



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

**Update prepared by
Climate Prediction Center / NCEP
February 6, 2012**



Outline

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



Overview

- **The MJO continued to propagate eastward to the western Pacific during the past week.**
- **Dynamical model MJO index forecasts indicate continued MJO activity through the period. There is some spread between the models for the magnitude and eventual phase by the end of Week-2, but most favor the enhanced phase nearing the western Indian Ocean by the end of the period.**
- **Based on the latest observations and model forecasts, the MJO is forecast to remain active during the upcoming 1-2 weeks.**
- **The MJO is forecast to contribute to enhanced convection for areas across the South Pacific Convergence Zone (SPCZ) and South America during Week-1 and parts of Africa and the western Indian Ocean during Week-2. Suppressed convection is favored for parts of the eastern Indian Ocean (Weeks 1 and 2) and northern Australia (Week-2).**
- **For the U.S., upcoming forecast phases of the MJO favor a tendency for stronger jet streams to develop and one consequence of this may be higher chances for above-average precipitation across some areas of the southern tier of the U.S., not typical during La Nina.**

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

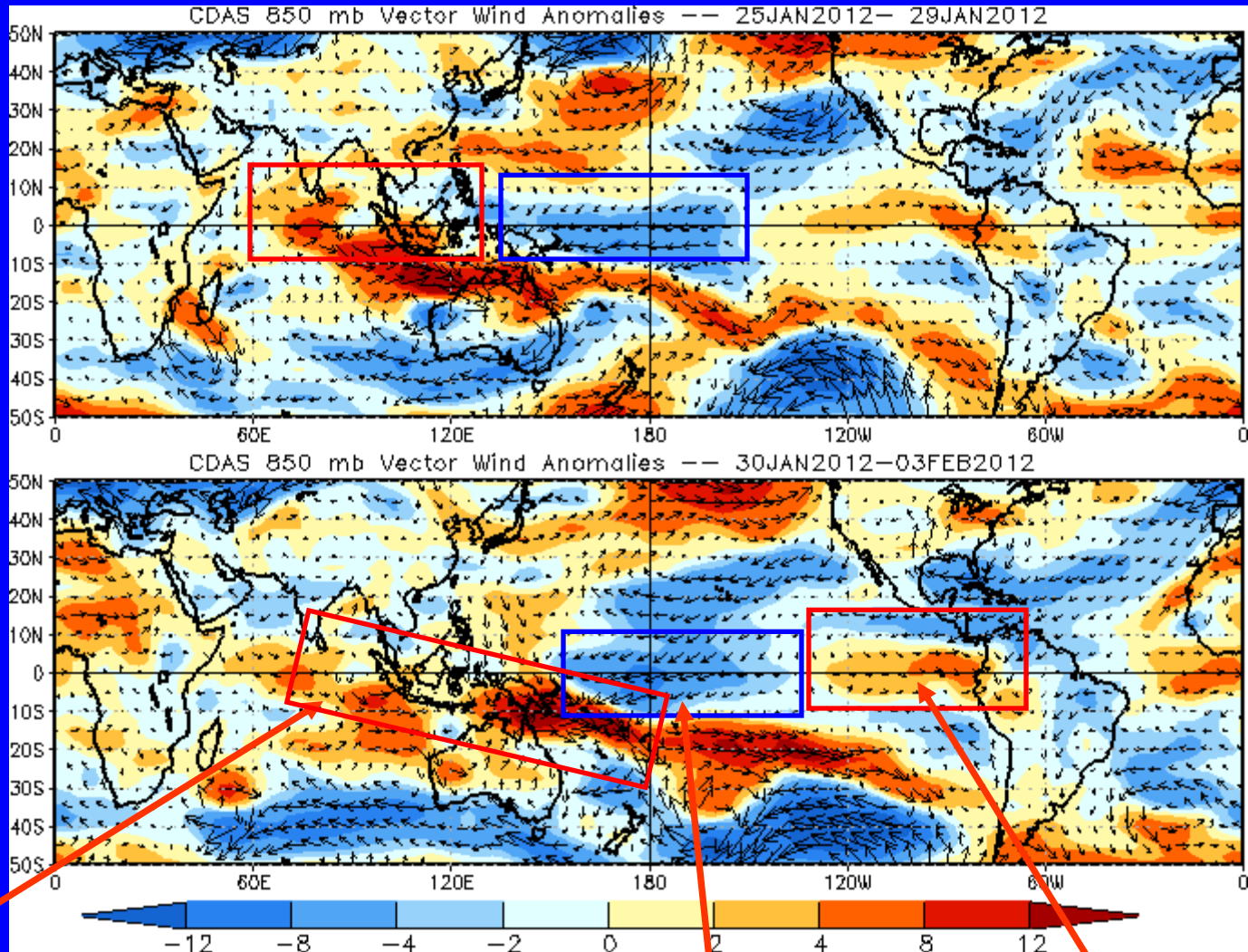


850-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



Westerly anomalies continued over the eastern Indian Ocean and Maritime Continent during the past five days, while strengthening in the western Pacific and well east of the Date Line south of the equator.

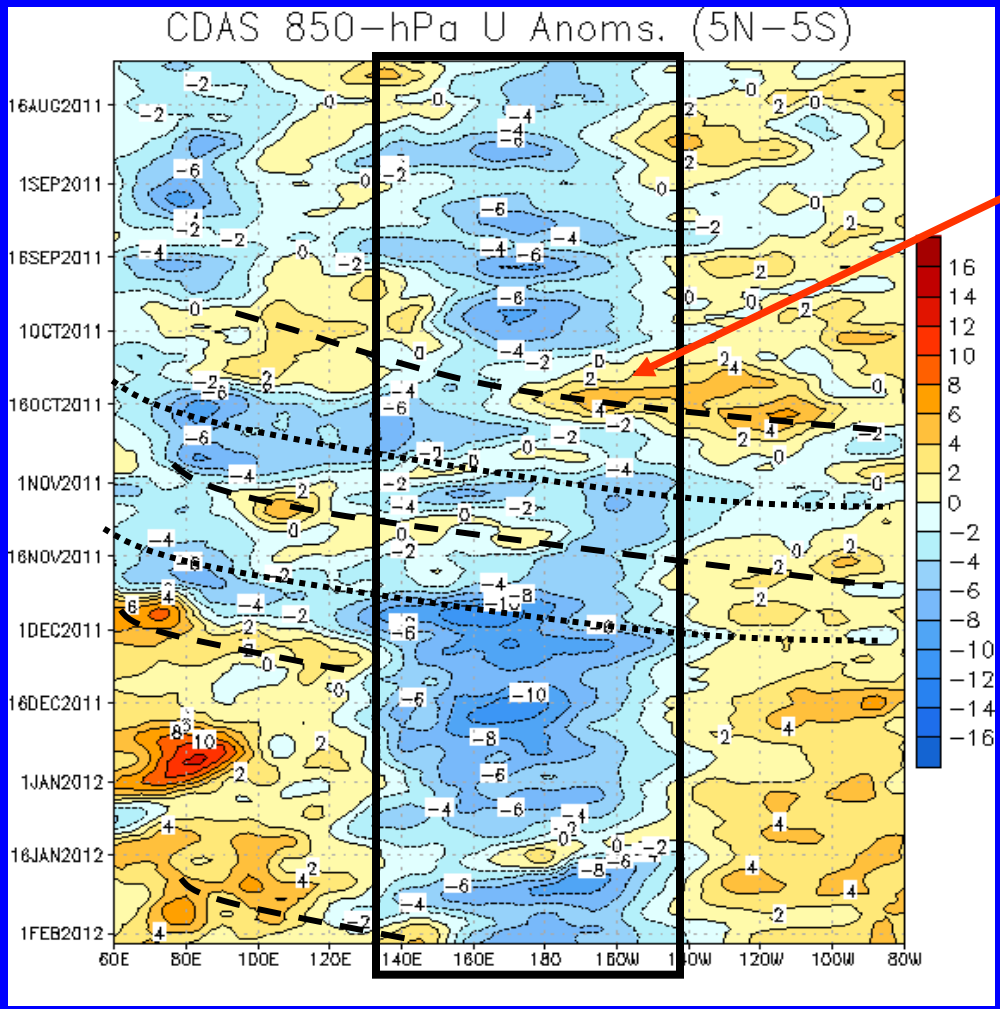
Easterly anomalies shifted eastward over the equatorial Pacific.

Westerly wind anomalies continued over the east Pacific Ocean.



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 most recently westerly (easterly) wind anomalies across the Indian Ocean (western Pacific) have become more stationary.

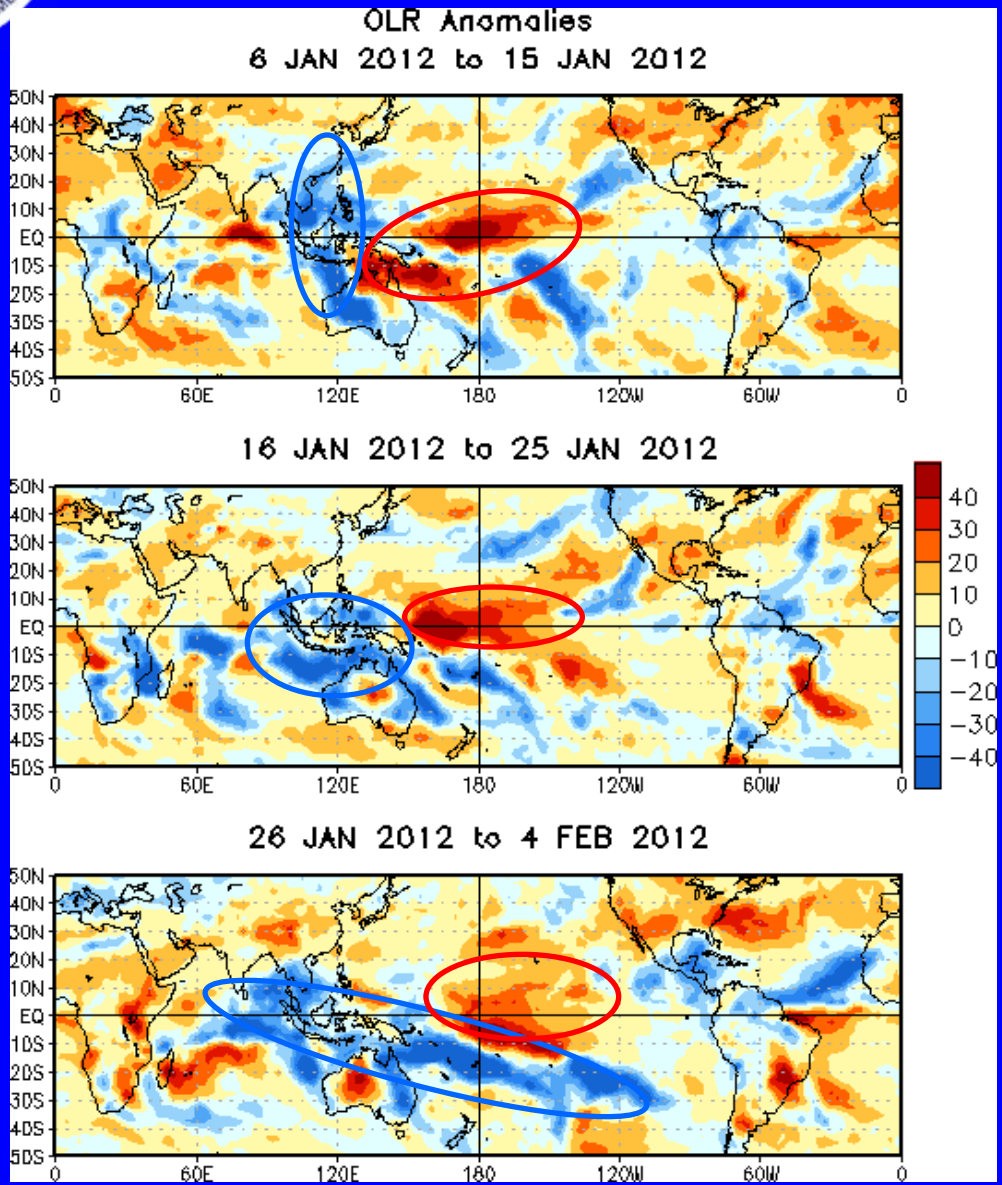
In mid-January, interaction with the extratropics contributed to decreased easterlies near the Date Line.

Recently, westerly anomalies shifted eastward into the western 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 the beginning of January, enhanced convection (blue circle) continued in the Philippines and the western Maritime continent. Suppressed convection (red circle) developed in the southwest Pacific.

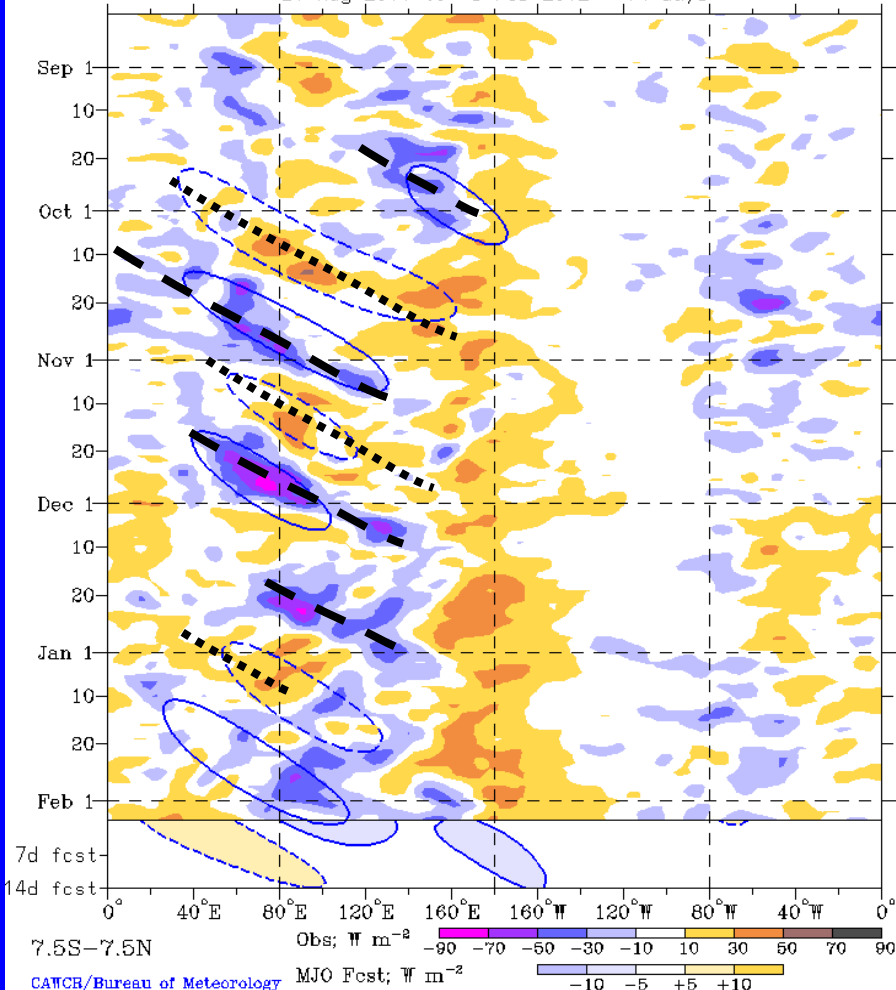
Enhanced (suppressed) convection continued into mid-January around the Maritime Continent (equatorial Pacific Ocean).

During mid-to-late January, convection markedly increased for a large area from the eastern Indian Ocean and Maritime continent to the SPCZ and south-central 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
21-Aug-2011 to 5-Feb-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 clear but during late December, eastward propagation of OLR anomalies was again observed.

Strong enhanced convection developed across the Indian Ocean during late January. In early February enhanced convection shifted eastward into the western Pacific.

Longitude

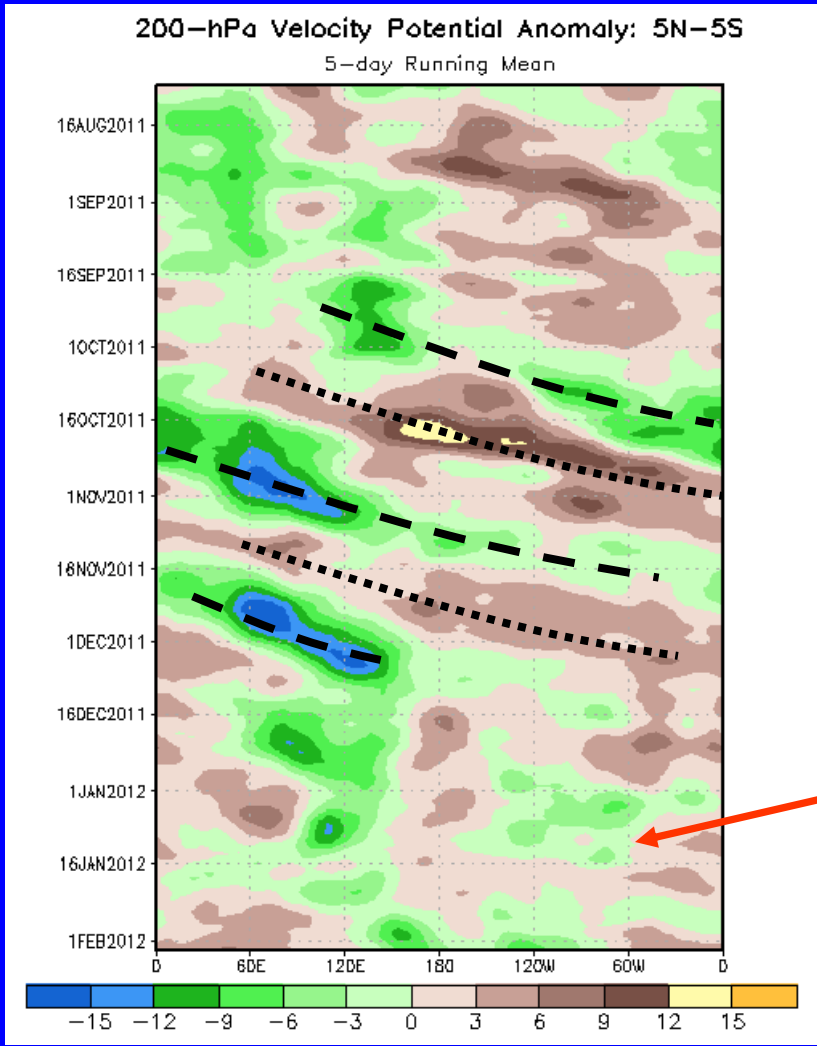


200-hPa Velocity Potential Anomalies (5°S-5°N)

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

Negative anomalies (green shading) indicate favorable conditions for precipitation

Time
↓



During 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.

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 January and anomalies became very weak.

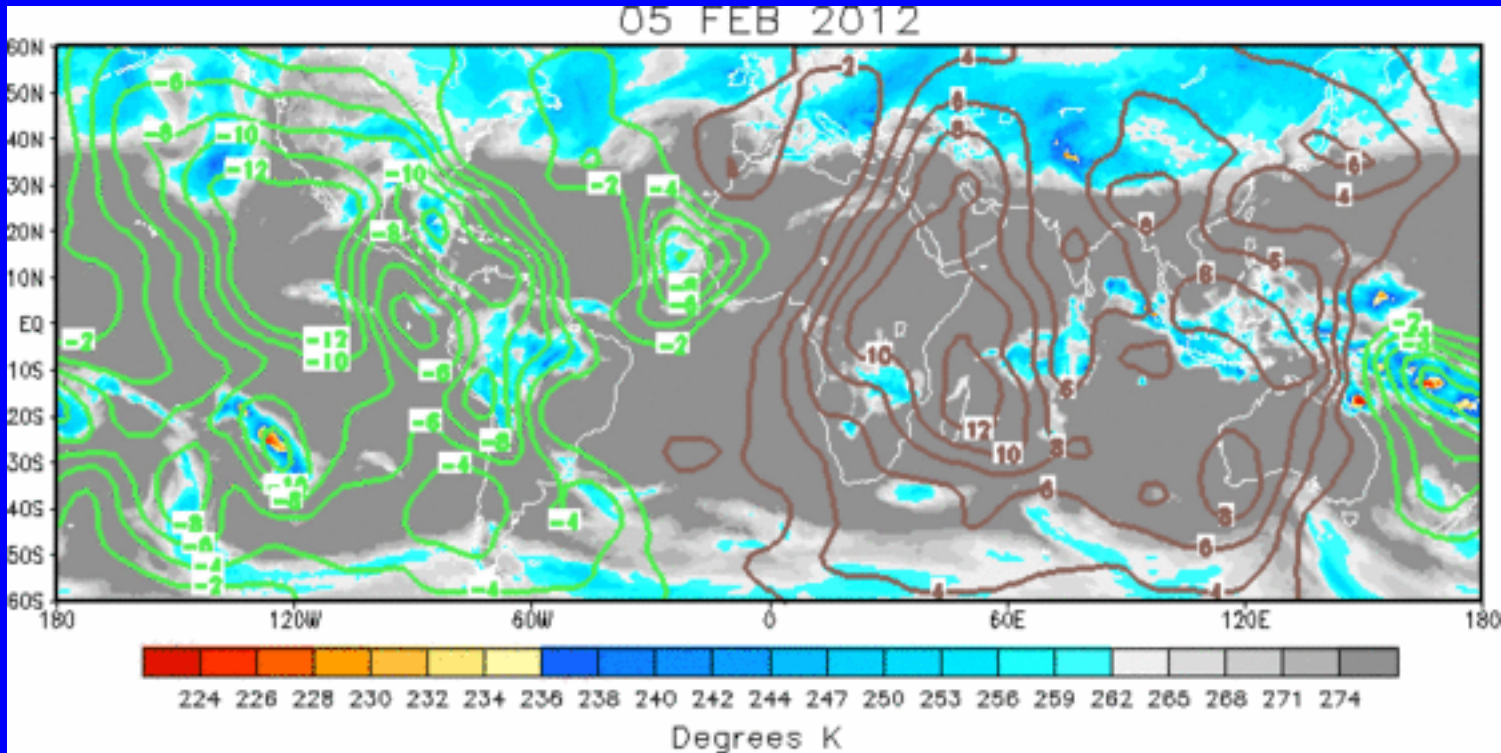
Longitude



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 latest large scale velocity potential pattern recently became more coherent, with negative anomalies over the Pacific and the Americas and negative anomalies across Africa and the Indian Ocean.

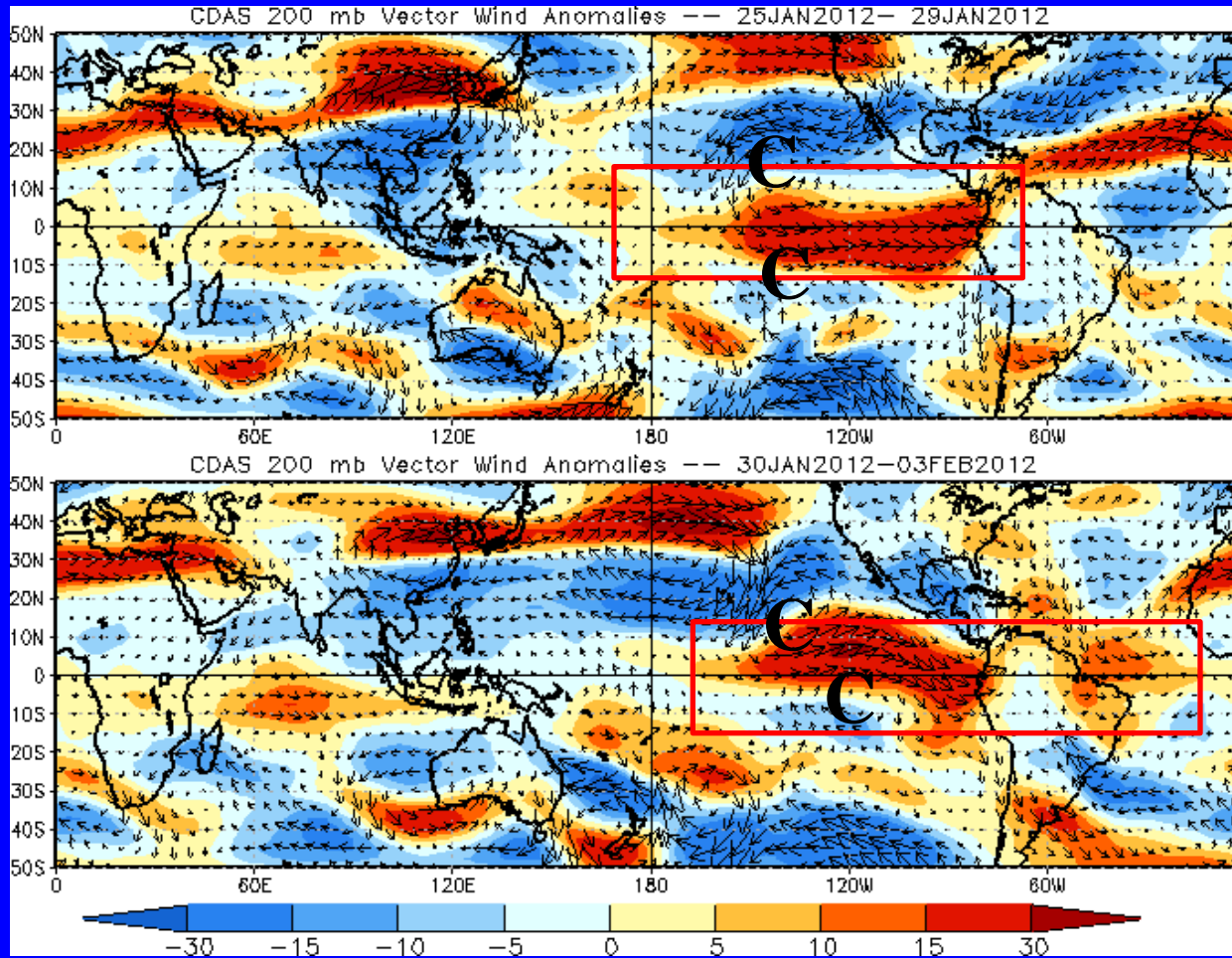


200-hPa Vector Wind Anomalies ($m s^{-1}$)

Note that shading denotes the zonal wind anomaly

Blue shades: Easterly anomalies

Red shades: Westerly anomalies



Large scale cyclonic circulations are evident both north and south of the equator east of the Date Line.

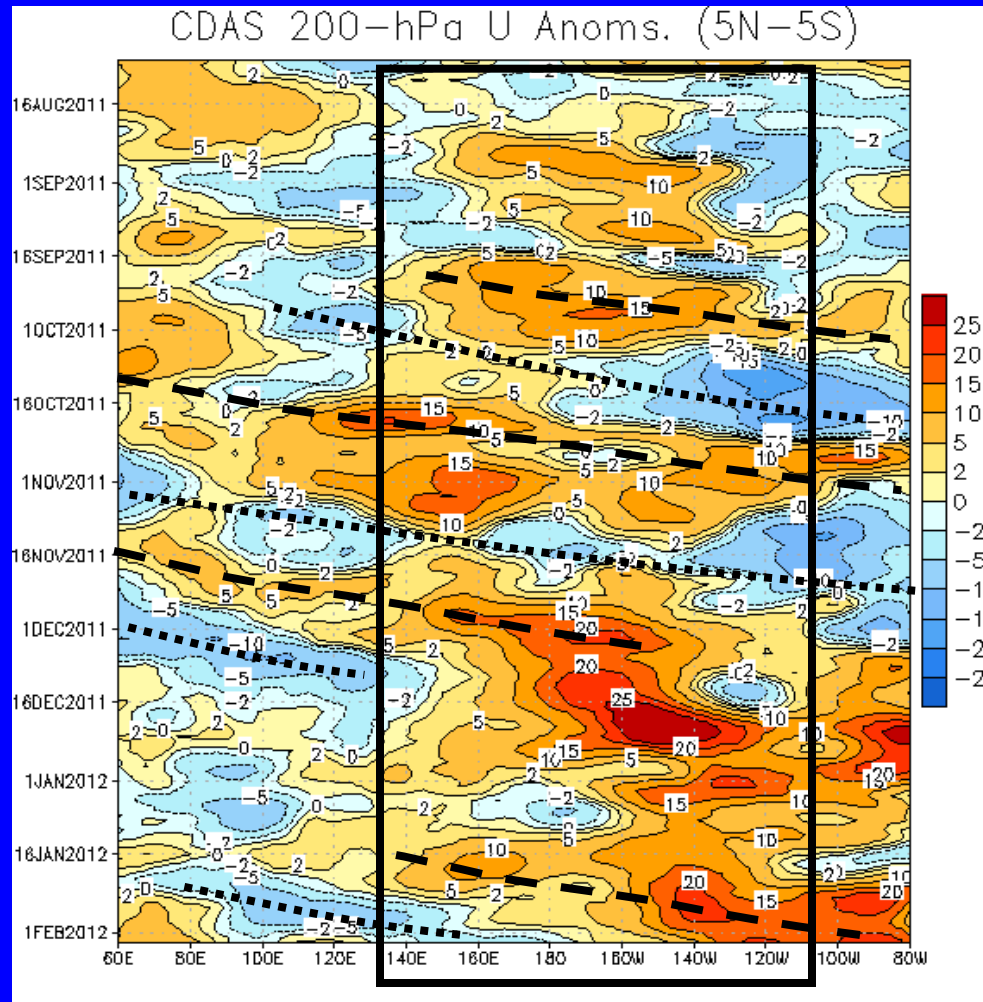
During the past five days, westerly anomalies strengthened over the Indian Ocean and developed over the Atlantic.



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



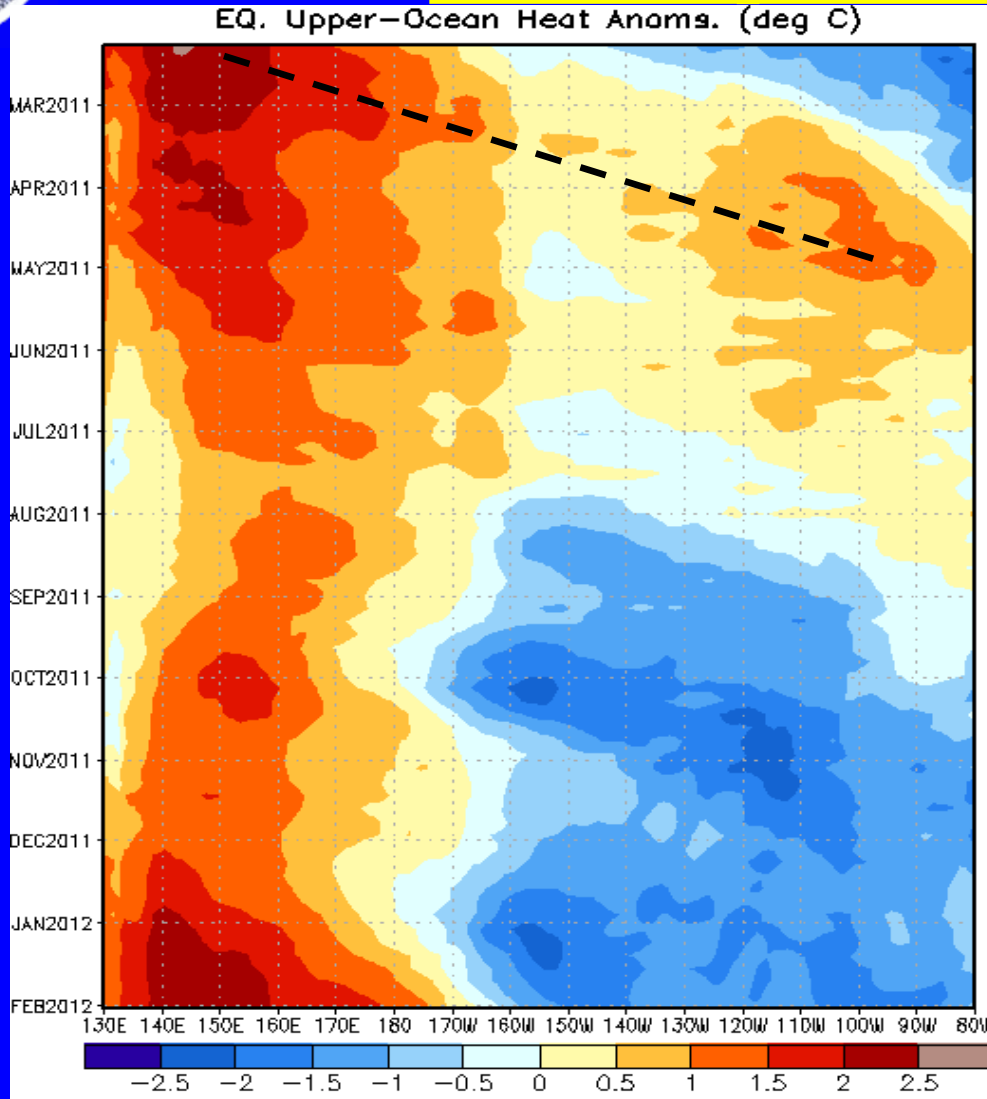
Westerly anomalies persisted across a large area from the Maritime Continent to the central Pacific (black solid box) during much of the period prior to mid-September.

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.



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 late July, 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.

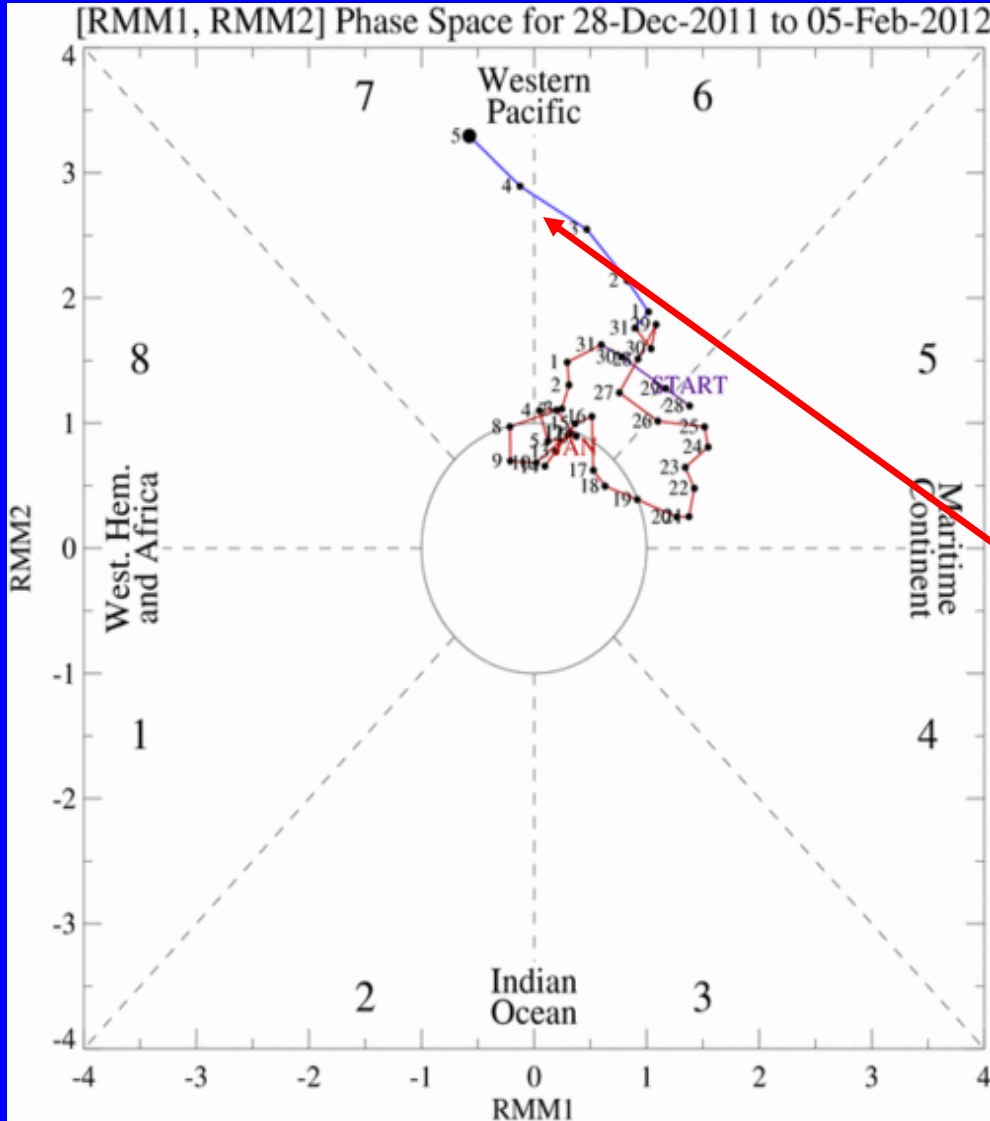
- The methodology is very similar to that described in WH2004 but does not include the linear removal of ENSO variability associated with a sea surface temperature index. The methodology is consistent with that outlined by the U.S. CLIVAR MJO Working Group.

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

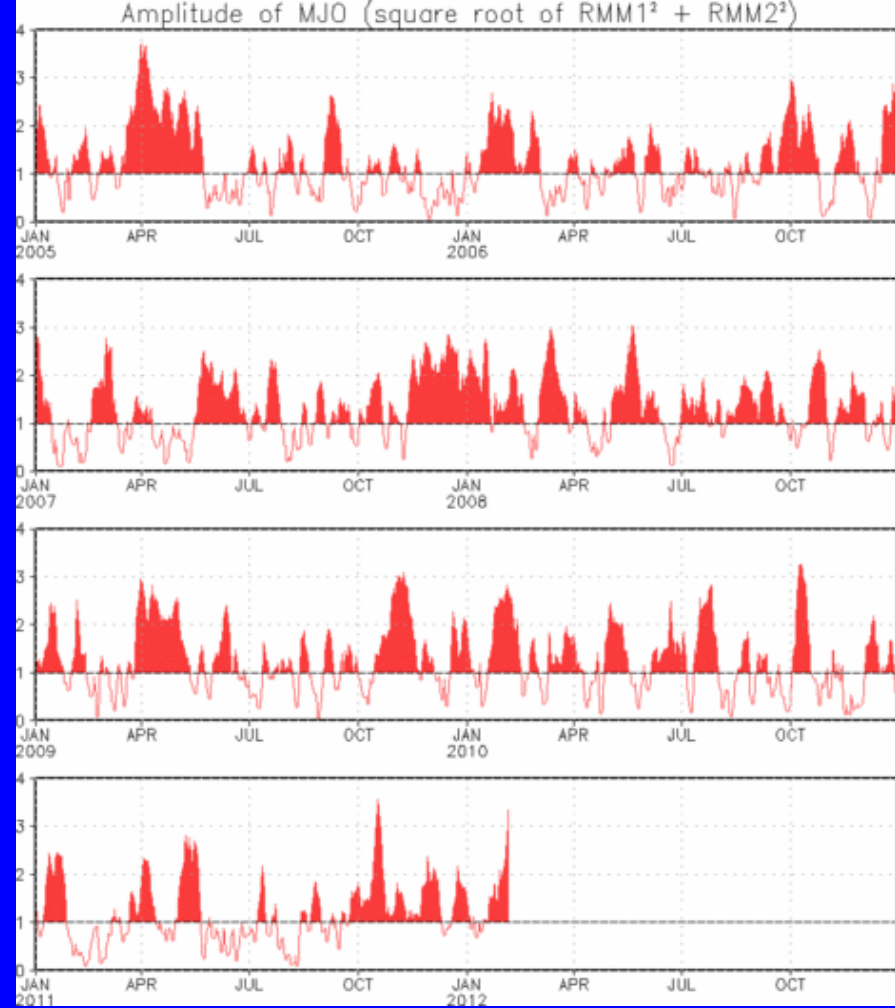
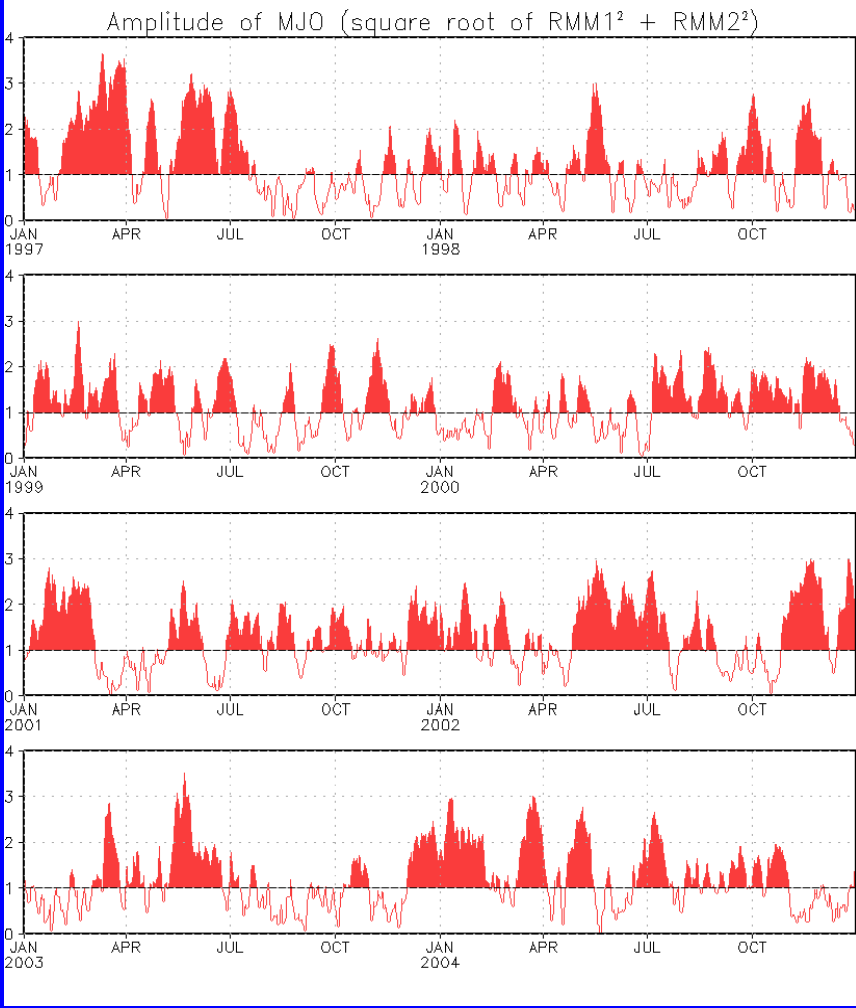


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation. Large dot most recent observation.
- Distance from the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

During the first half of January the MJO index was fairly weak with no eastward propagation. Recently, the amplitude increased over the Maritime continent and eastward propagation into the western Pacific is evident.



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.



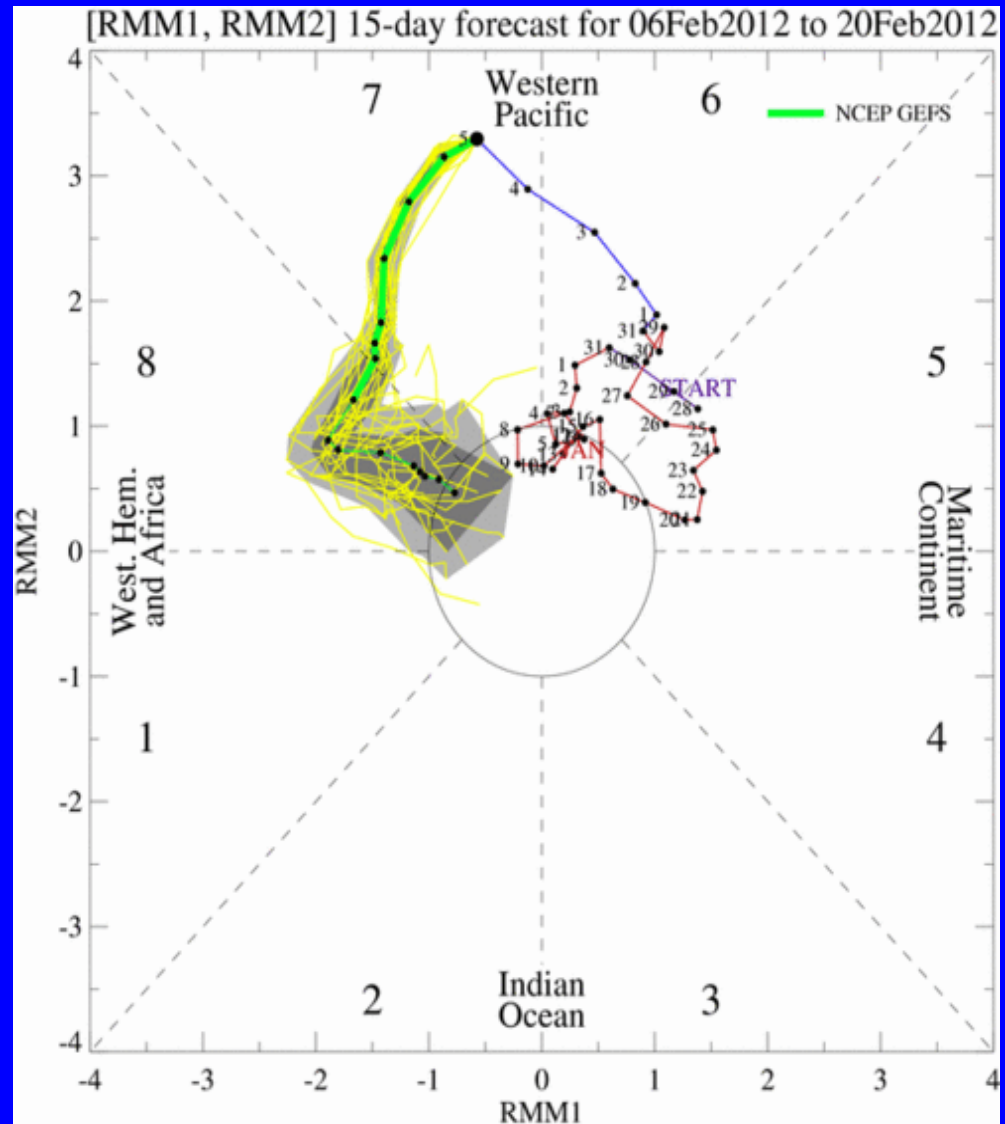
Ensemble GFS (GEFS) MJO Forecast

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 with the enhanced phase shifting across the Pacific and into the western hemisphere during Week-2.



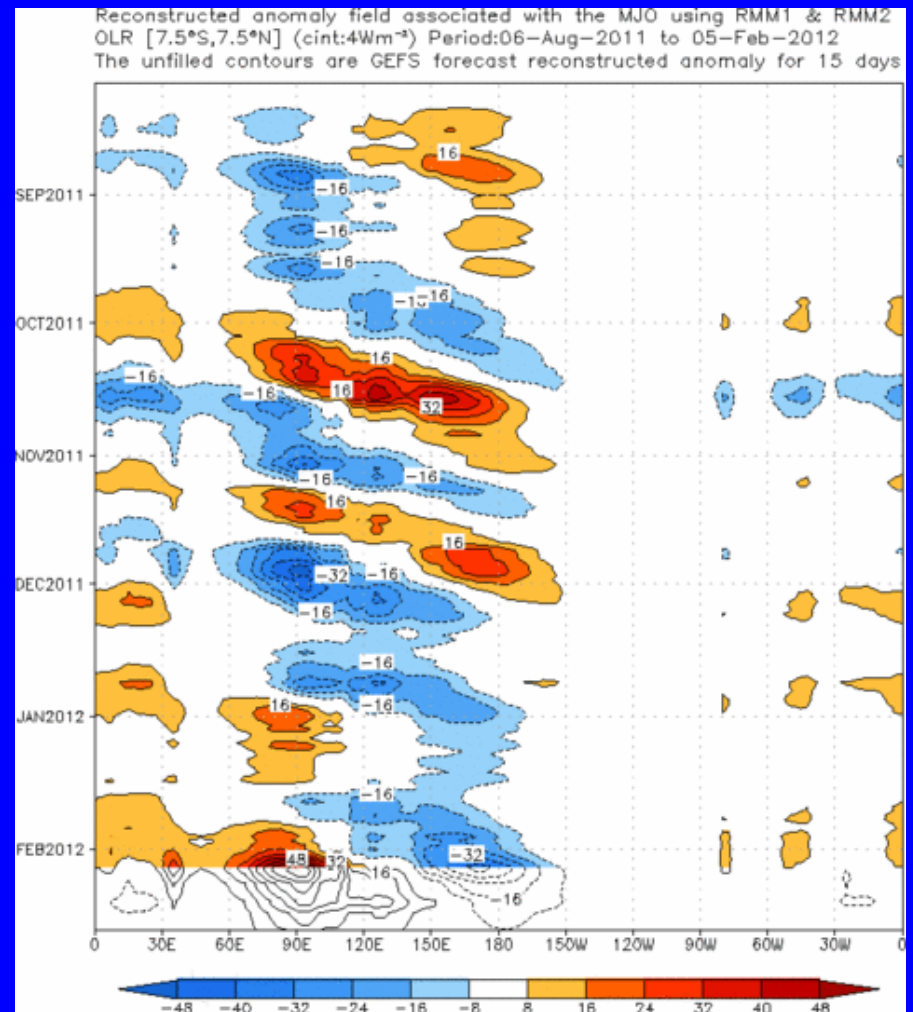
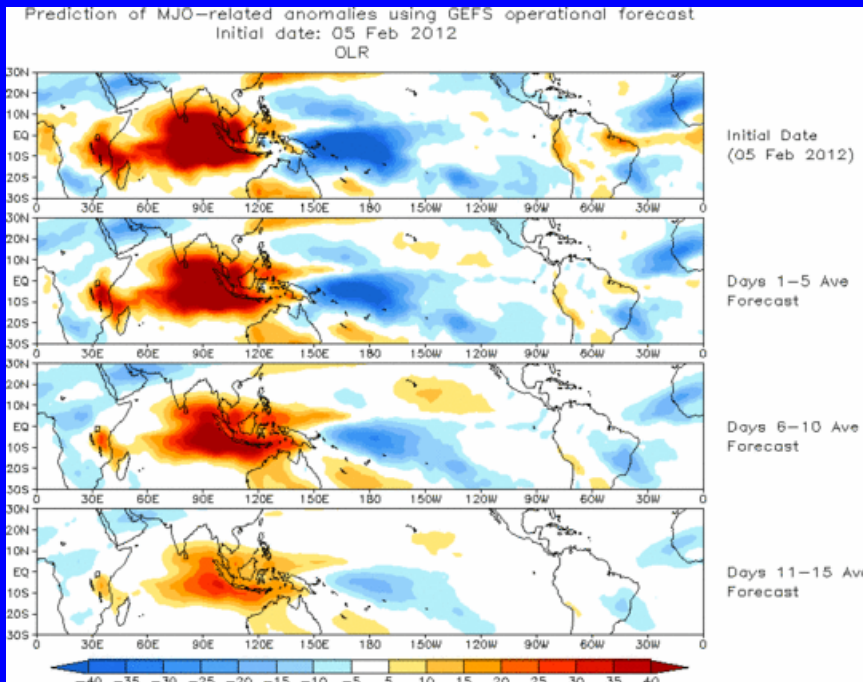


Ensemble Mean GFS MJO Forecast

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

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 west-central Pacific, parts of Brazil, and parts of Africa during the next two weeks with suppressed convection across the Indian Ocean and Maritime Continent.

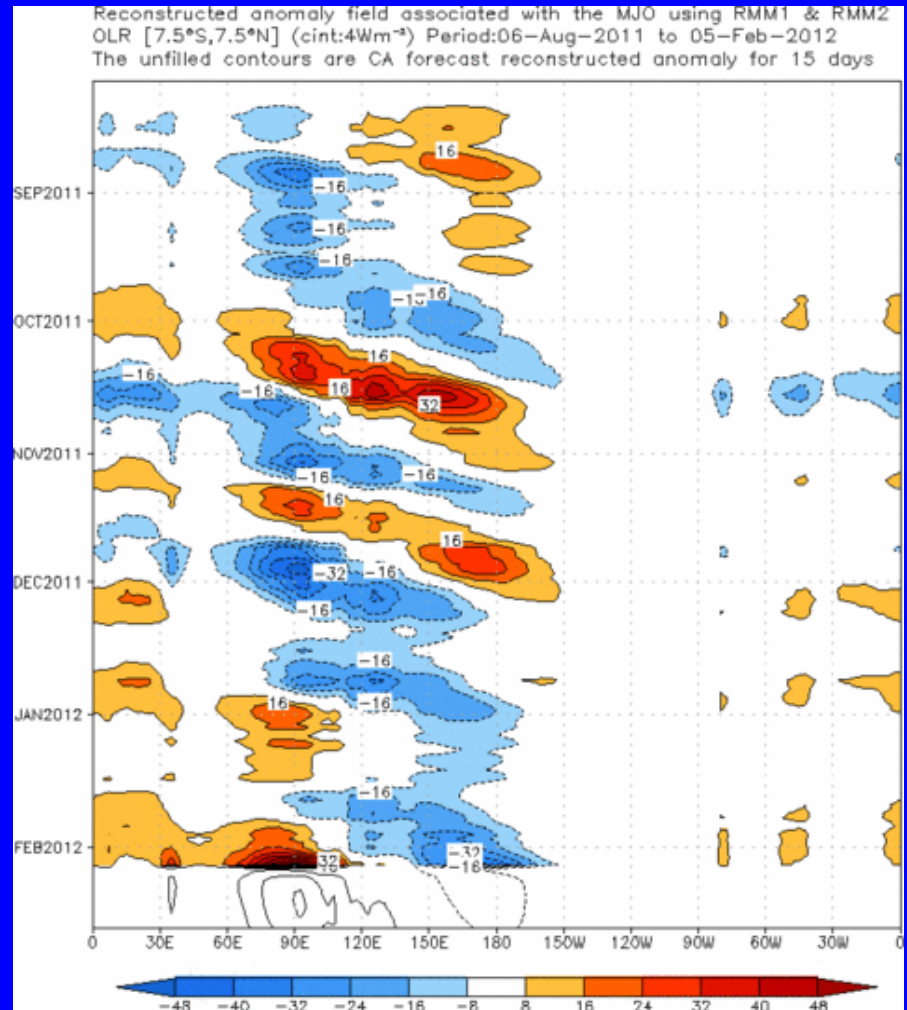
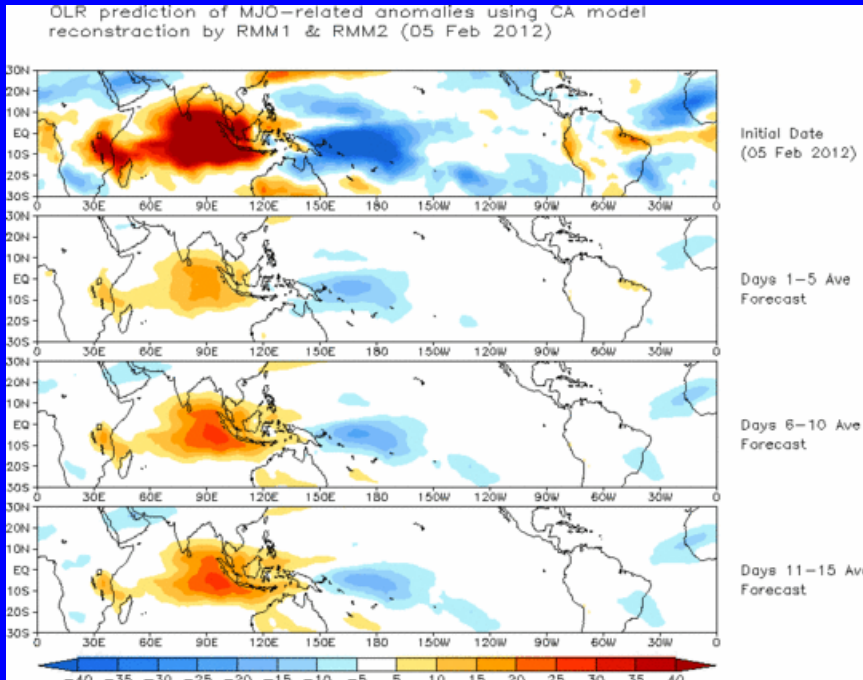


Constructed Analog (CA) MJO Forecast

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

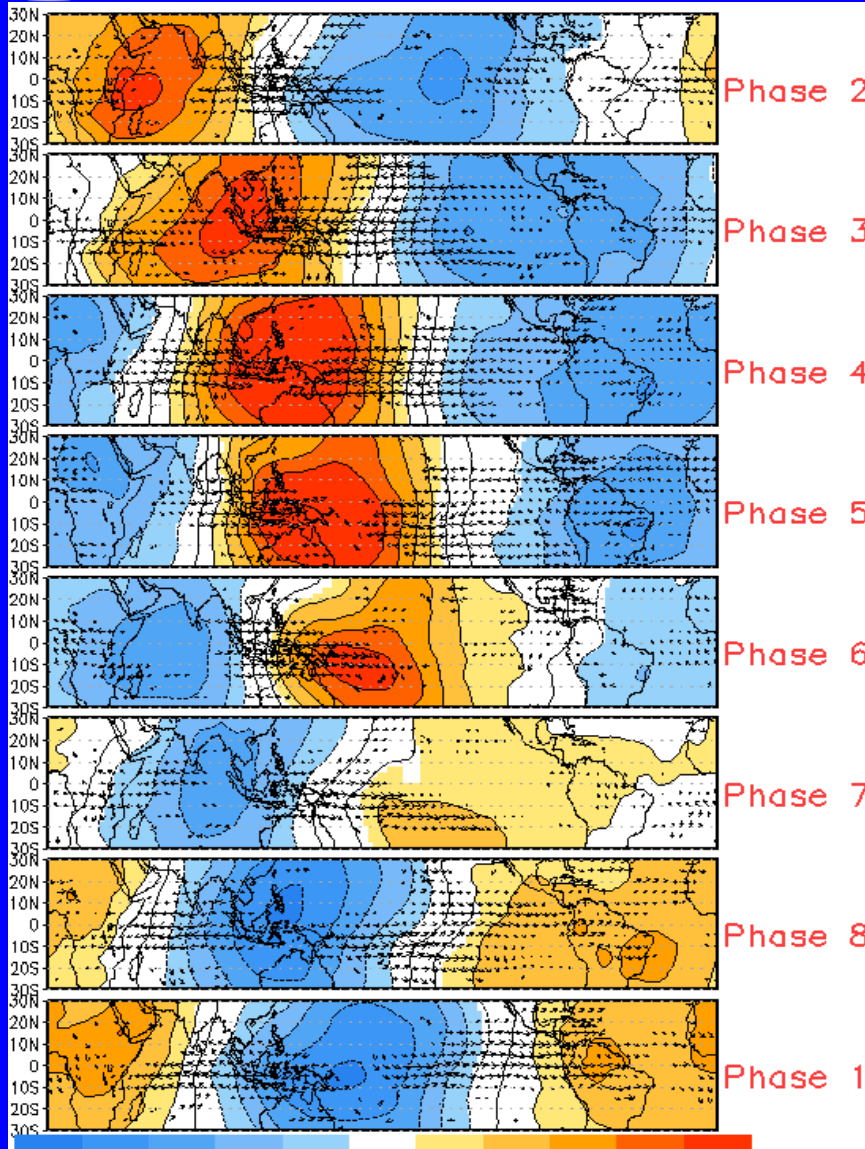


The CA forecast shows enhanced convection over the west-central Pacific, parts of Brazil, and parts of Africa while suppressed convection dominates the region from the central Indian Ocean to the western Maritime Continent.

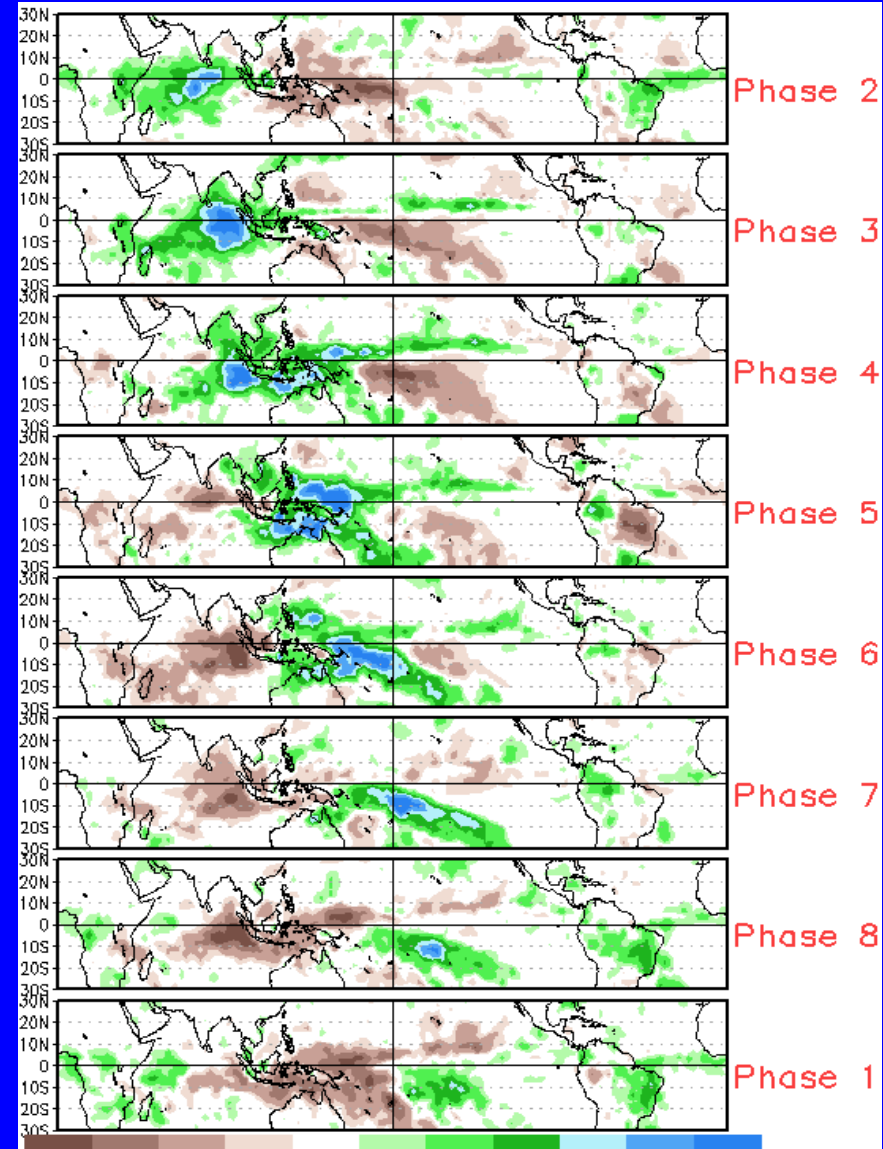


MJO Composites – Global Tropics

850-hPa Wind Anomalies (Nov-Mar)



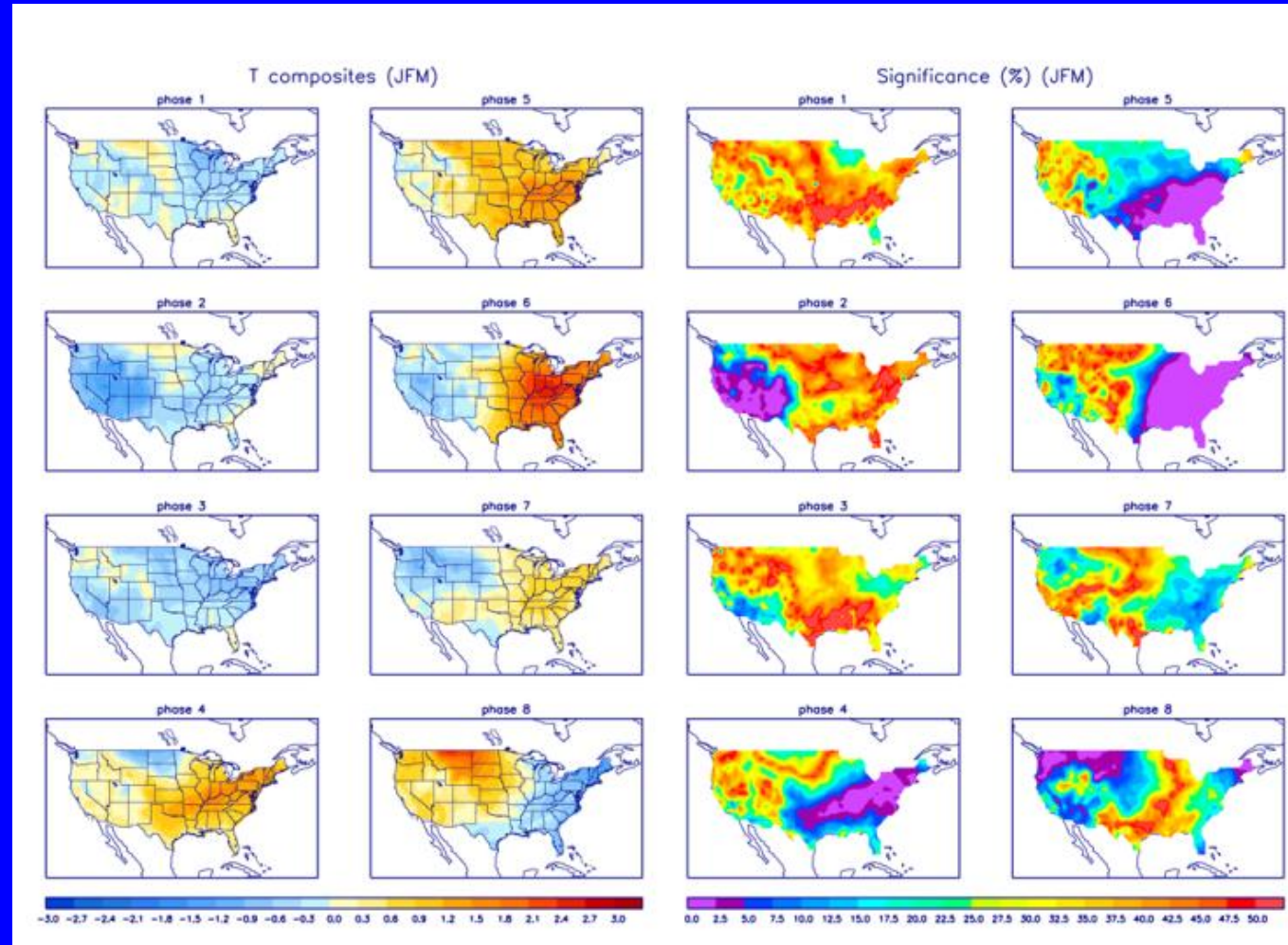
Precipitation Anomalies (Nov-Mar)





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.



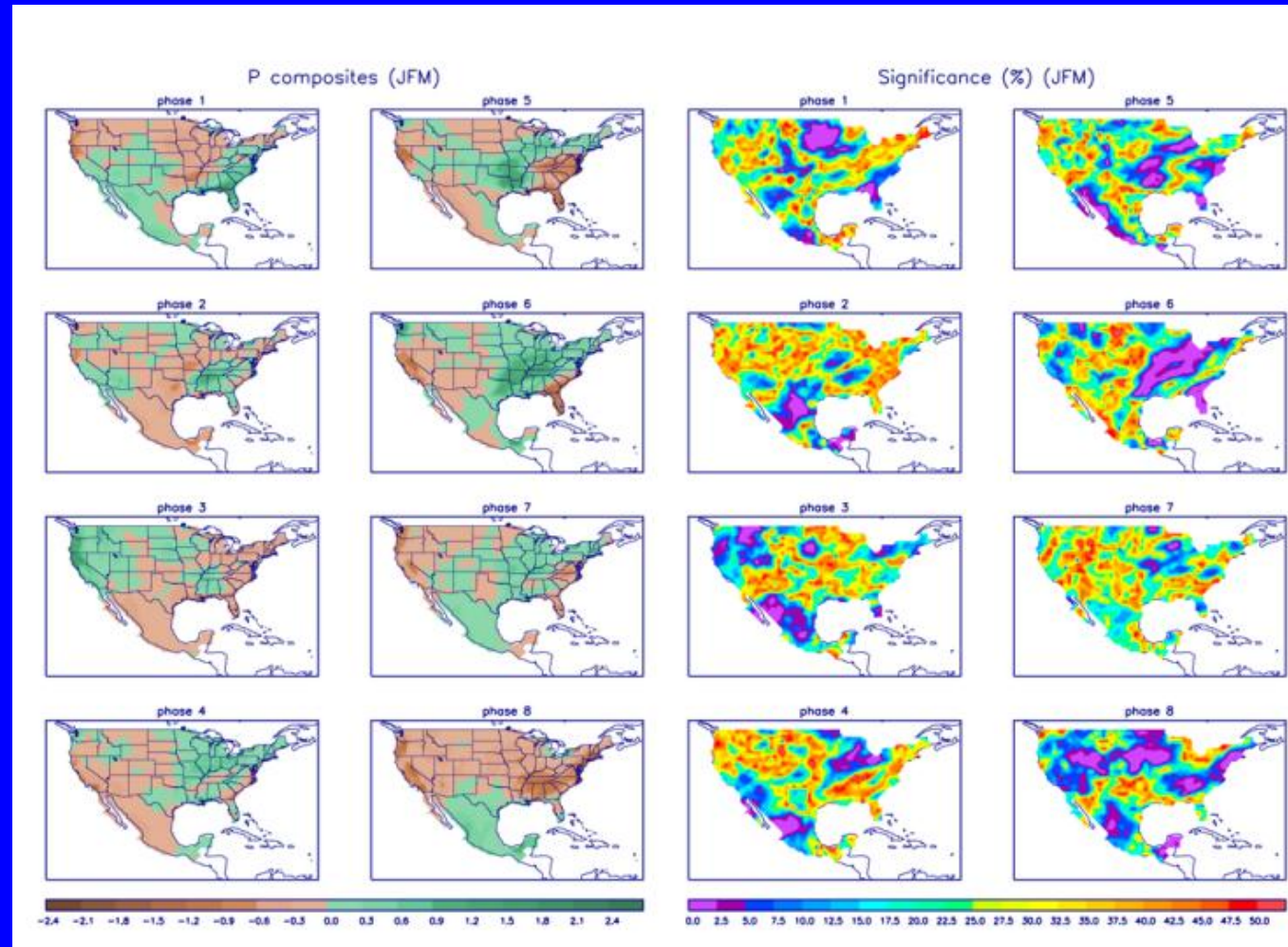
Zhou et al. (2011): A composite study of the MJO influence on the surface air temperature and precipitation over the Continental United States, *Climate Dynamics*, 1-13, doi: 10.1007/s00382-011-1001-9

<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

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