dashed line) shifted eastward during February and March 2011. Much of the Pacific basin now indicates above- or near-normal integrated heat content.

Since the beginning of August, negative heat content anomalies are evident across the equatorial central and eastern 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.

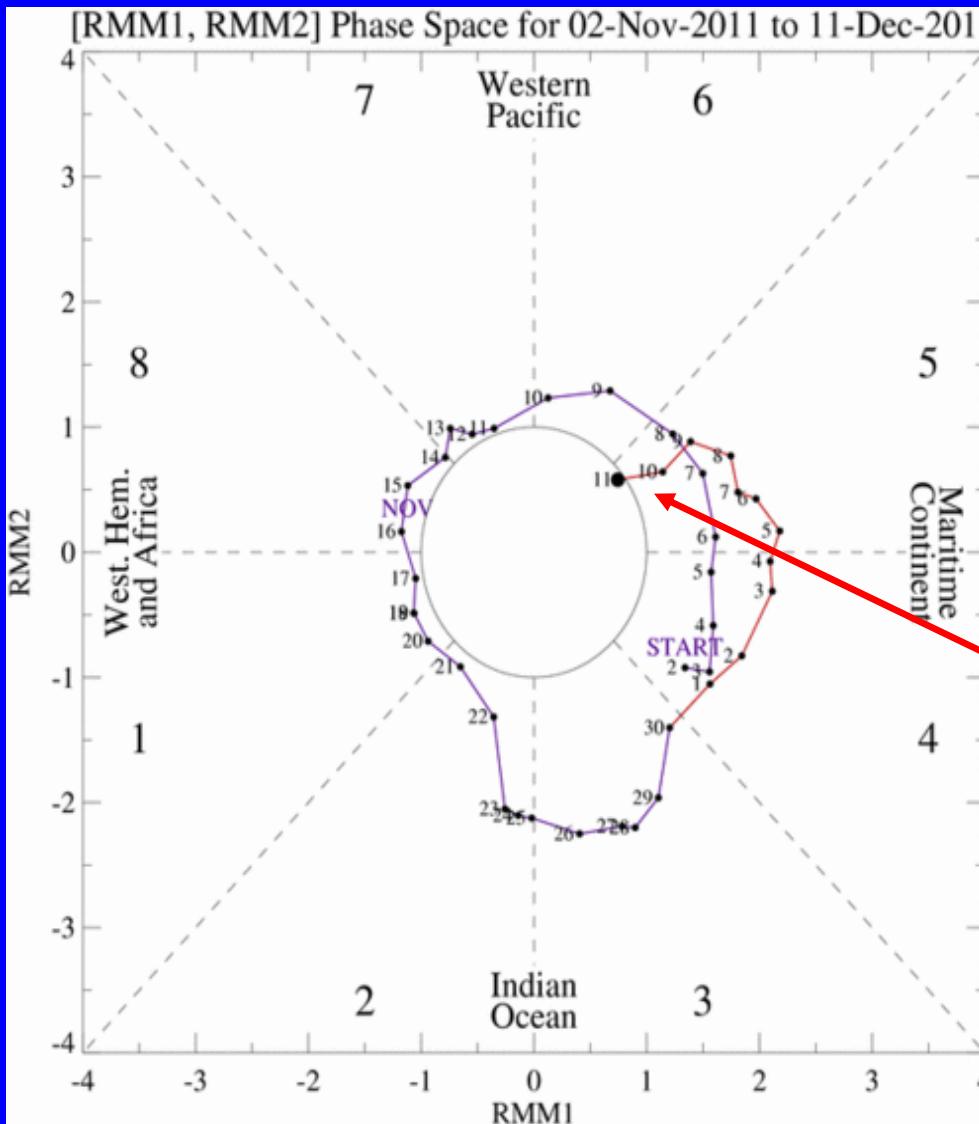
- The methodology is very similar to that described in WH2004 but does not include the linear removal of ENSO variability associated with a sea surface temperature index. The methodology is consistent with that outlined by the U.S. CLIVAR MJO Working Group.

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

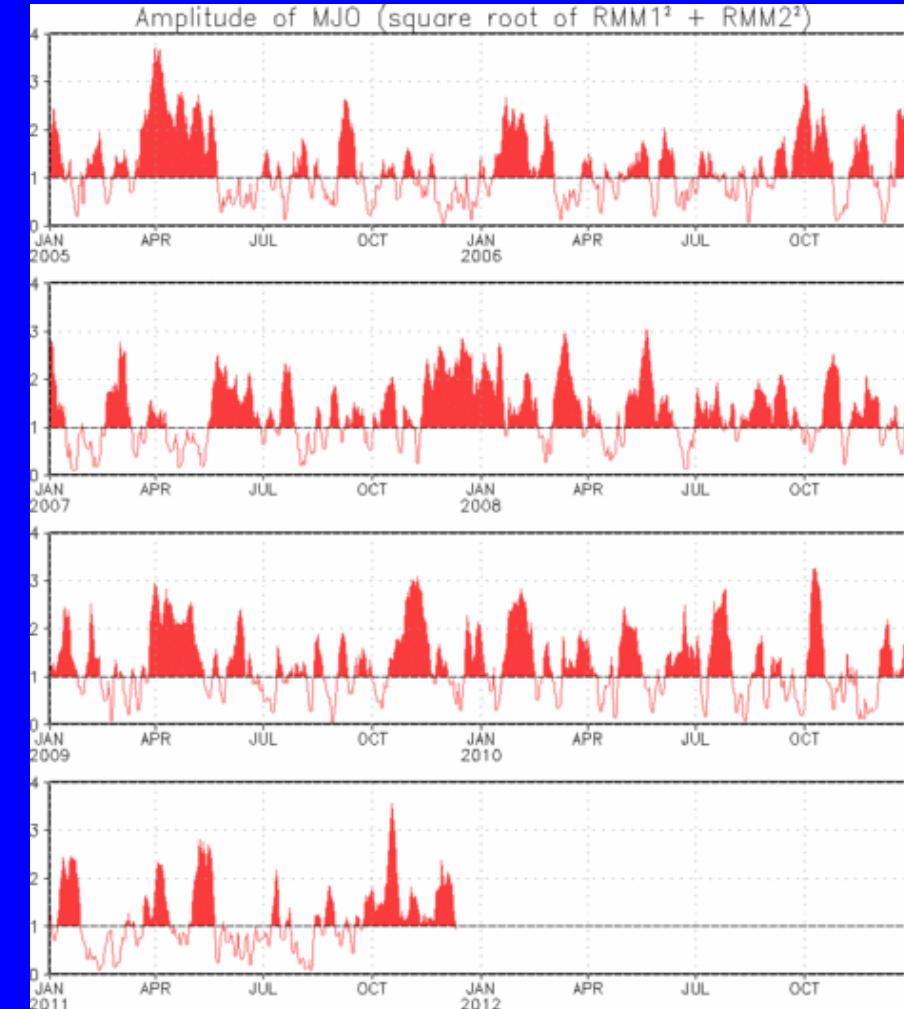
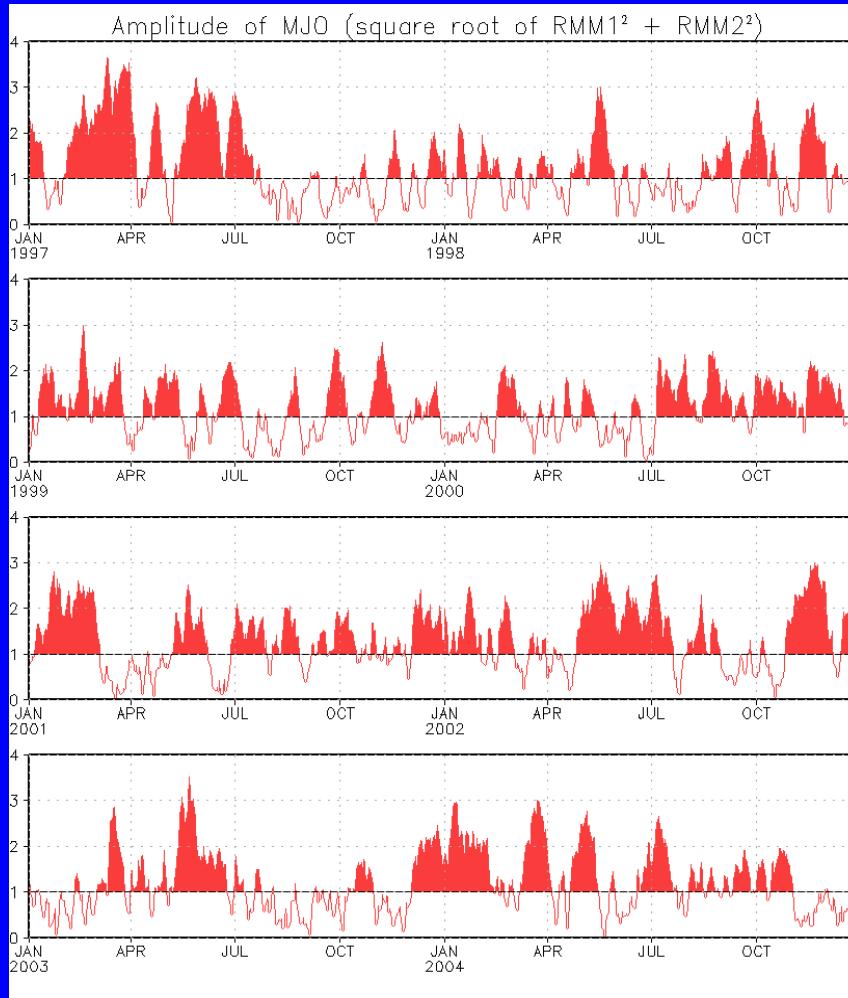


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The MJO index has propagated eastward, however, it has weakened substantially during the past week.



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.

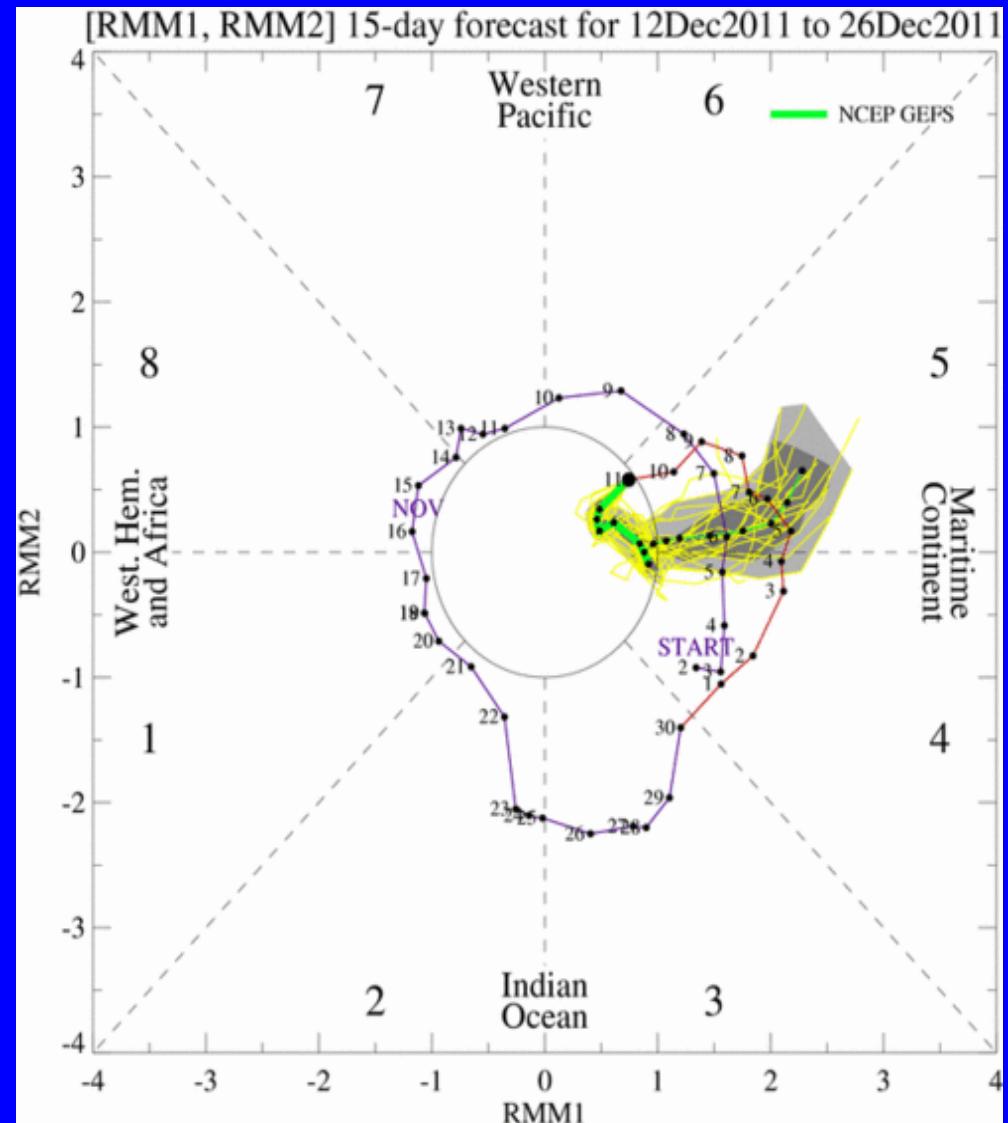


Ensemble GFS (GEFS) MJO Forecast

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 indicate a weak signal during Week-1 with an increase in amplitude during Week-2.

Yellow Lines – 20 Individual Members
Green Line – Ensemble Mean

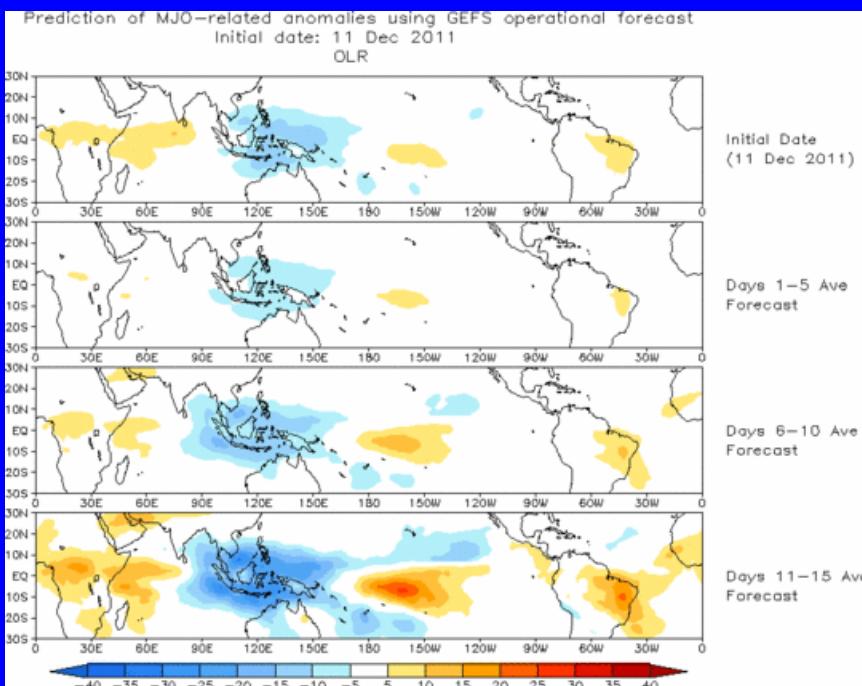




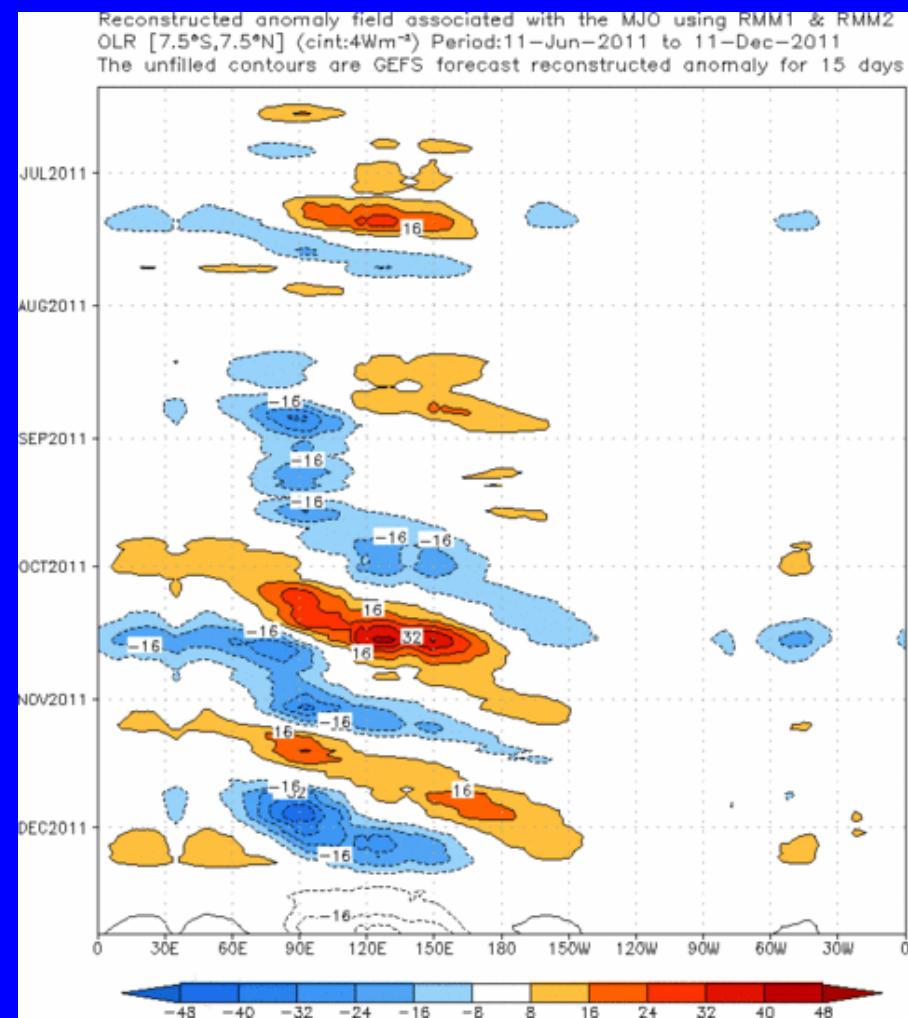
Ensemble Mean GFS MJO Forecast

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



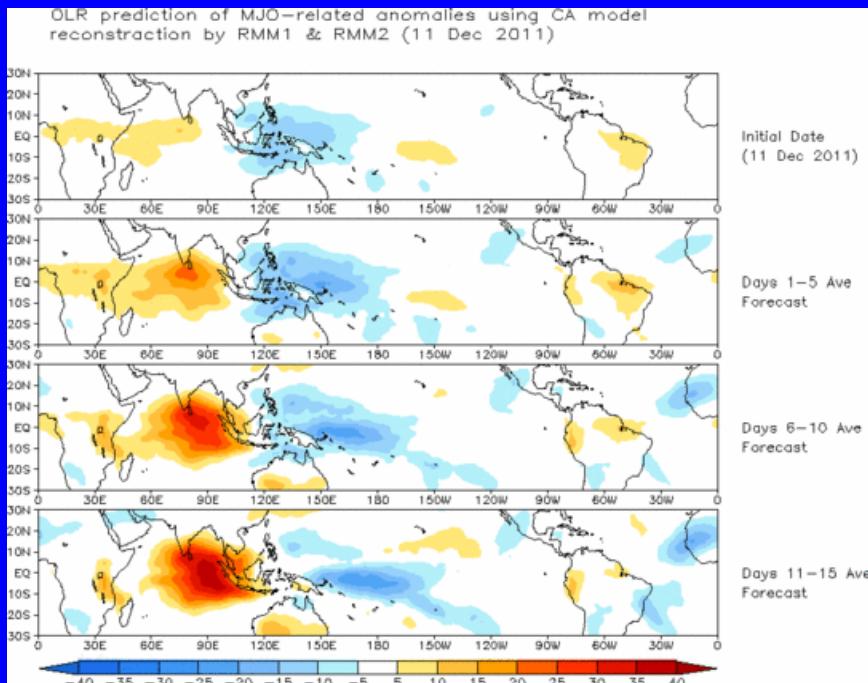
The ensemble mean GFS forecast indicates a weakening of enhanced convection over the Maritime Continent and suppressed convection over Africa and western Indian Ocean during Week-1, with a strengthening in Week-2



Constructed Analog (CA) MJO Forecast

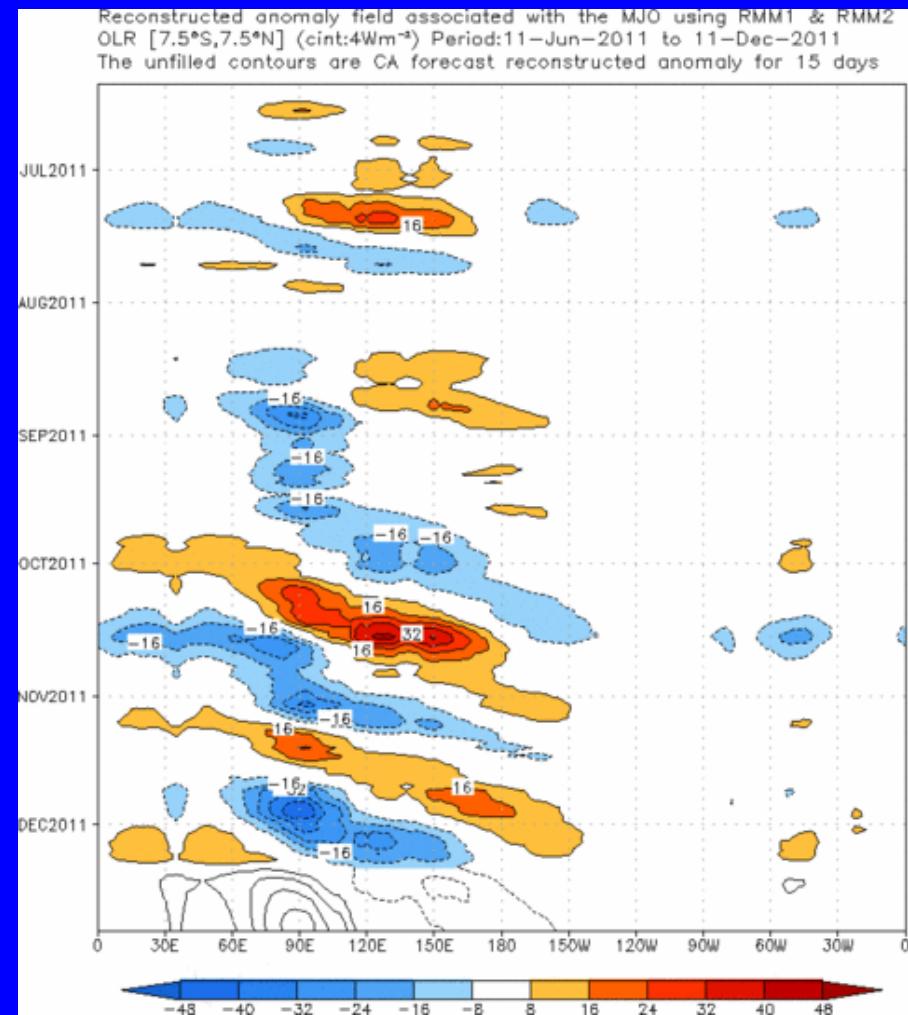
Figure below shows MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

Spatial map of OLR anomalies for the next 15 days



The CA forecast indicates eastward propagation with enhanced convection shifting across the west Pacific during Week-1, and the strengthening of suppressed convection over the Indian Ocean during Week-2.

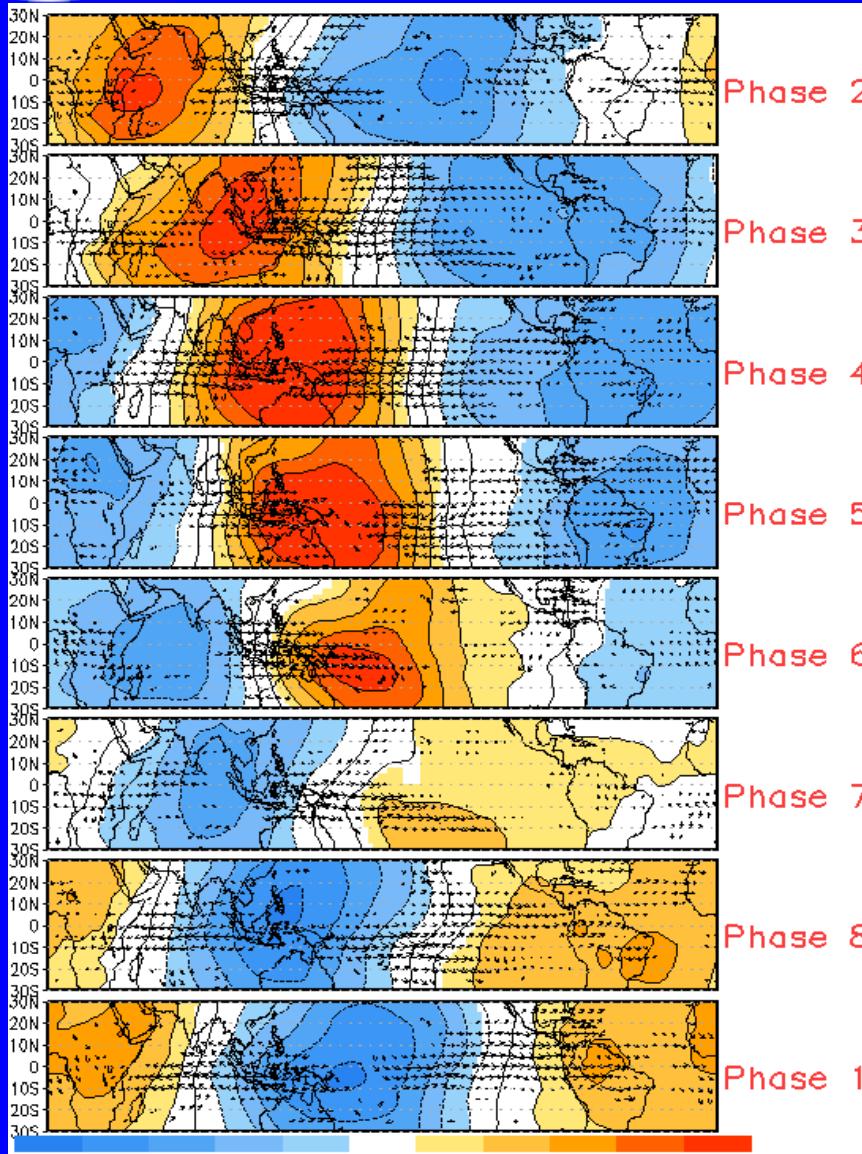
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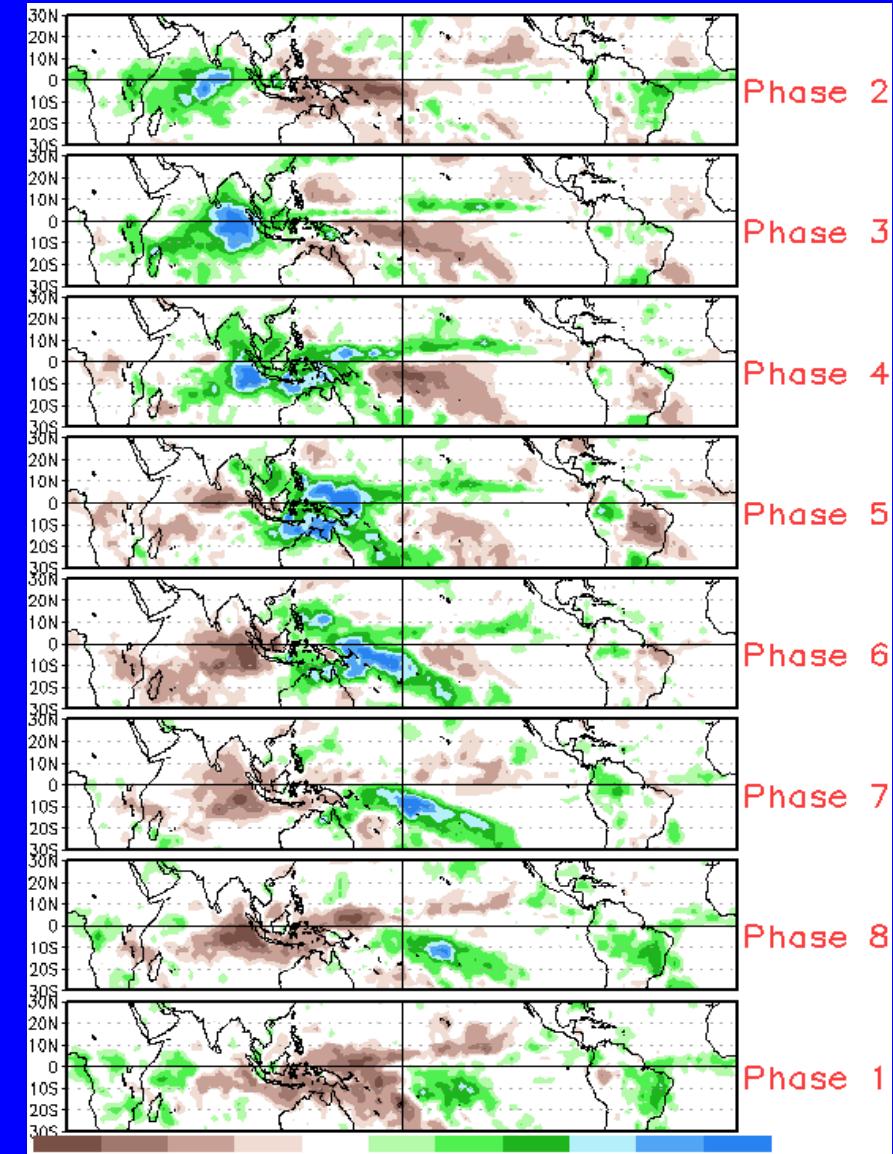


MJO Composites – Global Tropics

850-hPa Wind Anomalies (Nov-Mar)



Precipitation Anomalies (Nov-Mar)

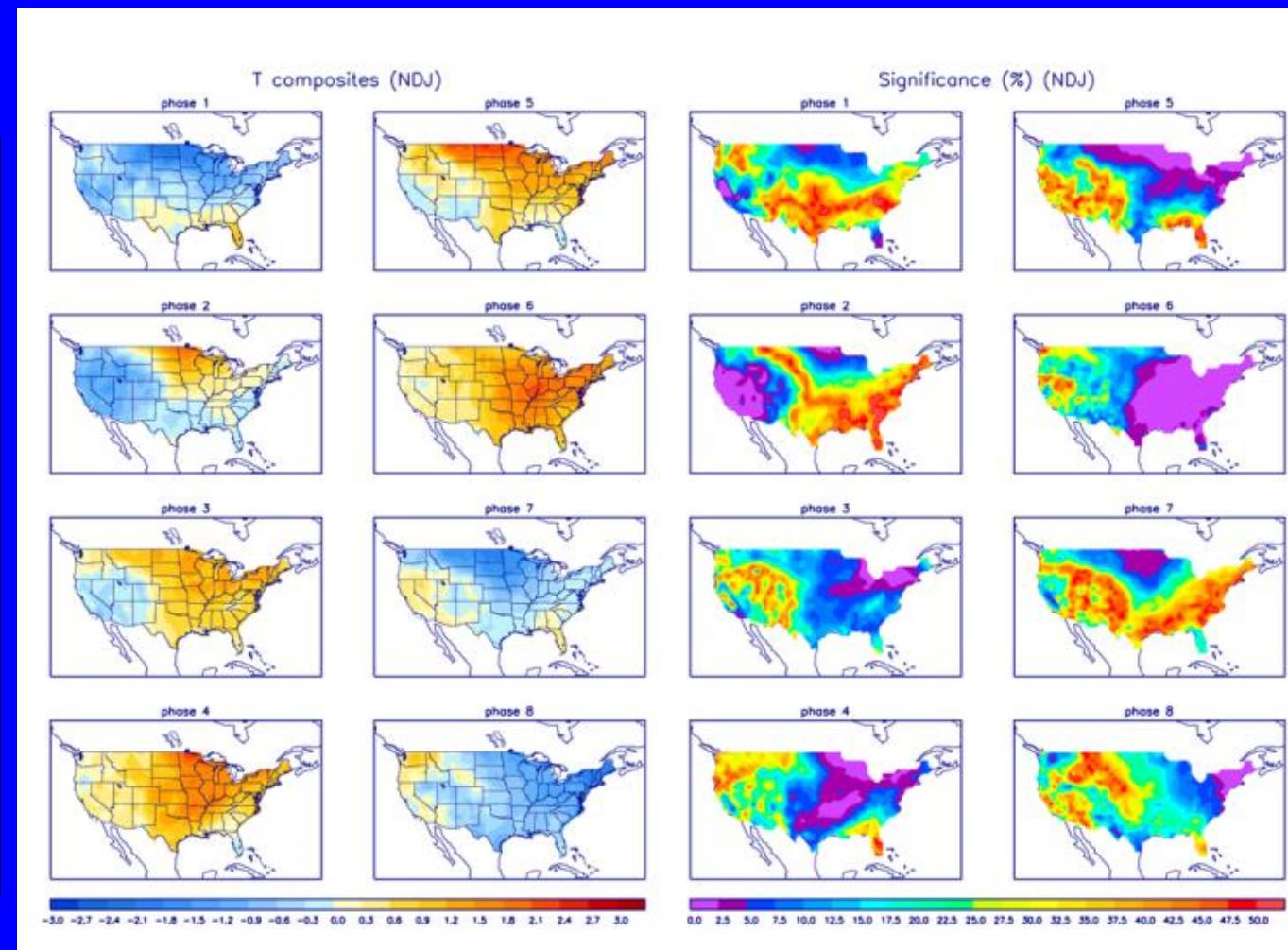




U.S. MJO Composites – Temperature

- 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.



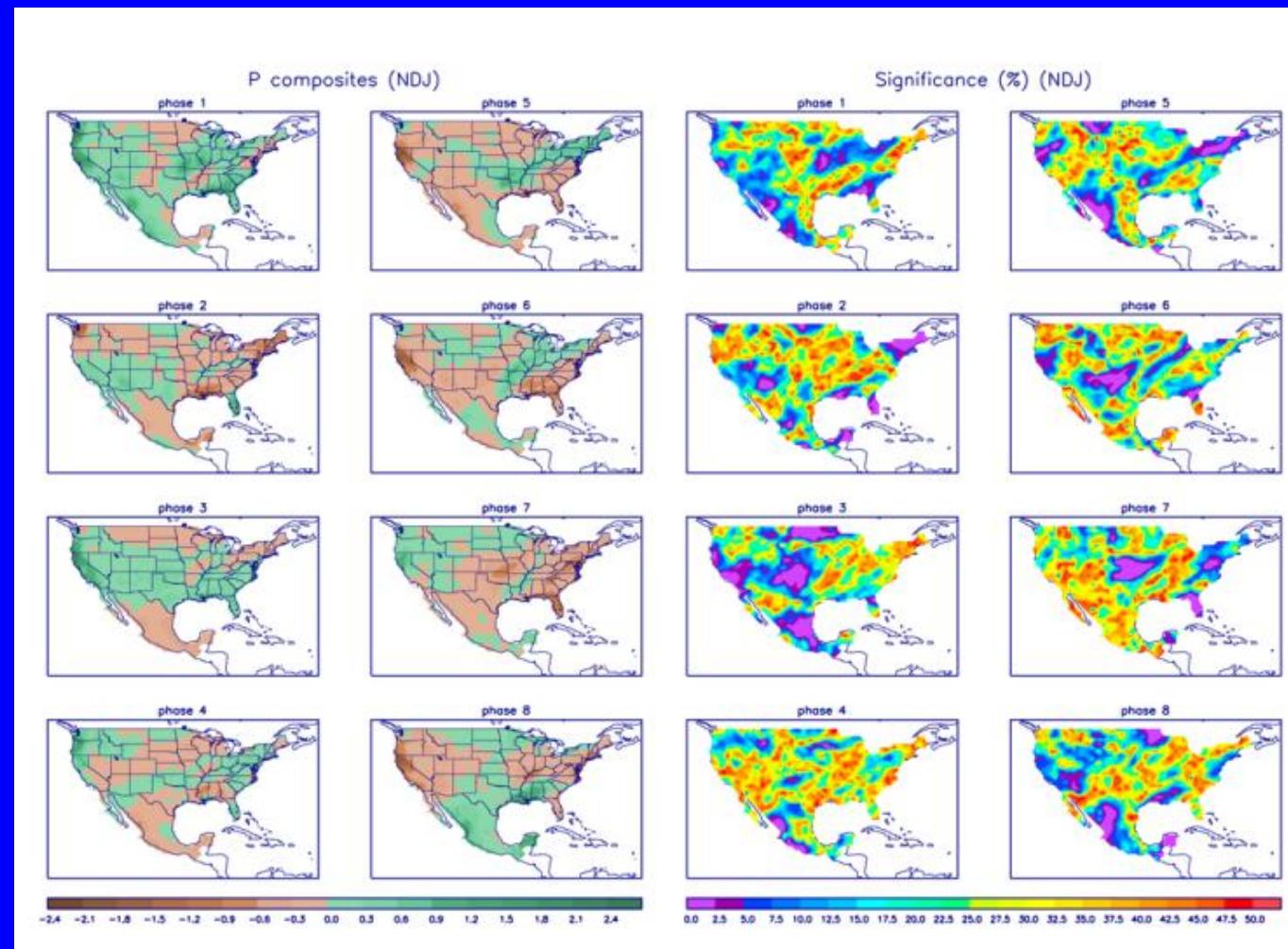
Zhou et al. (2011): A composite study of the MJO influence on the surface air temperature and precipitation over the Continental United States, *Climate Dynamics*, 1-13, doi: 10.1007/s00382-011-1001-9

<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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