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

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

Outline

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

Overview

• The MJO remained weak during the past seven days.

• There is large spread amongst the dynamical model MJO index forecasts during the upcoming 1-2 week period. A few models do indicate some eastward propagation of a weak signal during Week-2.

• Based on recent observations and the high degree of uncertainty with MJO index model forecasts, the MJO is forecast to remain weak during the period.

• The MJO is not expected to contribute substantially to anomalous convection across the global tropics during the period.

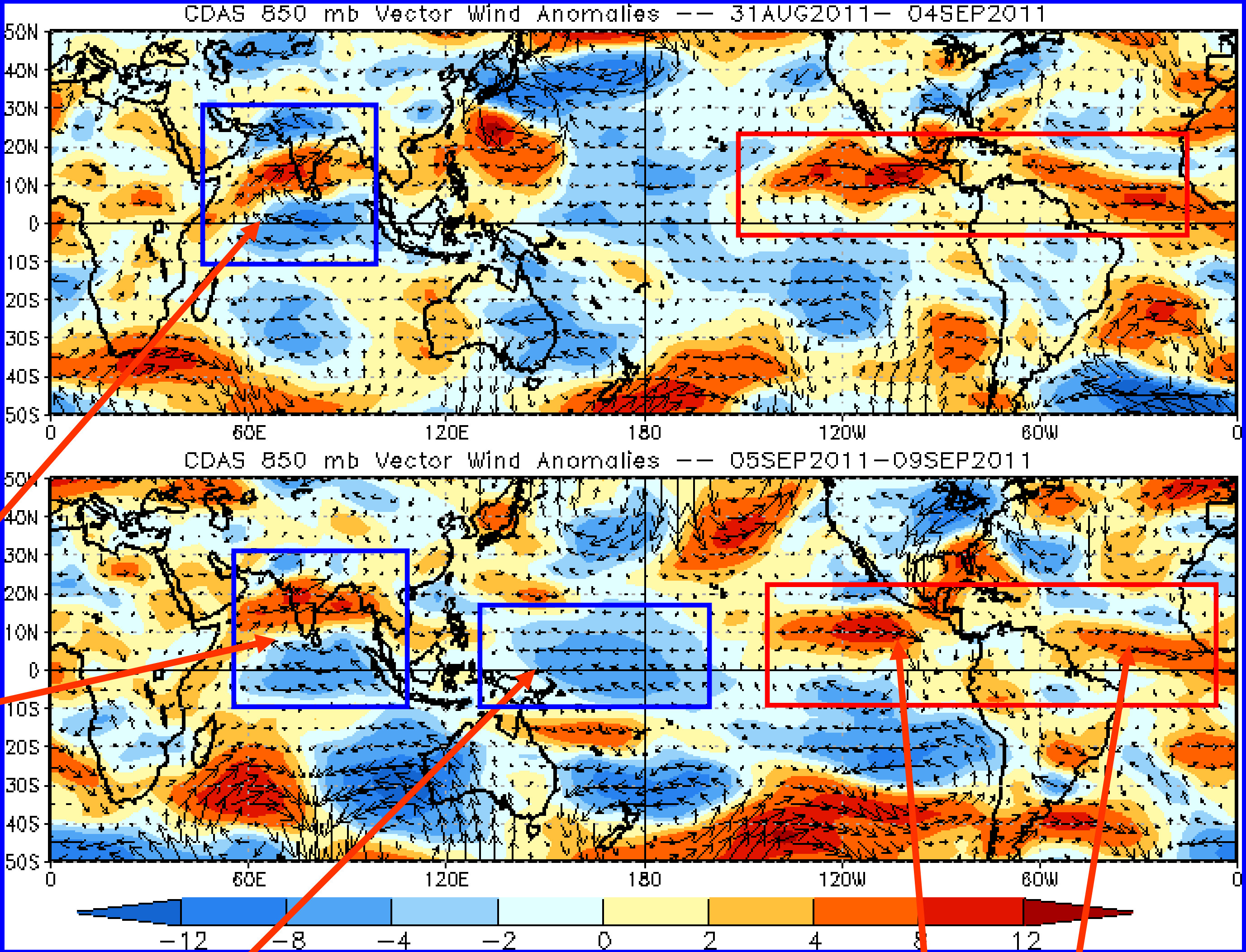
Additional potential impacts across the global tropics are available at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



A strong monsoon circulation into southern Asia continued during the last five days.

Easterly wind anomalies returned to portions of the western Pacific during the last 5 to 10 days.

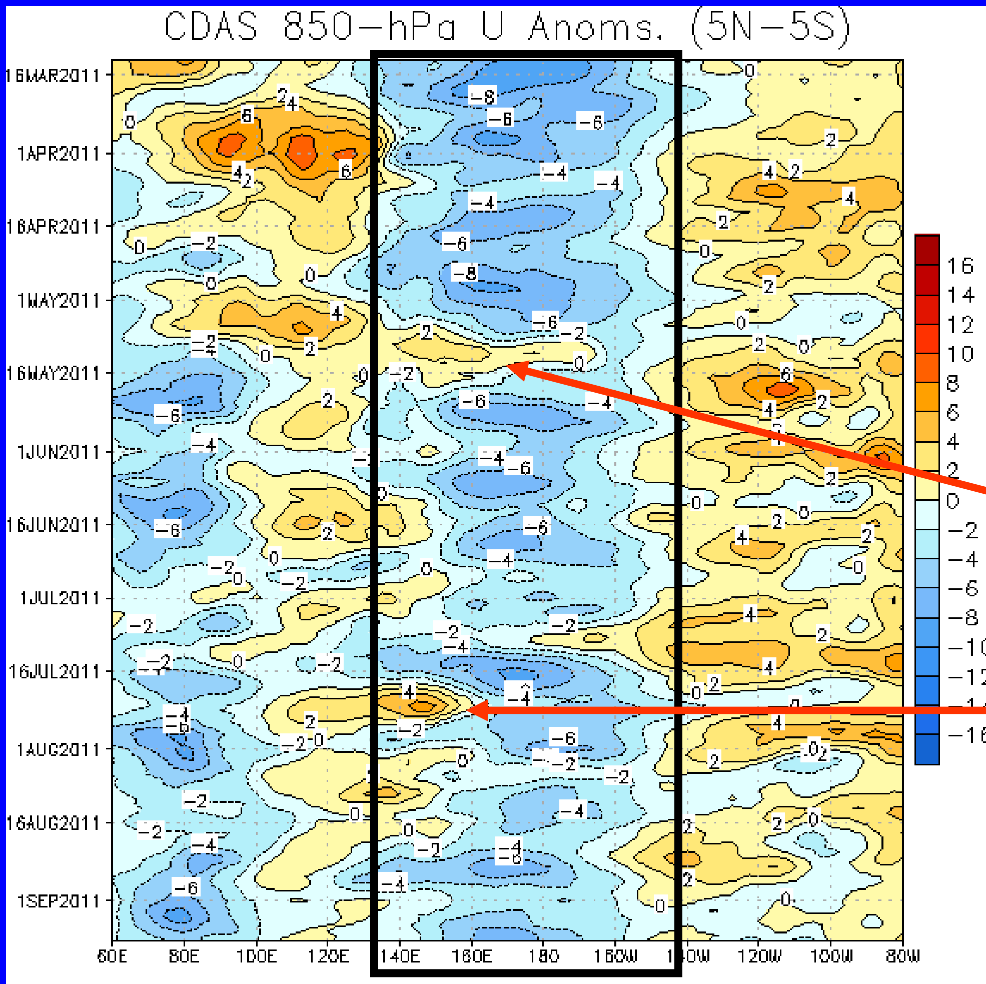
Westerly anomalies continued across the eastern Pacific and tropical Atlantic.

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



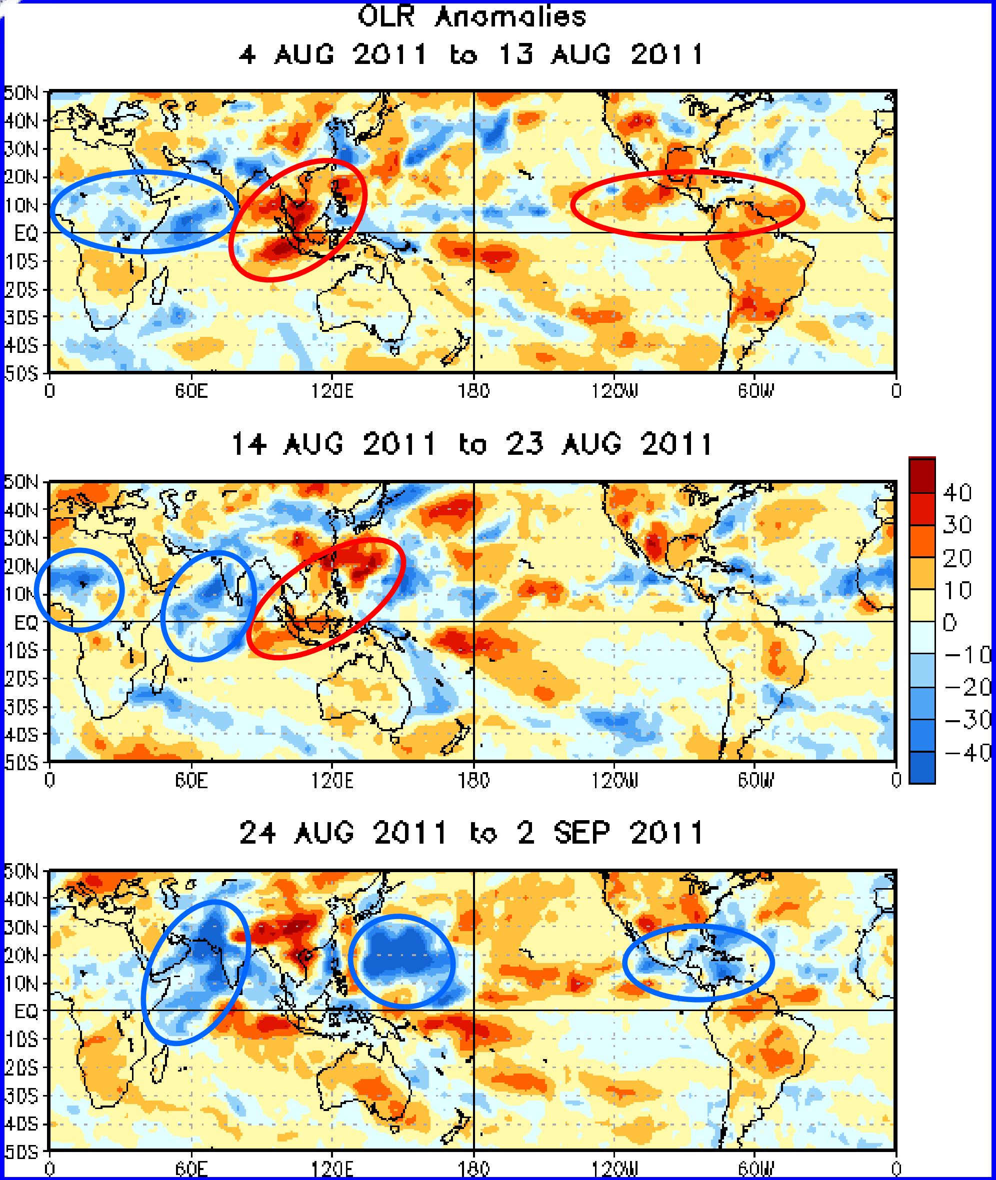
Longitude

Easterly anomalies have persisted in the west-central Pacific since January (black box) consistent with La Nina conditions during much of the period. The magnitude of these anomalies, however, weakened from the early portion of the period.

A burst of westerly wind anomalies associated with the MJO moved across the Pacific in early-to-mid May.

Strong westerly anomalies developed across the western Pacific near 150E during the second half of July.

OLR Anomalies – Past 30 days



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

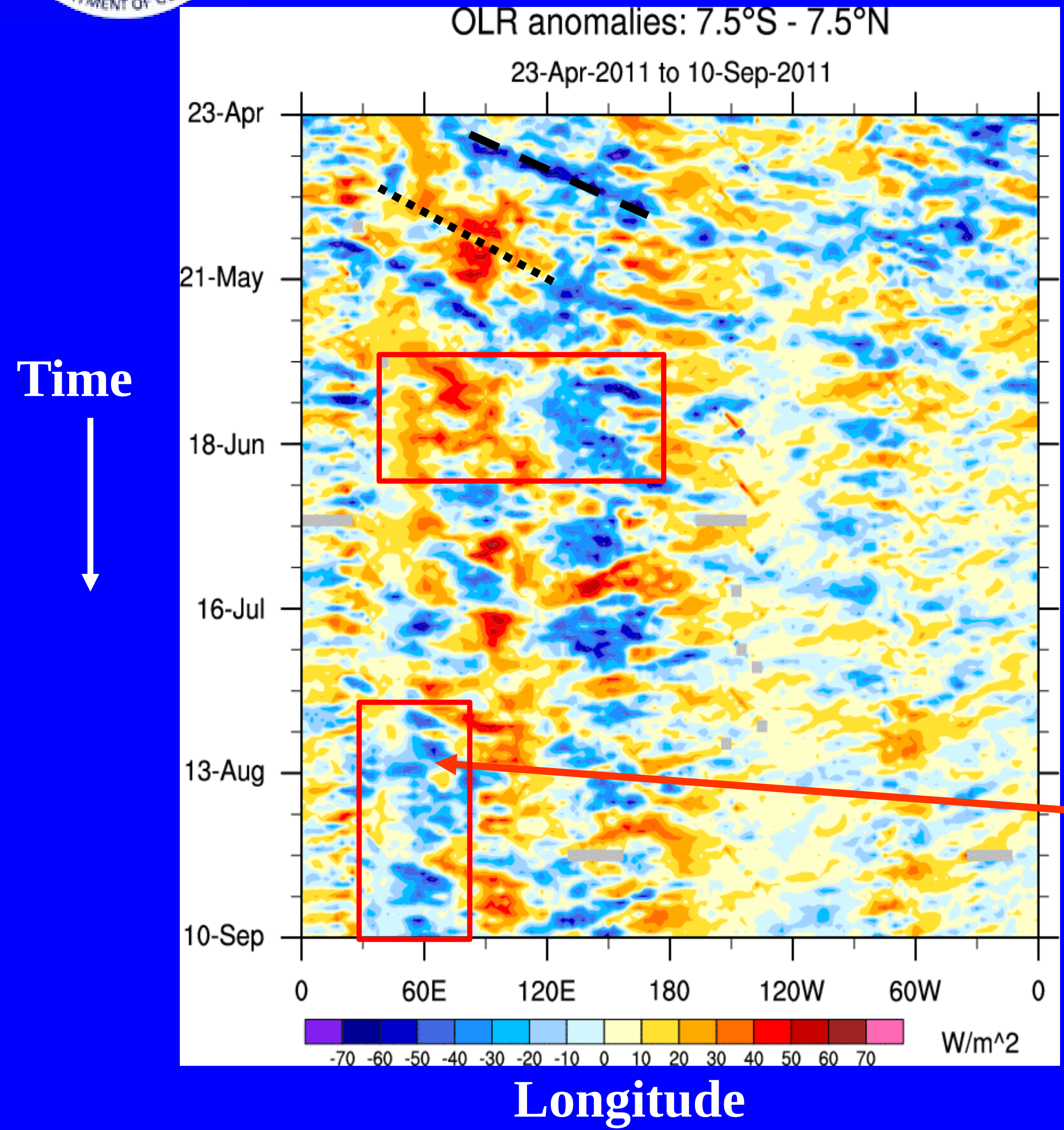
Wetter-than-normal conditions, negative OLR anomalies (blue shading)

During early August, enhanced convection (blue circle) developed over Africa and the western Indian Ocean, while suppressed convection (red circles) developed across western Indonesia, the eastern Pacific, and most of the tropical western Hemisphere.

During mid-August, enhanced convection continued across parts of Africa and the western Indian Ocean, and suppressed convection continued across western Indonesia.

During late August, enhanced convection was associated with an increase in tropical cyclone activity across the Atlantic, east Pacific, and west Pacific. The Indian Monsoon became more active noted by the enhanced convection in this area.

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 the Cooperative Institute for Climate and Satellites (CICS-NC) and NCDC)

During late April, areas of enhanced convection propagated eastward followed by suppressed convection thereafter. This activity was in part associated with MJO activity.

During mid-June, a couplet of suppressed (enhanced) convection was evident and centered near 80E (140E).

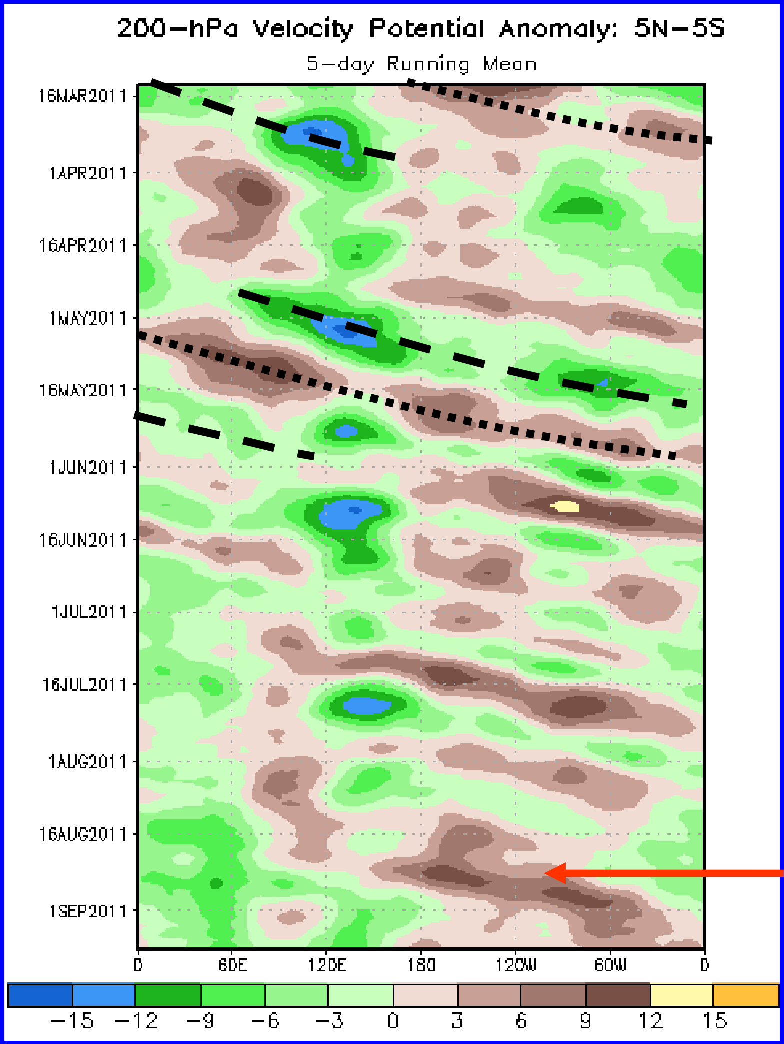
In early August, enhanced convection centered near 60E intensified and has persisted into September.

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

Eastward propagation of anomalies was observed during March associated with weak MJO activity.

Robust MJO activity was observed during late April into May as upper-level divergence (green shades) shifted eastward from the Indian Ocean beginning in early May followed by upper-level divergence (brown shades).

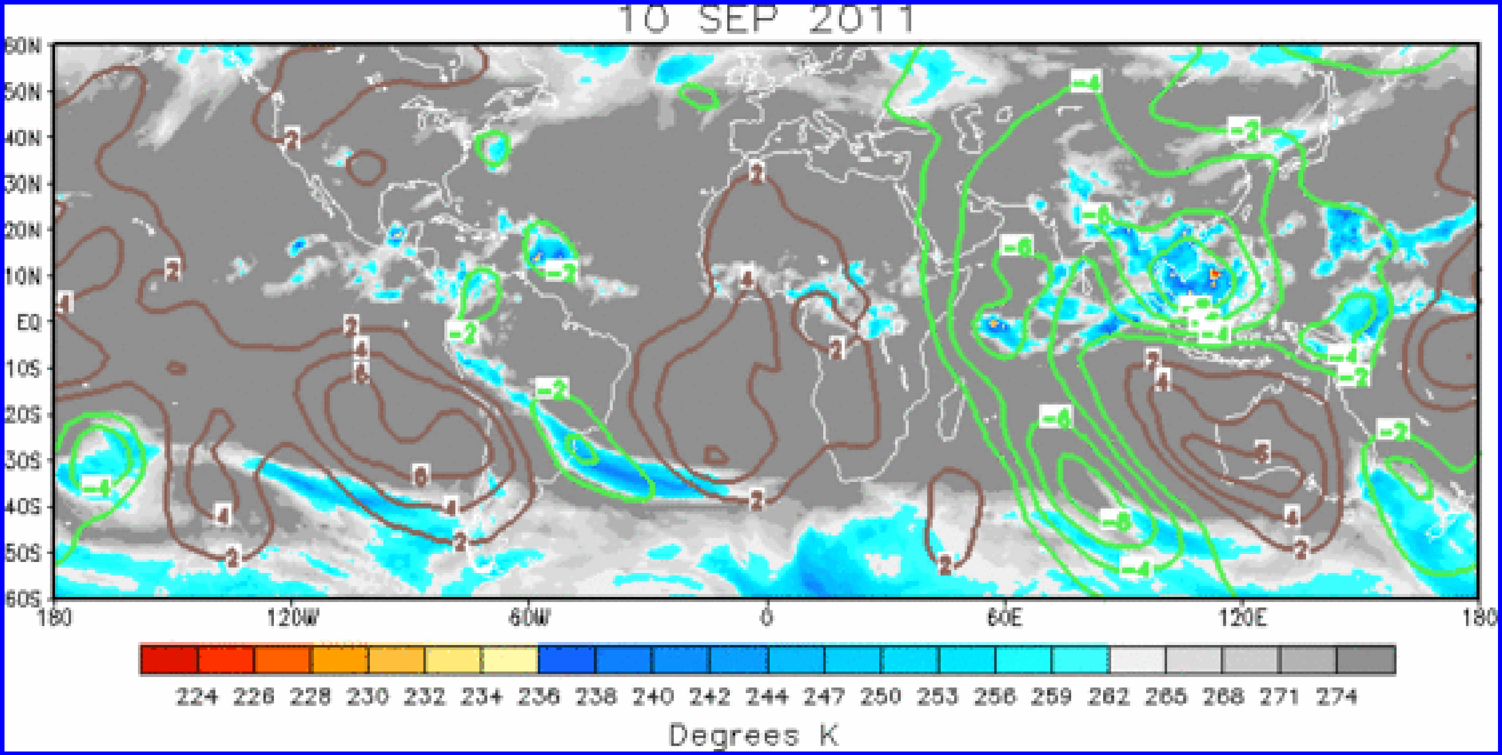
During parts of June, July and August very fast eastward propagation was evident and mainly associated with higher frequency sub-seasonal coherent tropical variability.

Anomalies increased in magnitude and in coverage during mid-to-late August.

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



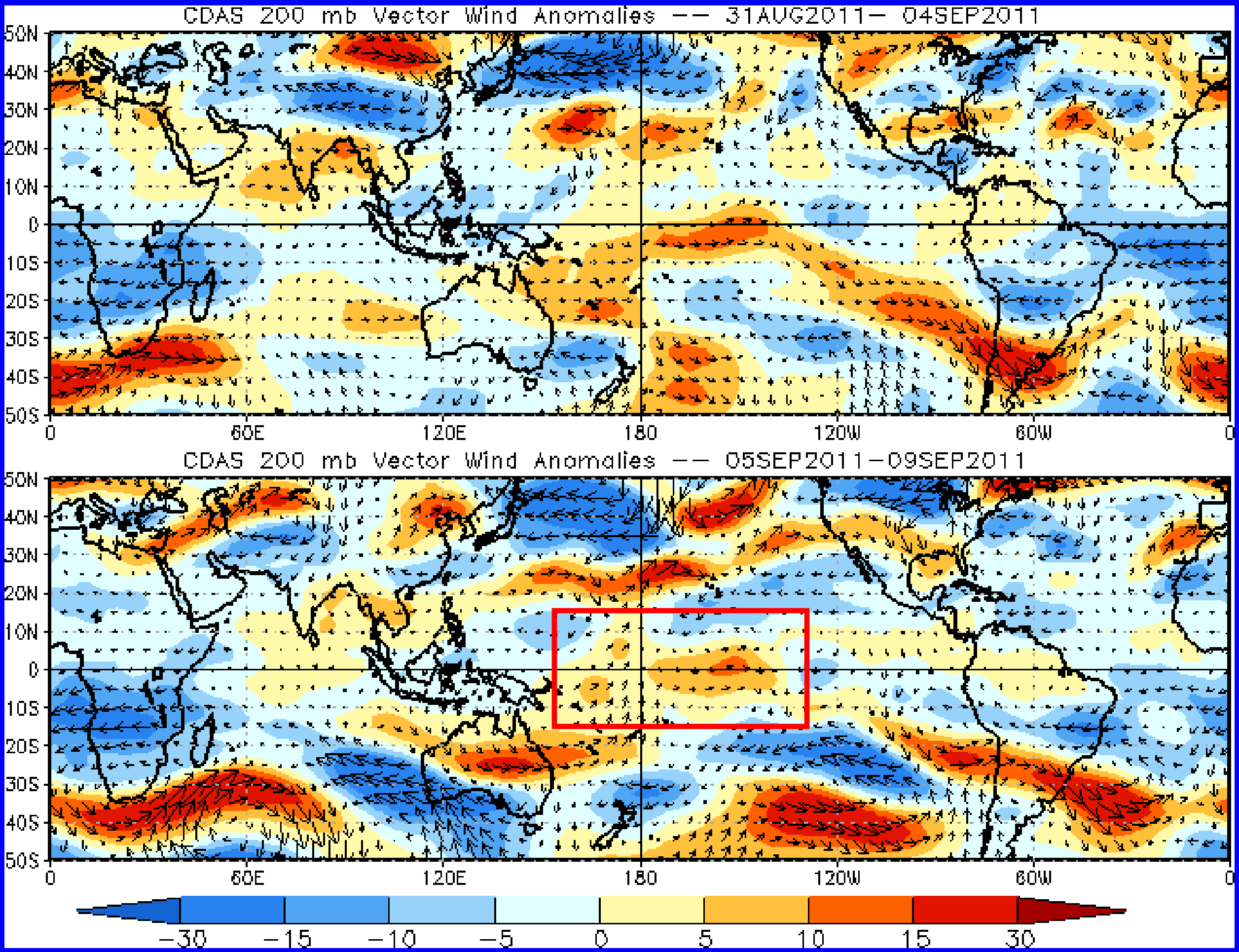
The large scale velocity potential pattern does not indicate a coherent MJO pattern. Anomalous upper-level divergence is indicated mainly over the Indian Ocean, southeast Asia, and the far western Pacific. Weak anomalous upper-level convergence is observed mainly across the Pacific Ocean and western Africa.

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

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



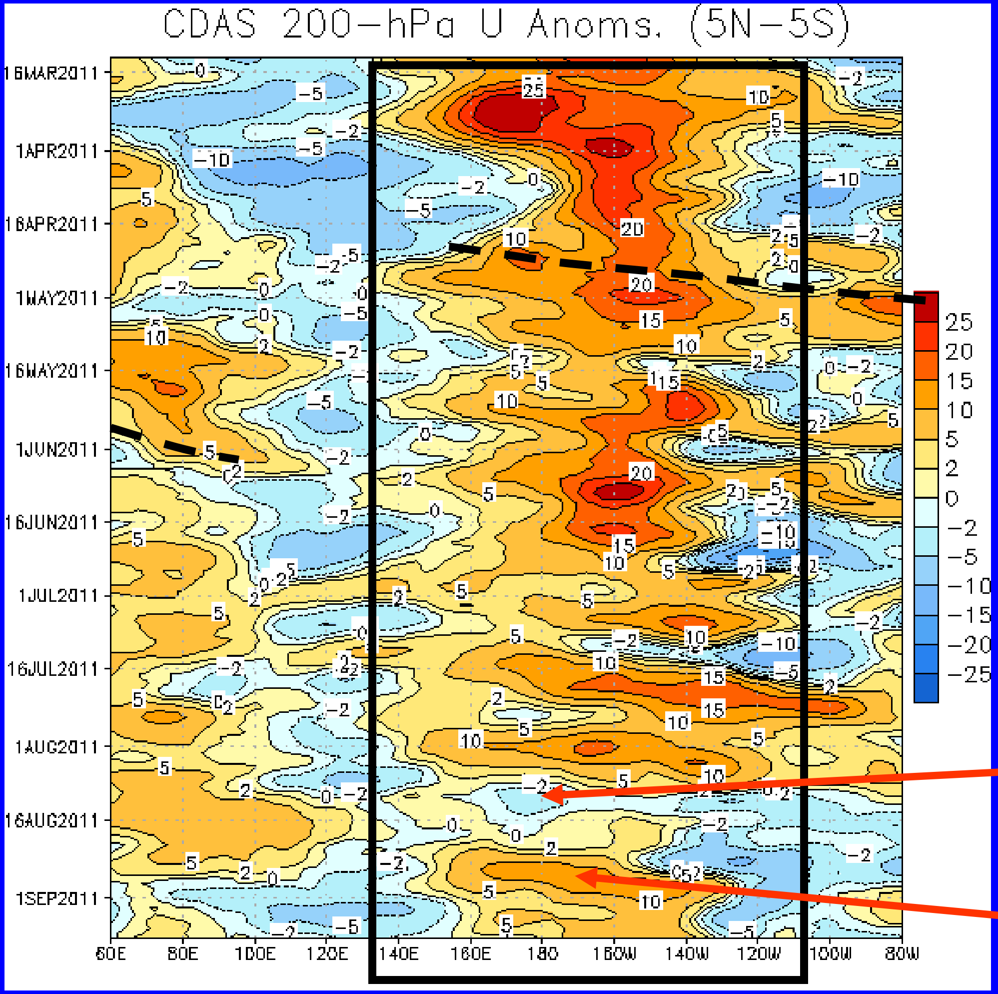
Westerly anomalies continued across the central Pacific, but have weakened some in over the last 5 days (red box). Easterly anomalies have weakened in the equatorial Atlantic.

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

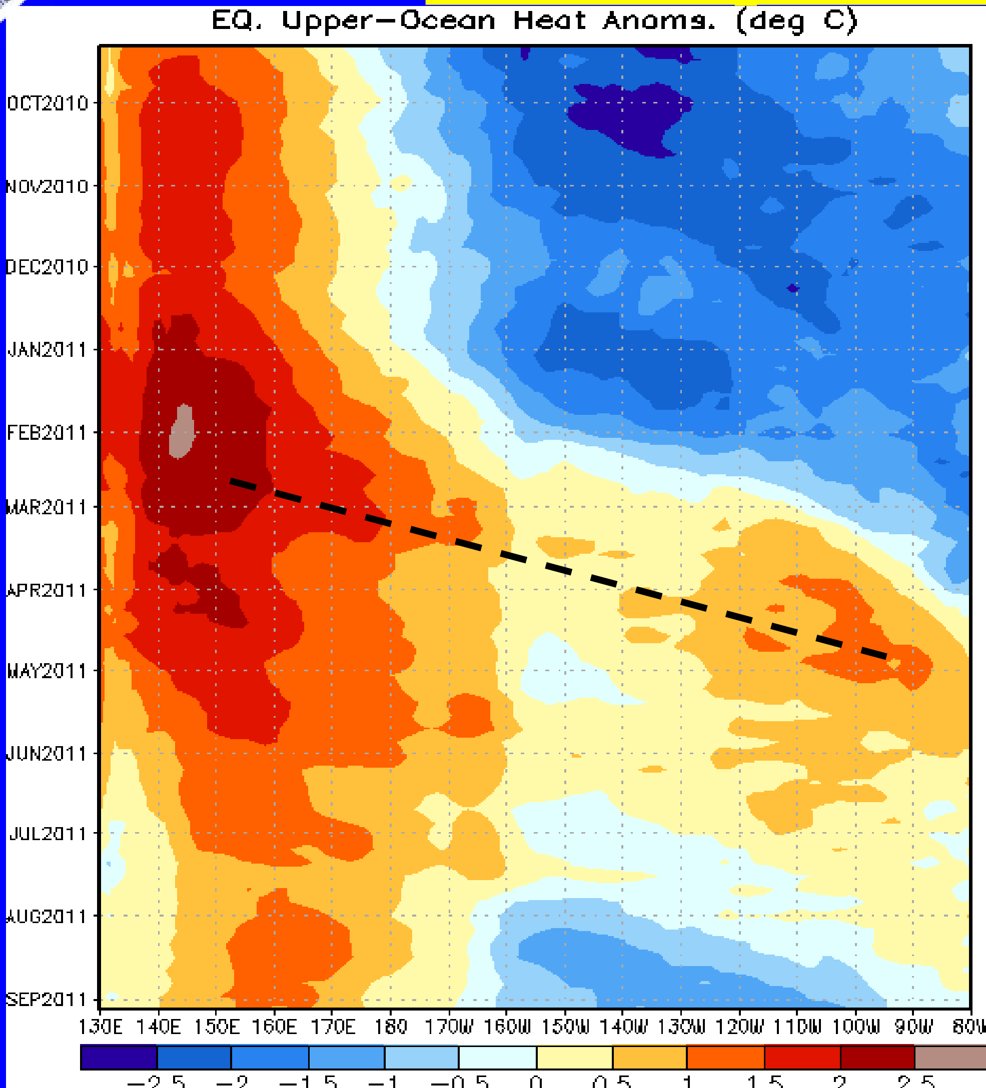
Significant eastward propagation of westerly anomalies was evident in late April and May (dashed line) associated with the MJO.

During mid-August, easterly anomalies developed near the Date Line.

Since mid-August, westerly anomalies have returned to the central Pacific.

Weekly Heat Content Evolution in the Equatorial Pacific

Time



Longitude

Beginning in April 2010 positive heat content anomalies decreased across the Pacific in association with the upwelling phase of a Kelvin wave and later during the early summer due to the development of La Nina.

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 increased across the equatorial central 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).

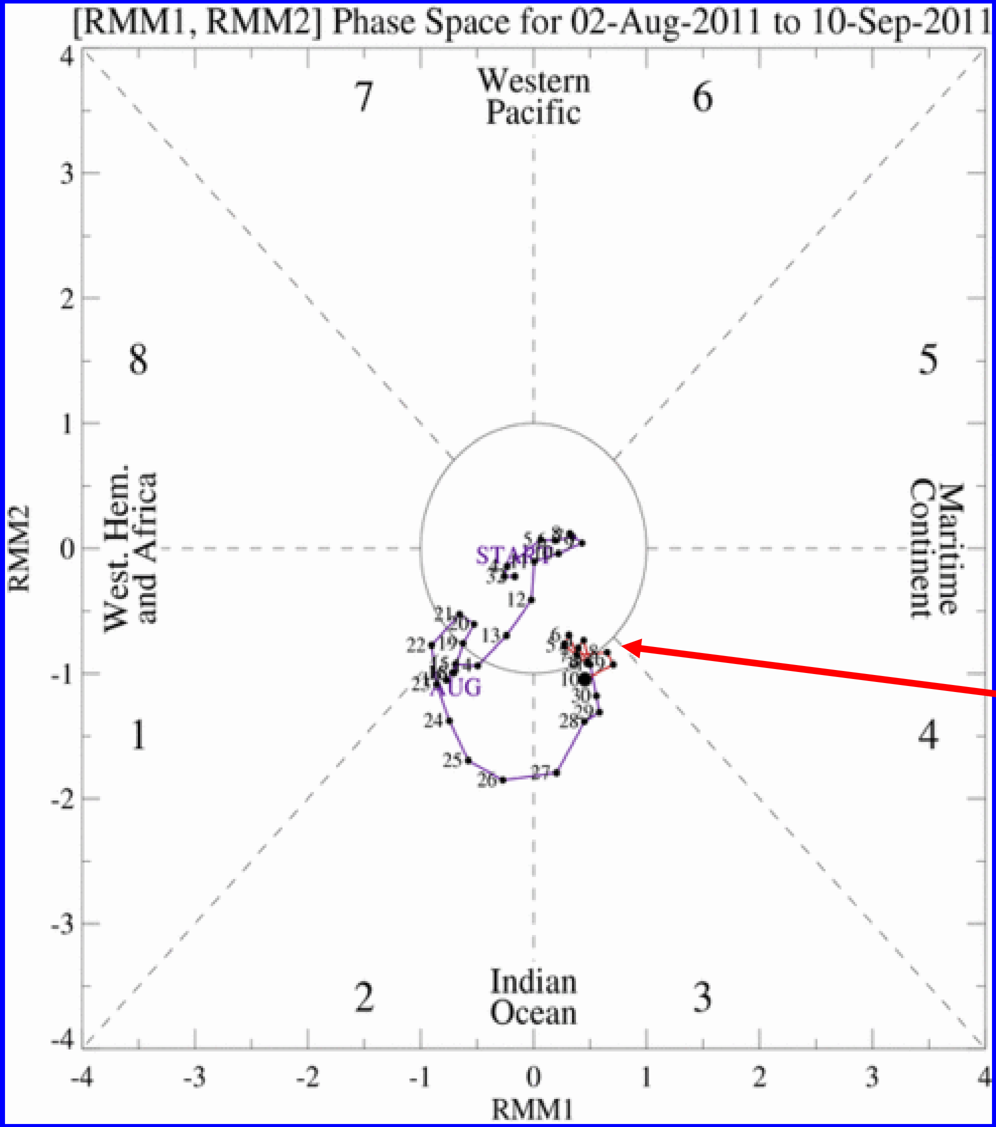
Wheeler M. and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction, *Monthly Weather Review,* 132, 1917-1932.

• 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).

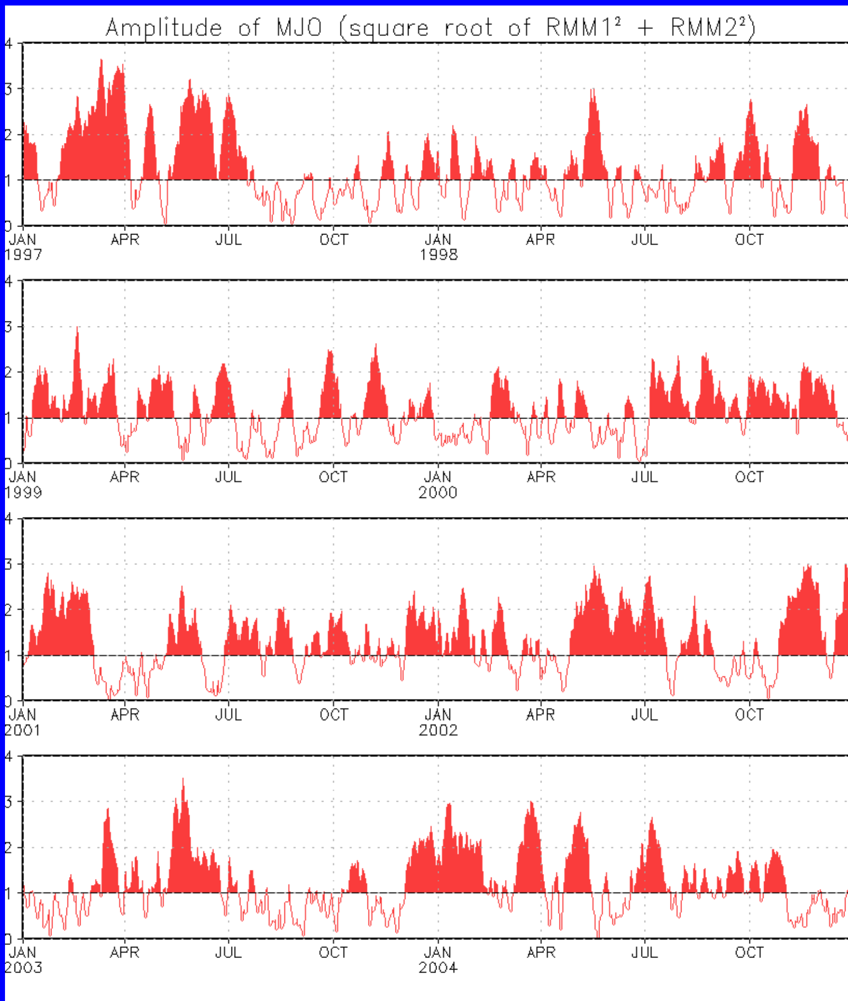
MJO Index -- Recent Evolution

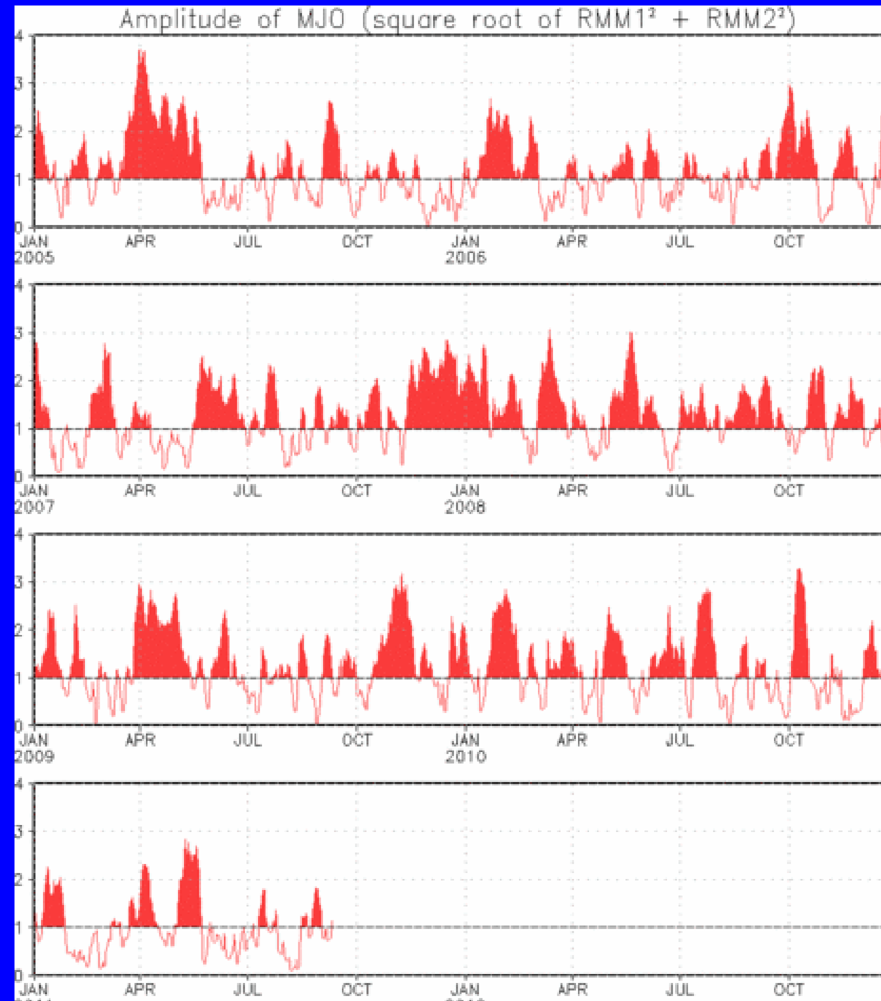


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

The MJO index indicates continued weak activity during the past ten days.

MJO Index – Historical Daily Time Series





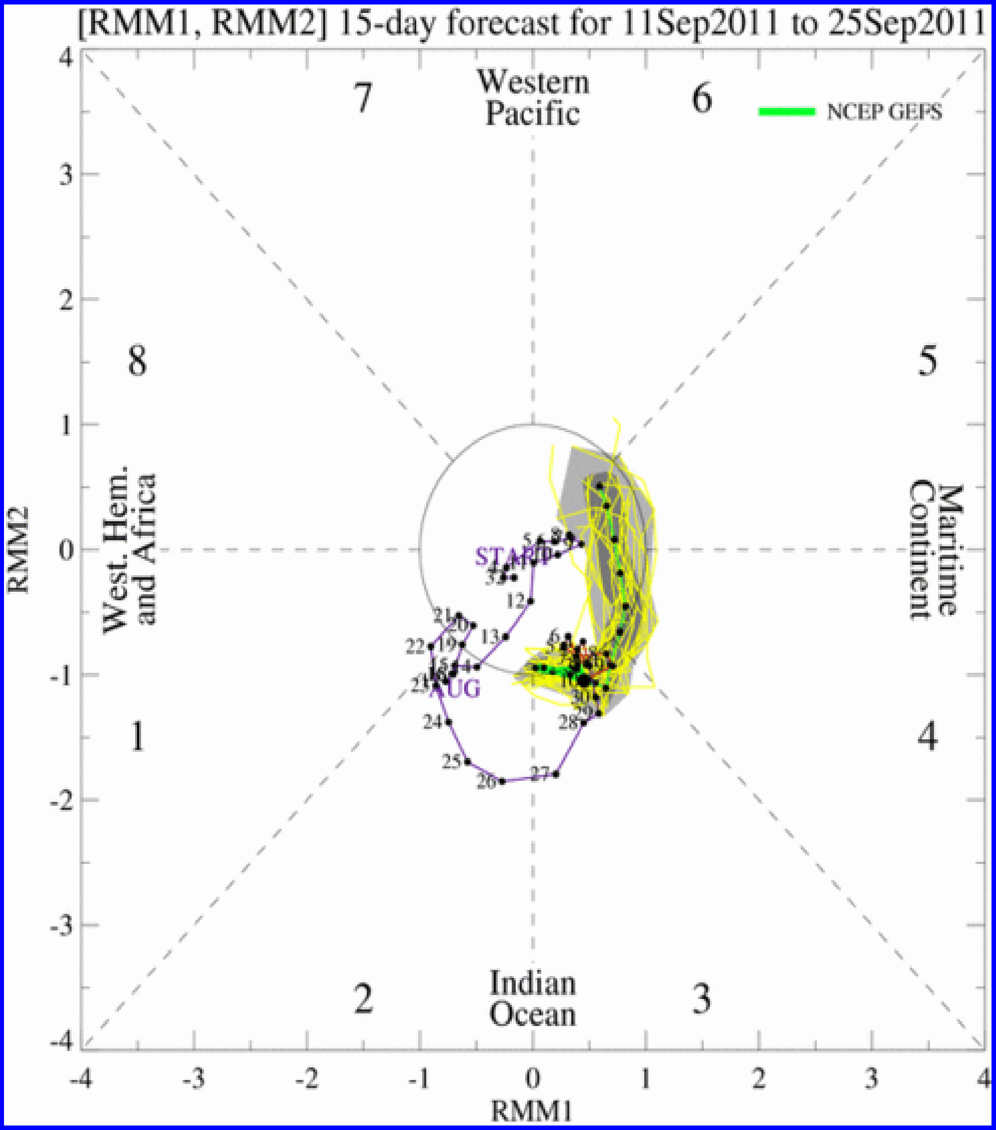
Time series of daily MJO index amplitude from 1997 to present. Plots put current MJO activity in historical context.

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

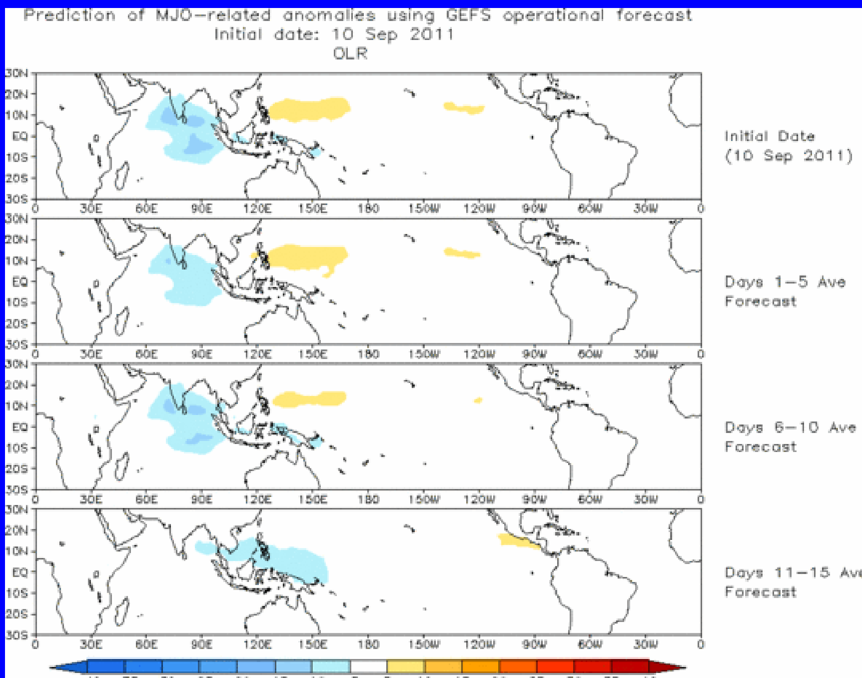


The ensemble GFS forecasts indicate a weak MJO signal during the upcoming two weeks. There is some eastward propagation of the signal during Week-2.

Ensemble Mean GFS MJO Forecast

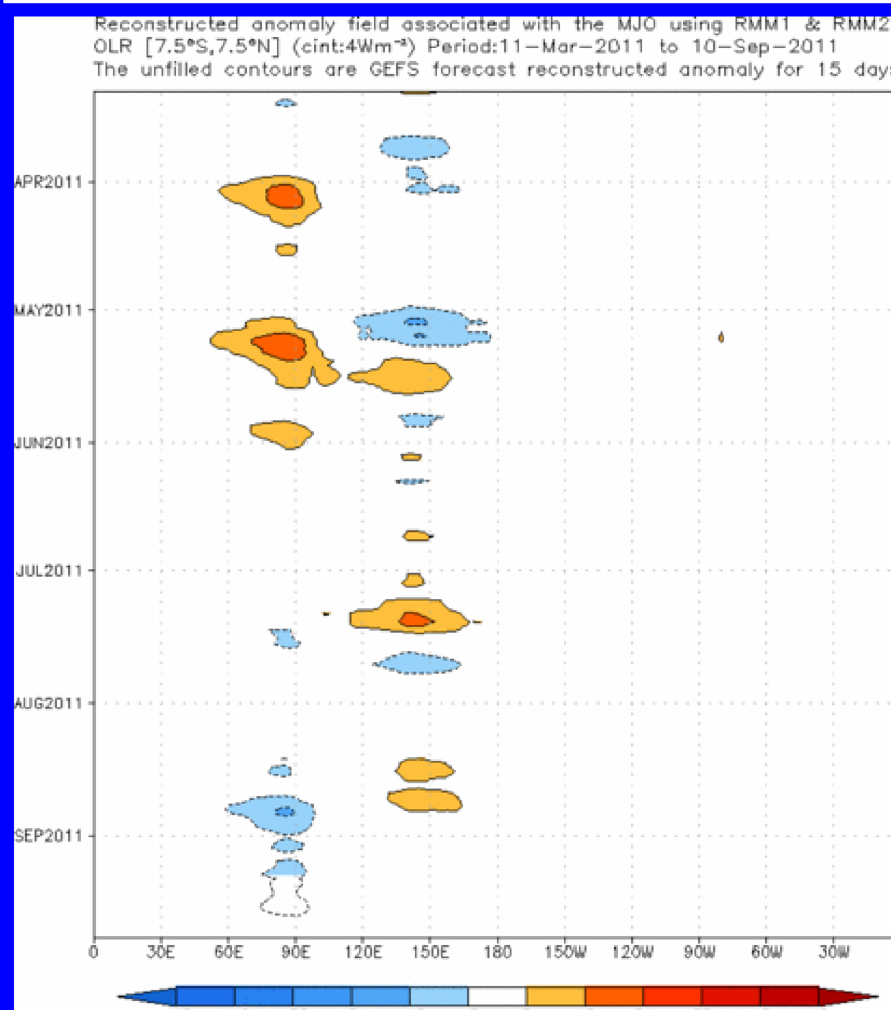
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

Spatial map of OLR anomalies for the next 15 days



The ensemble mean GFS forecast indicates weak enhanced convection across India and the Indian Ocean and weak suppressed convection in the northwest Pacific during the next week. Some enhanced convection is forecast across the Maritime Continent and western Pacific during the later part of 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

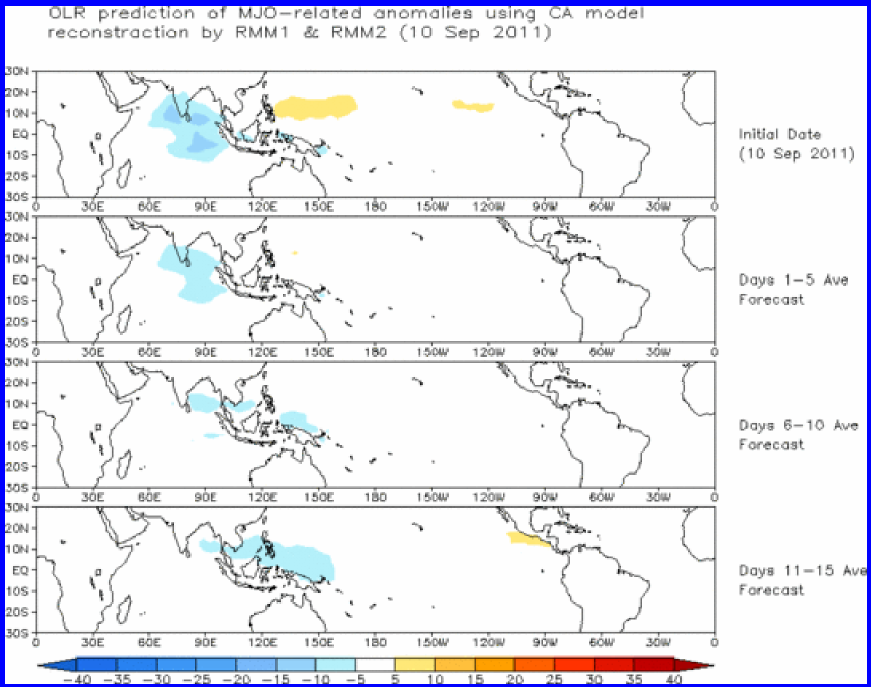


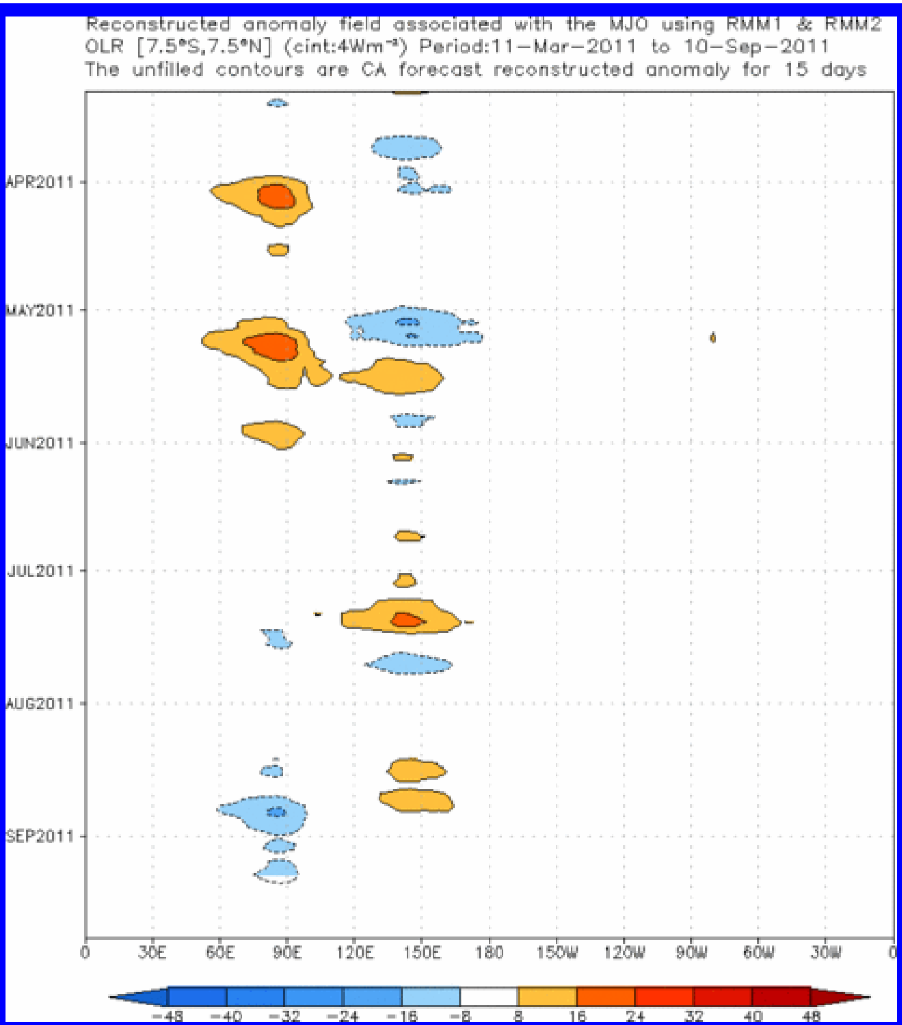
Constructed Analog MJO Forecast

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

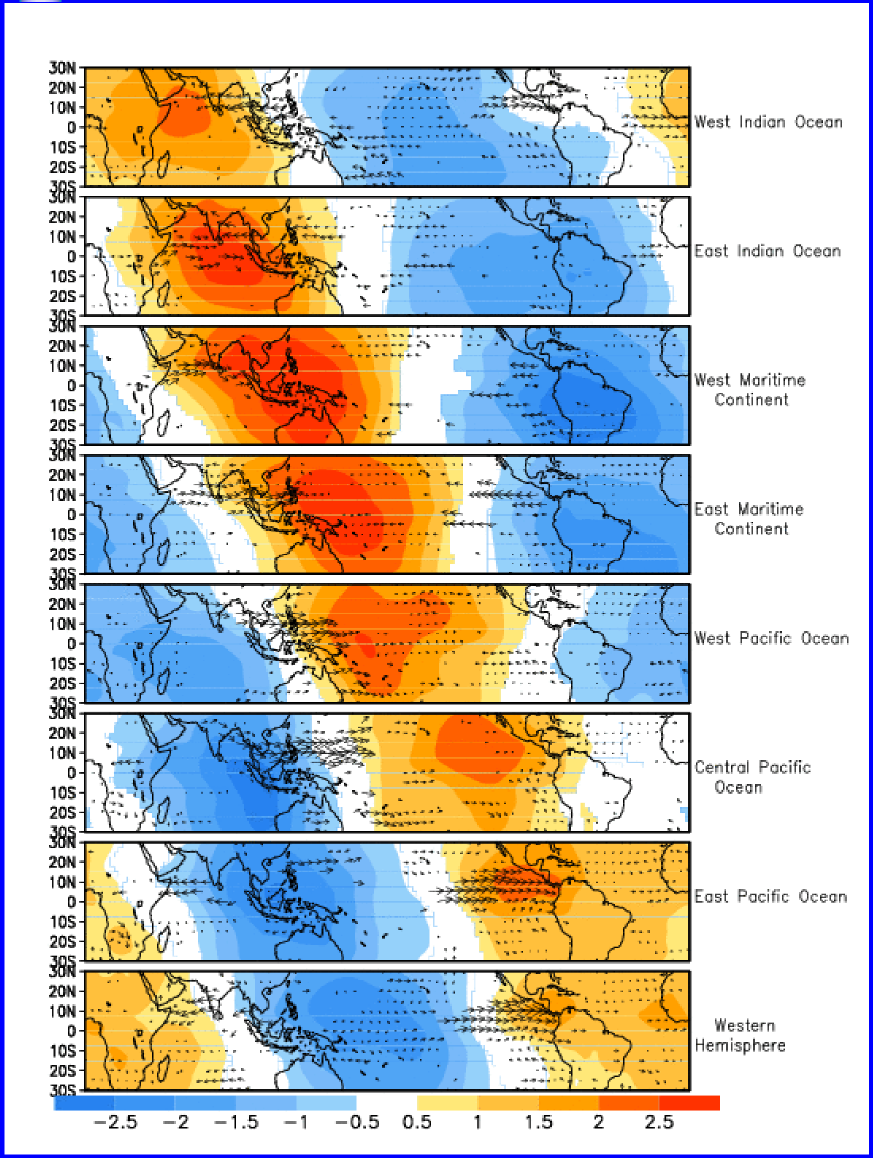




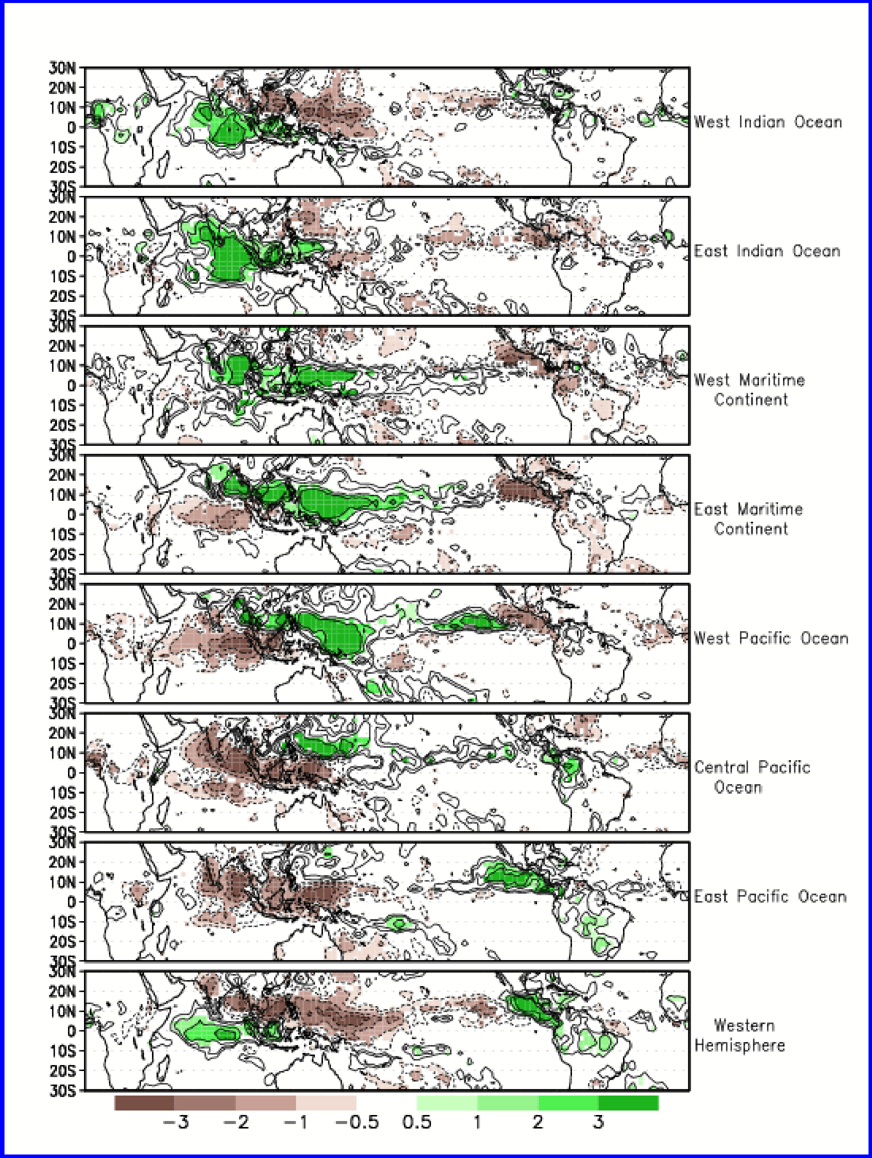
The CA forecast indicates weak enhanced convection in southern Asia and the Indian Ocean during Week-1, and weak enhanced convection over the Maritime Continent and western Pacific during Week-2.

MJO Composites – Global Tropics

850-hPa Wind Anomalies (May-Sep)



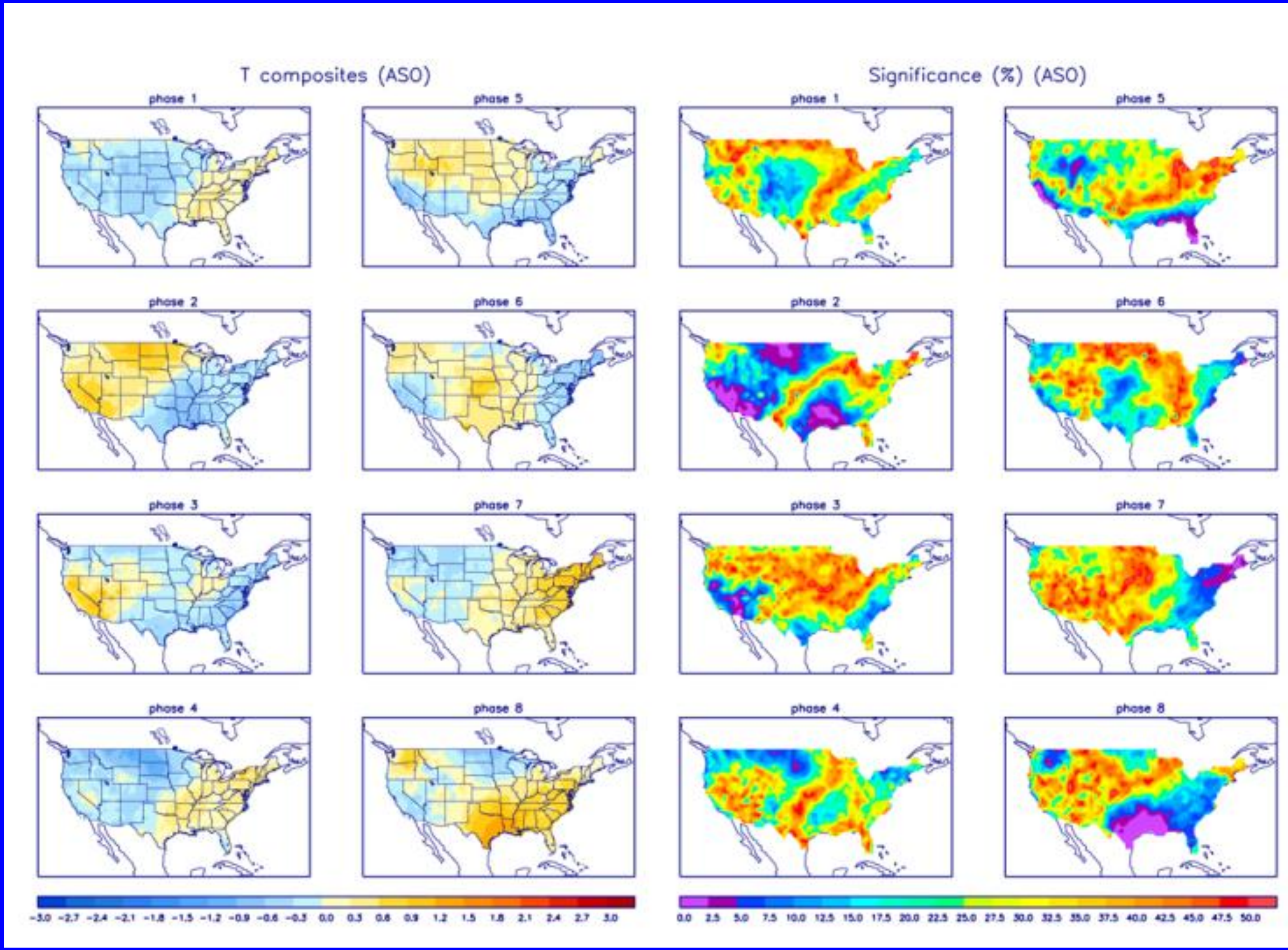
Precipitation Anomalies (May-Sep)



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.

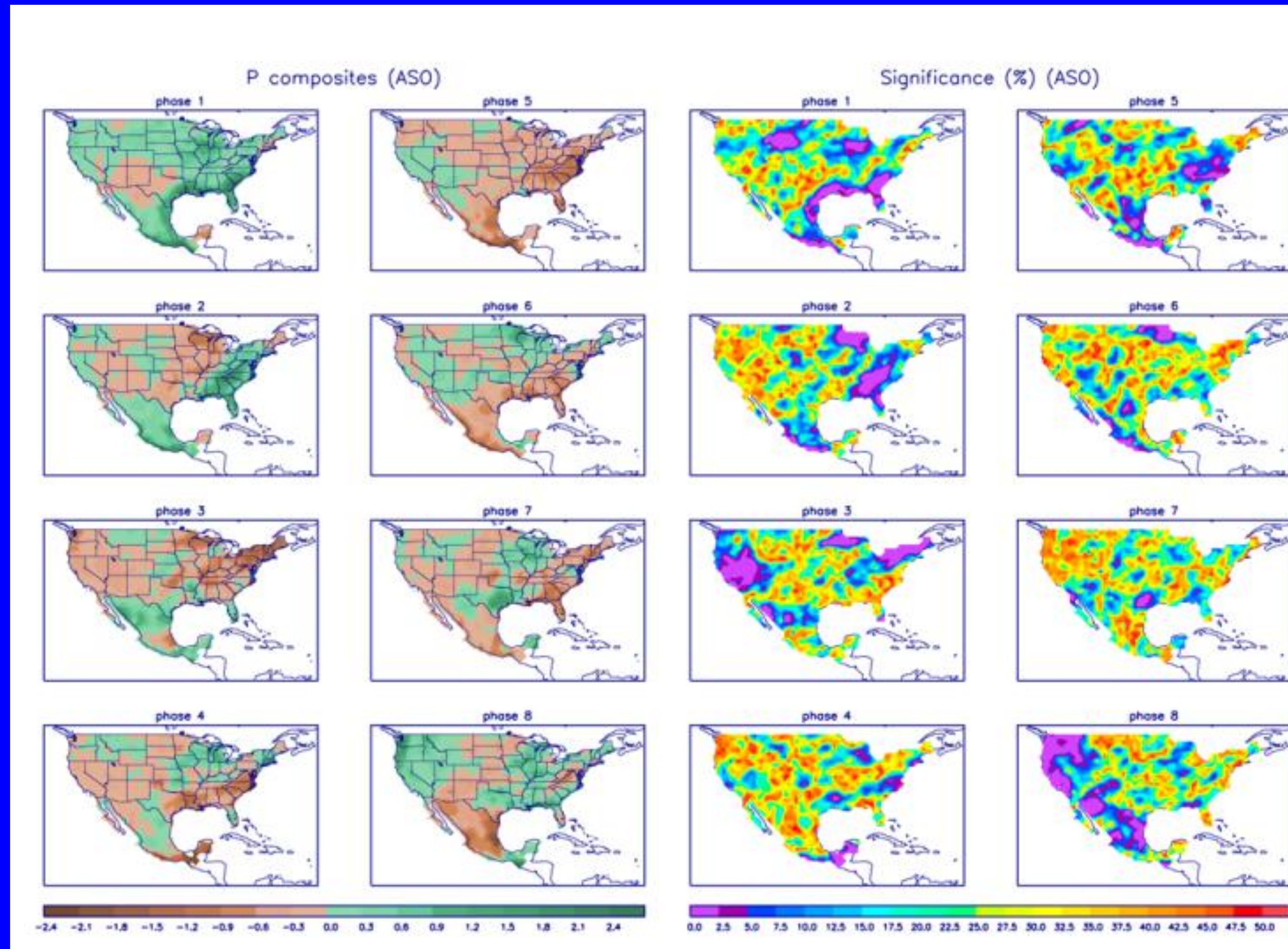


Zhou et al. (2011): A composite study of the MJO influence on the surface air temperature and precipitation over the Continental United States, *Climate Dynamics*, 1-13, doi: 10.1007/s00382-011-1001-9

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.



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