

Madden-Julian Oscillation:

Recent Evolution, Current Status and Predictions



Update prepared by the Climate Prediction Center
Climate Prediction Center / NCEP
16 September 2019

Overview

- The MJO remained weak over the past seven days, but models are in nearly universal agreement that an MJO will develop during the upcoming week.
 - Some of this perceived MJO development could be the result of a fairly strong equatorial Rossby wave, and weaker Kelvin wave, over the central/western Pacific, projecting onto the RMM index.
- Zonal wind shear is anomalously low over the central and eastern Pacific, partially due to the aforementioned equatorial wave activity, and is forecast to remain low during the next two weeks.
 - This results in enhanced probabilities of tropical cyclone development during the Global Tropical Hazards forecast period.

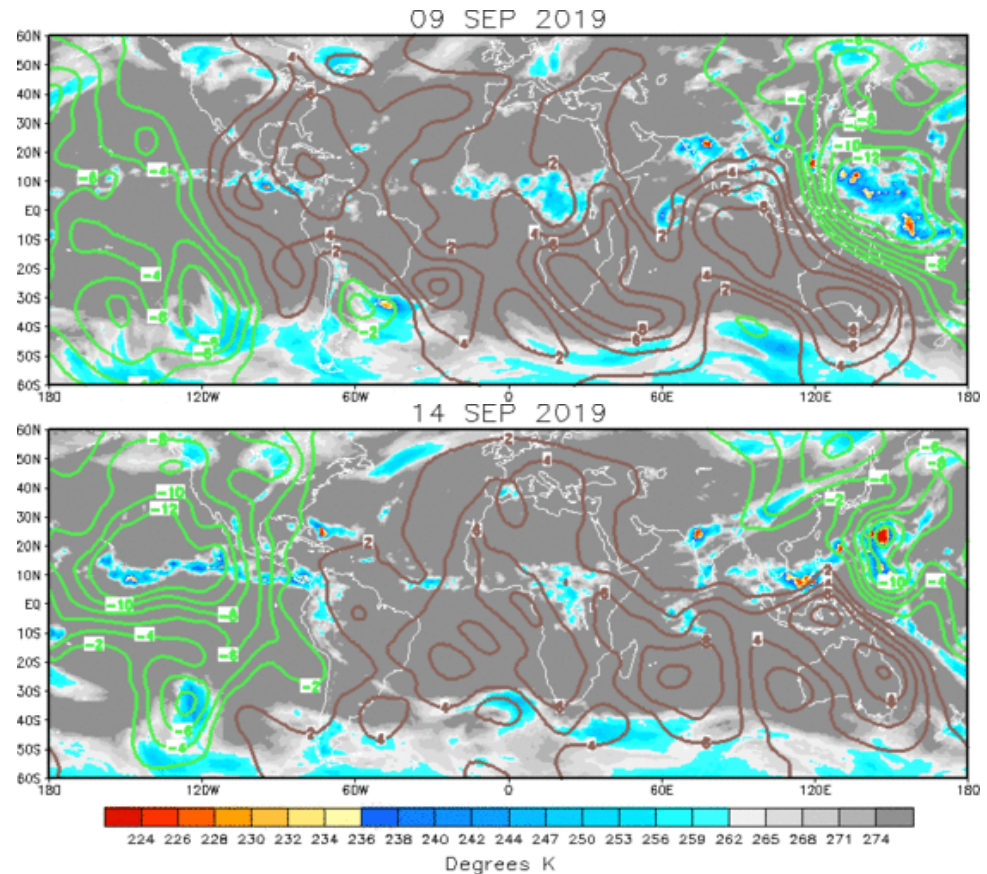
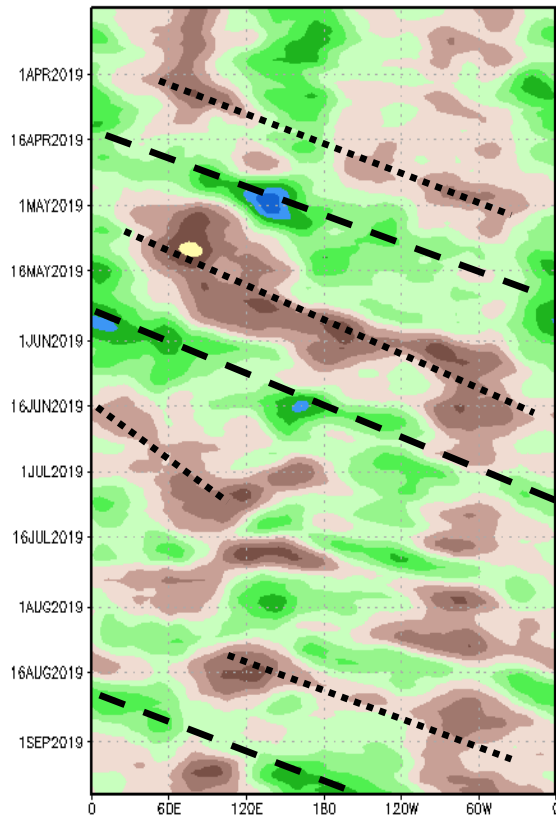
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation).

Brown shades: Anomalous convergence (unfavorable for precipitation).

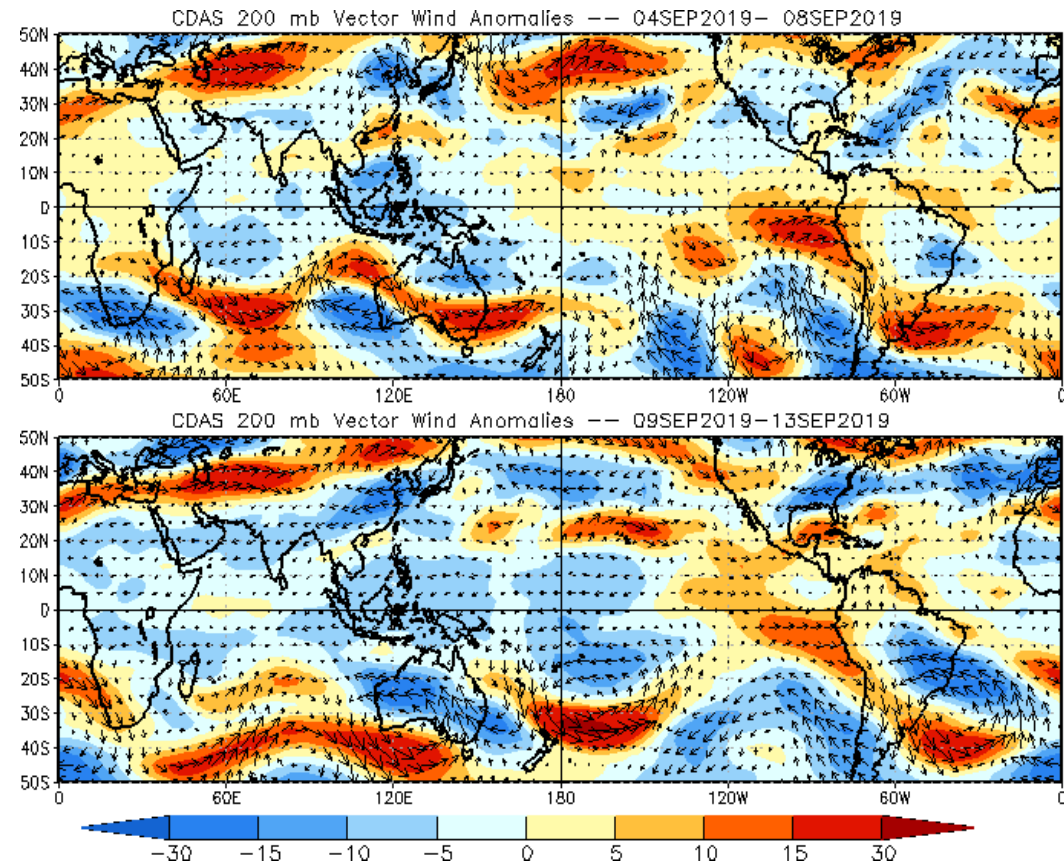
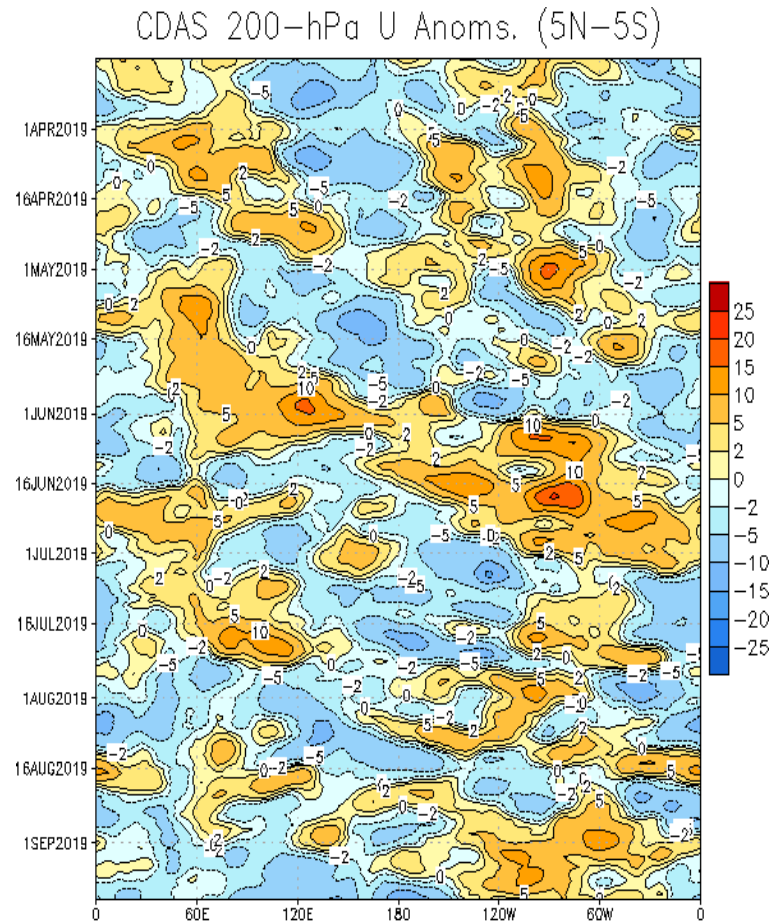
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- A Kelvin and equatorial Rossby wave crossed the central and western Pacific during the past week, which led to enhanced convection west of the Dateline.
- The velocity potential field is largely wave-1 due to this wave activity.

200-hPa Wind Anomalies

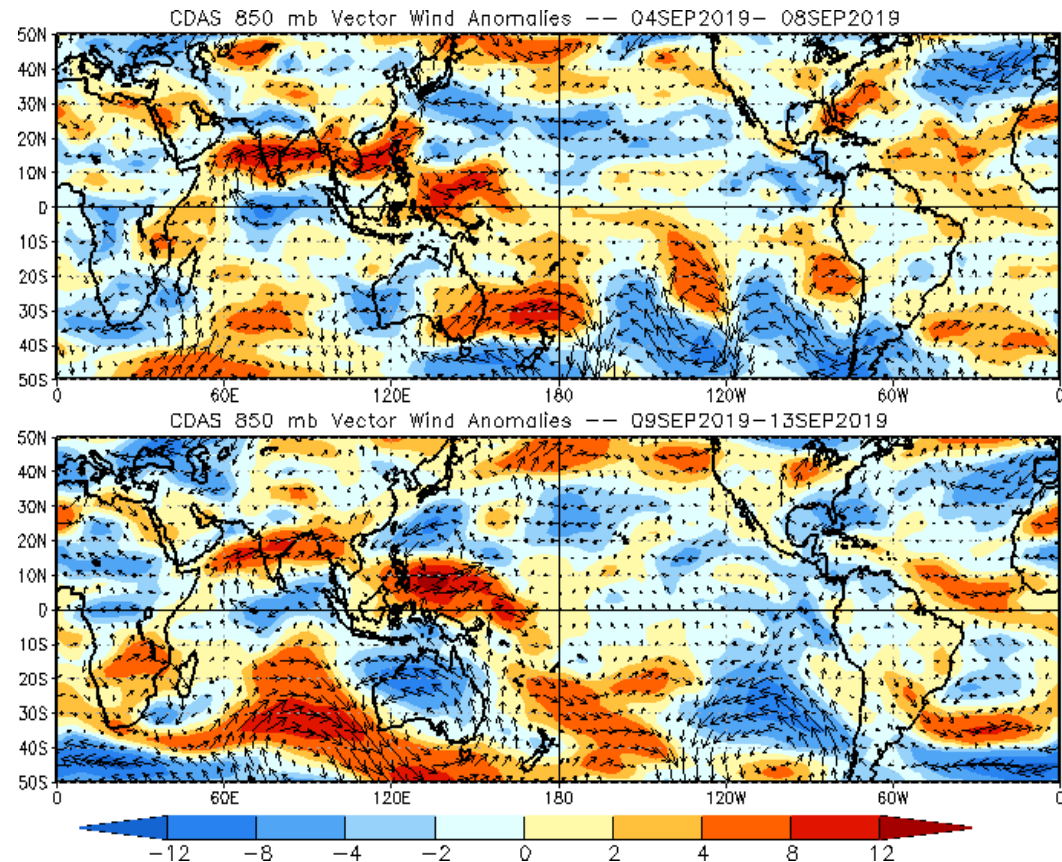
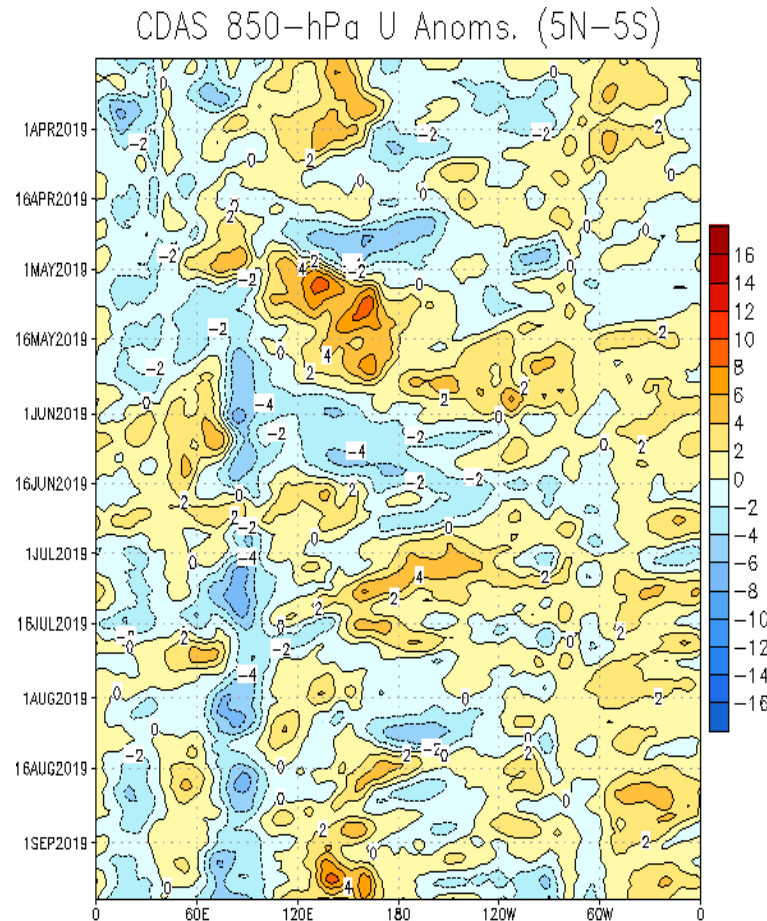
Shading denotes the zonal wind anomaly. **Blue shades: Anomalous easterlies.** **Red shades: Anomalous westerlies.**



- There are active wave trains in both the Northern and Southern Hemispheres. Persistent wave breaking over the central Pacific has helped fuel the development of low pressure systems in the equatorial Pacific.

850-hPa Wind Anomalies

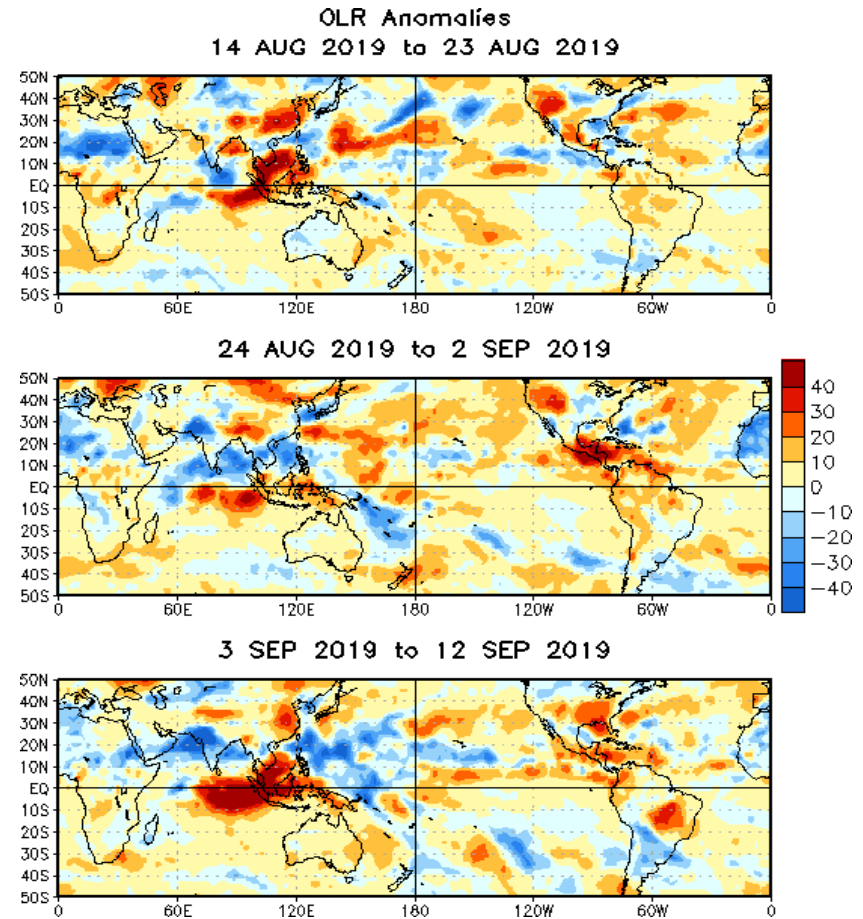
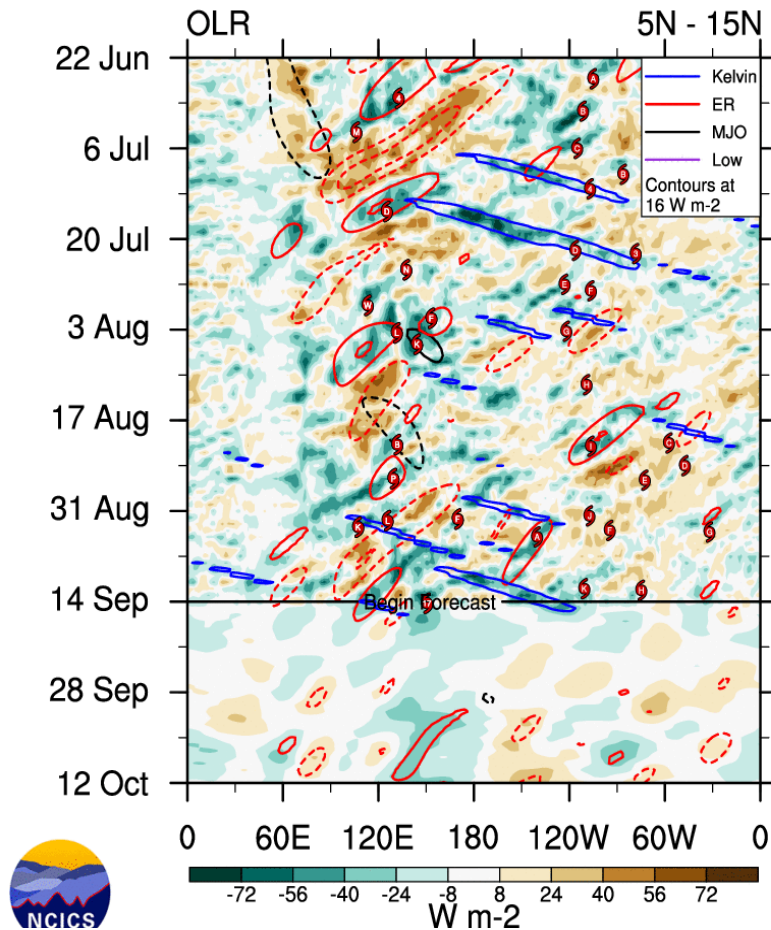
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Trade winds are near normal in the central Pacific, which is a result of the weakening El Niño.
- Anomalous easterlies continue from southern China to northern India, likely enhanced by the recent tropical cyclone activity, while a belt of anomalous westerlies continue just to the south of this area.

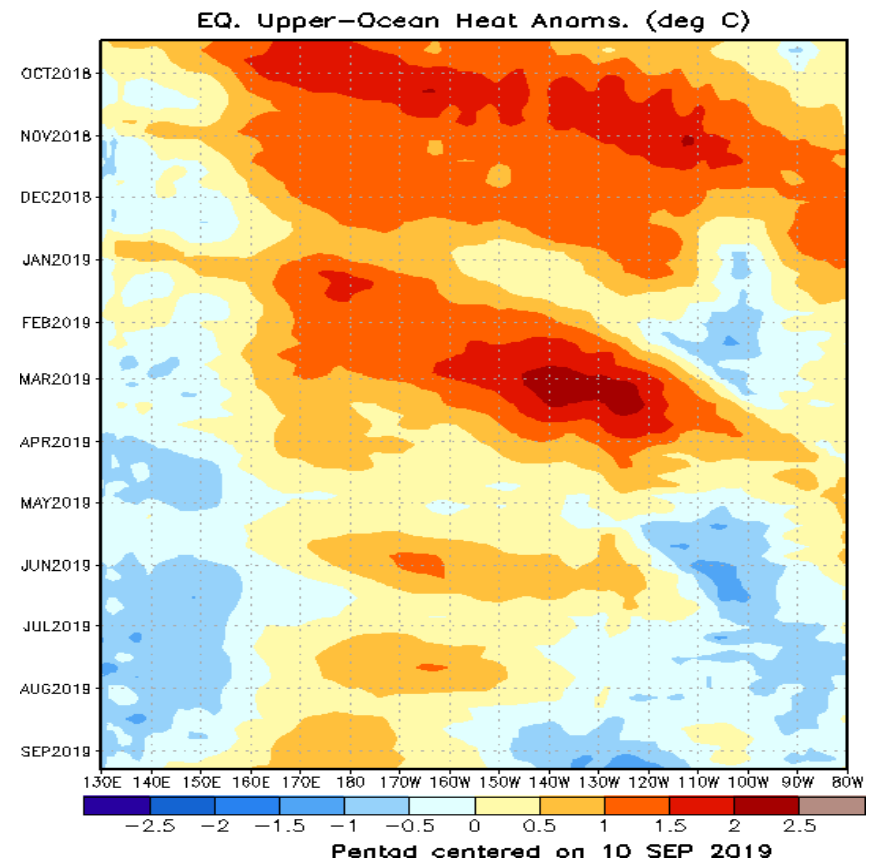
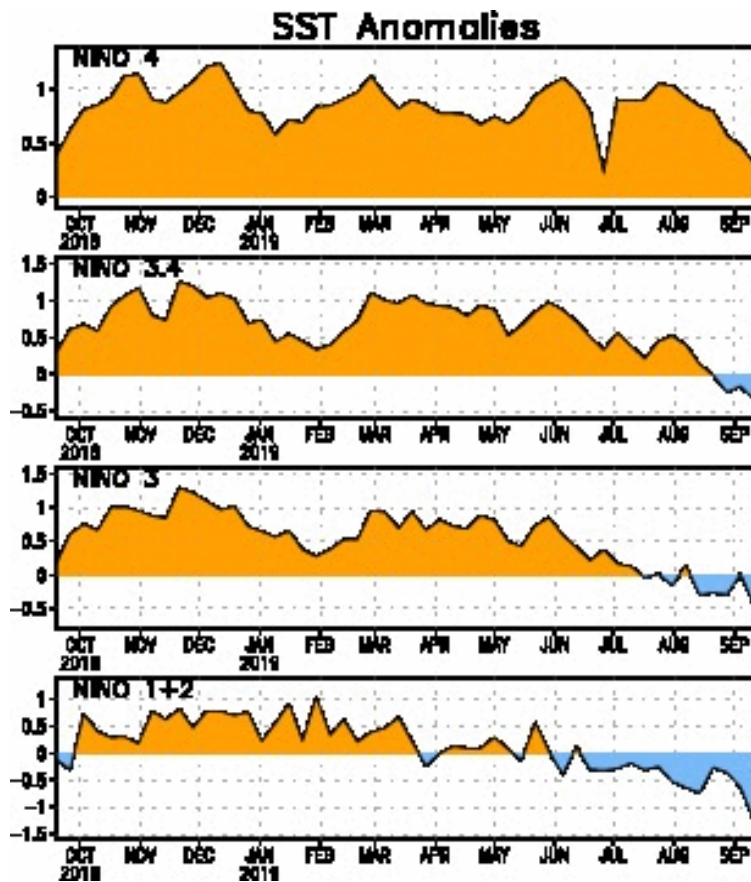
Outgoing Longwave Radiation (OLR) Anomalies

Blue shades: Anomalous convection (wetness). **Red shades:** Anomalous subsidence (dryness).



- Kelvin wave activity has been high during the past three weeks, likely aiding TC development in the Atlantic and eastern Pacific.
- Anomalous convection has overspread much of the western Pacific, likely due to the recent TC activity in this area.

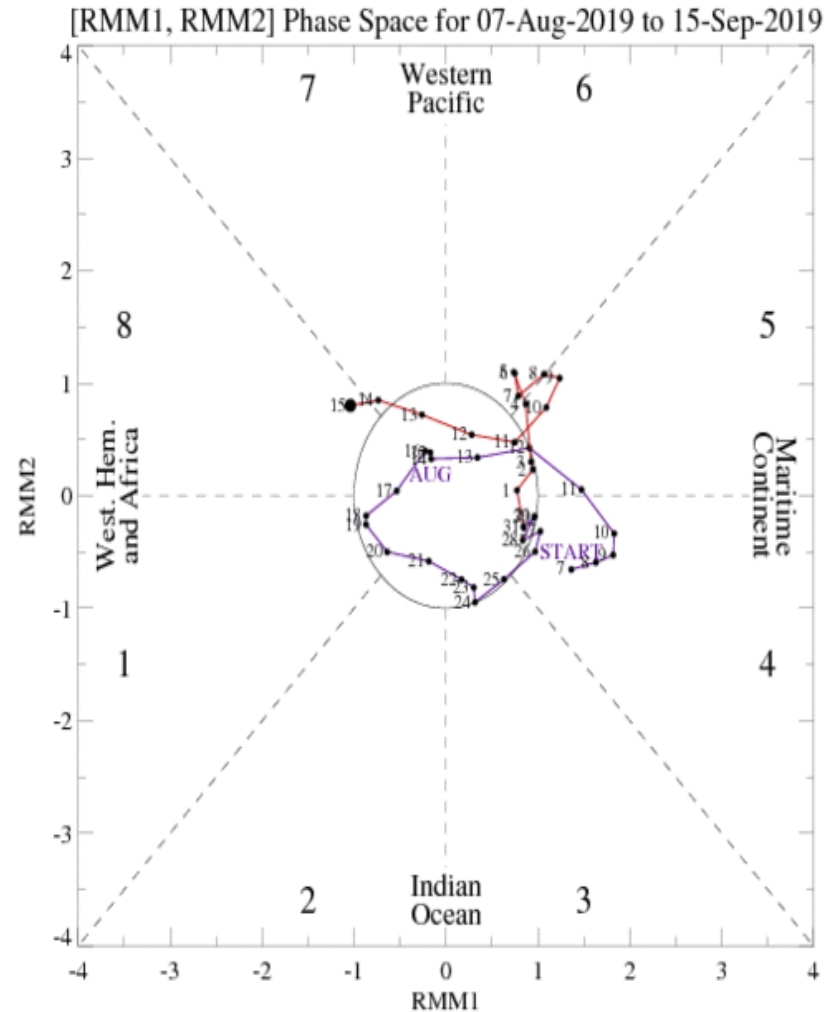
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Equatorial SST anomalies are near to slightly negative across much of the Pacific, particularly the eastern Pacific.
- A downwelling Kelvin wave event was evident over the central and eastern Pacific during mid-May through mid-June, but its amplitude was weaker than what was observed in previous events. Overall, upper-ocean heat content has continued to steadily decline over the past several months.
- Another weak downwelling wave developed in response to a recent period of anomalous westerlies over the central Pacific.

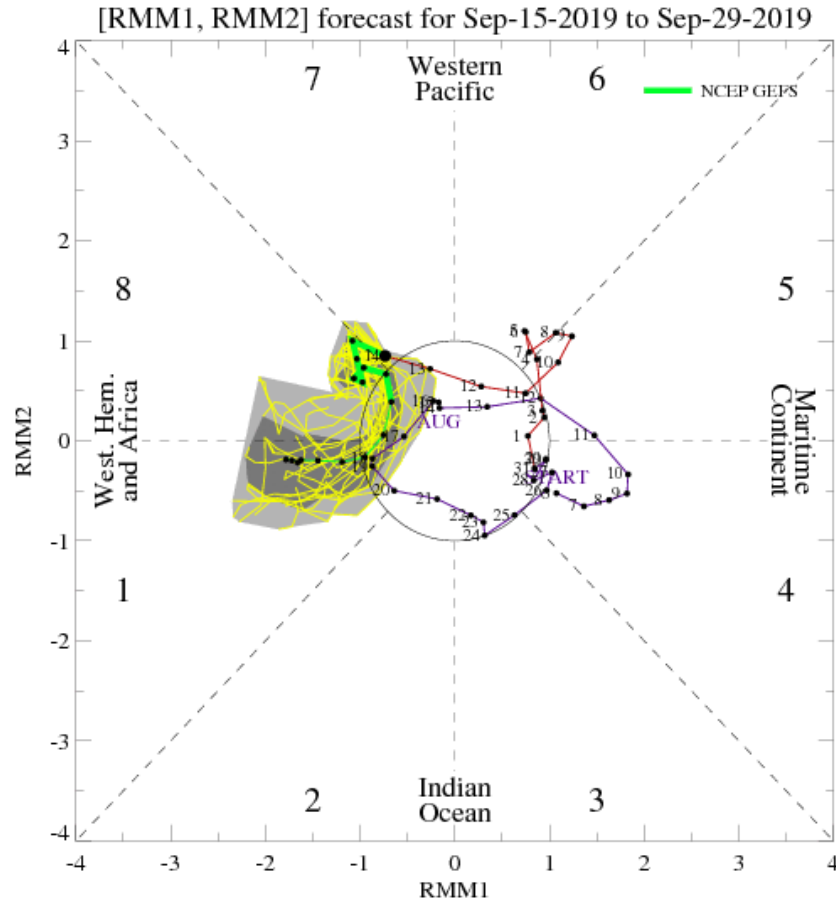
MJO Index: Recent Evolution

- The RMM index believes the MJO is in Phase 8 today, but this is instead due to projection of Kelvin and equatorial Rossby wave activity over the western Pacific.

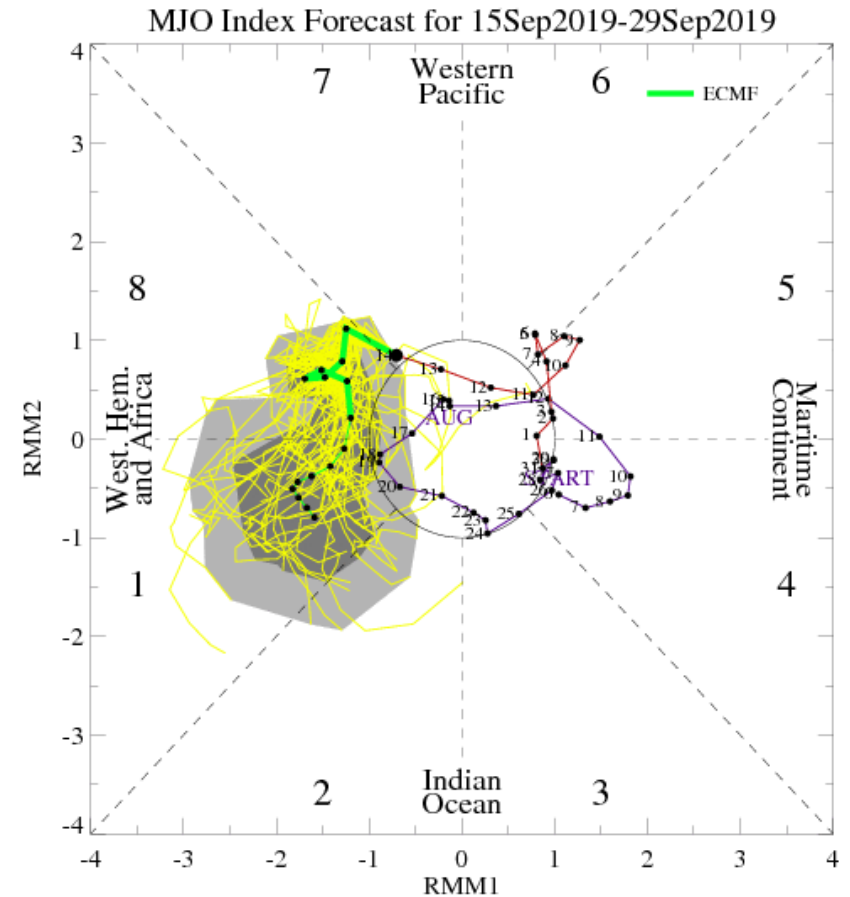


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



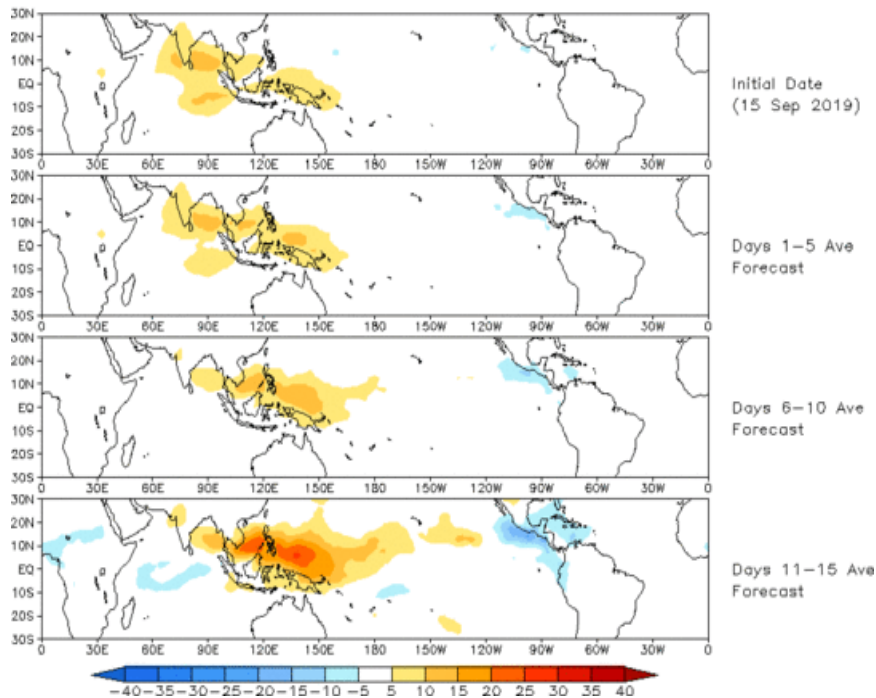
ECMWF Forecast

- Models are in agreement that a weak MJO is likely to develop during Week-1.
- This may be due to equatorial wave activity that is projecting on to the RMM index structures, rather than a full-fledged MJO.

MJO: GEFS Forecast Evolution

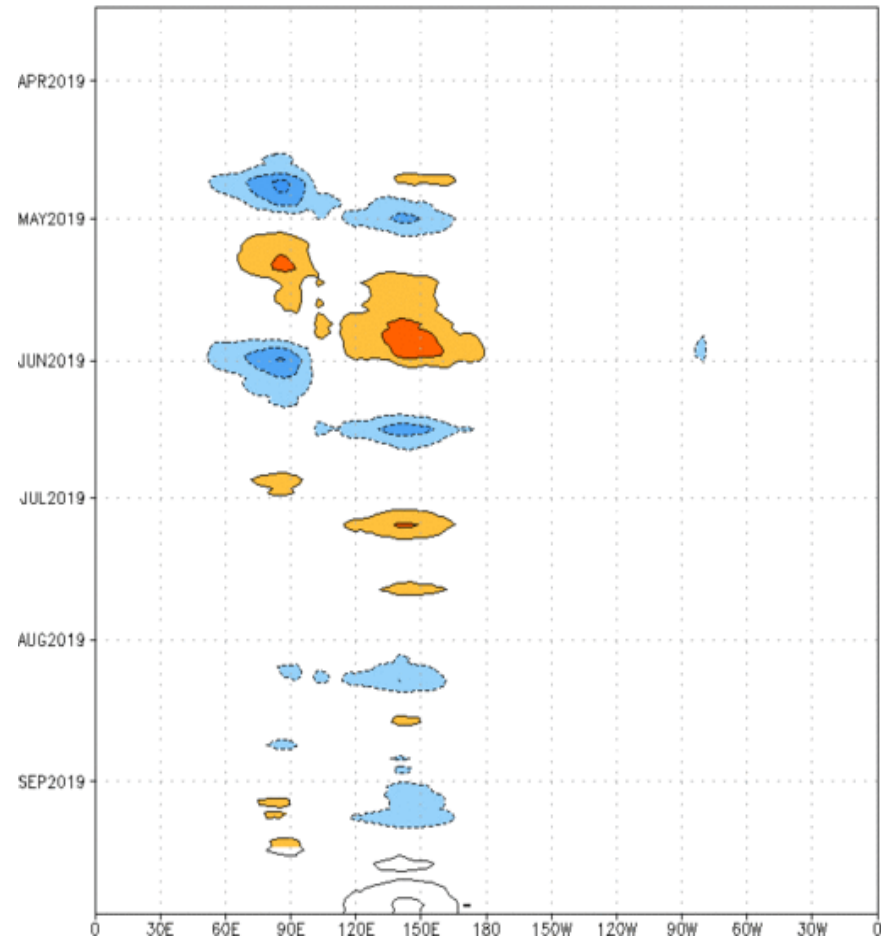
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

Prediction of MJO-related anomalies using GEFS operational forecast
Initial date: 15 Sep 2019
OLR



- The spatial depiction from the GEFS matches its RMM index and shows a slow moving suppressed convective envelope over the Eastern Hemisphere.

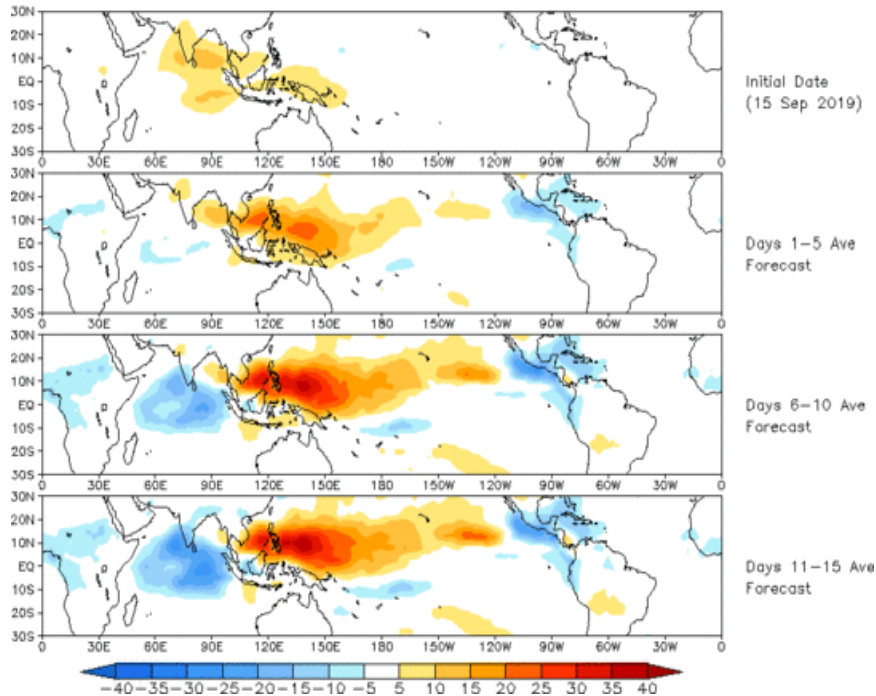
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [7.5°S,7.5°N] ($\text{cint:}4\text{Wm}^{-2}$) Period:16-Mar-2019 to 15-Sep-2019
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days



MJO: Constructed Analog Forecast Evolution

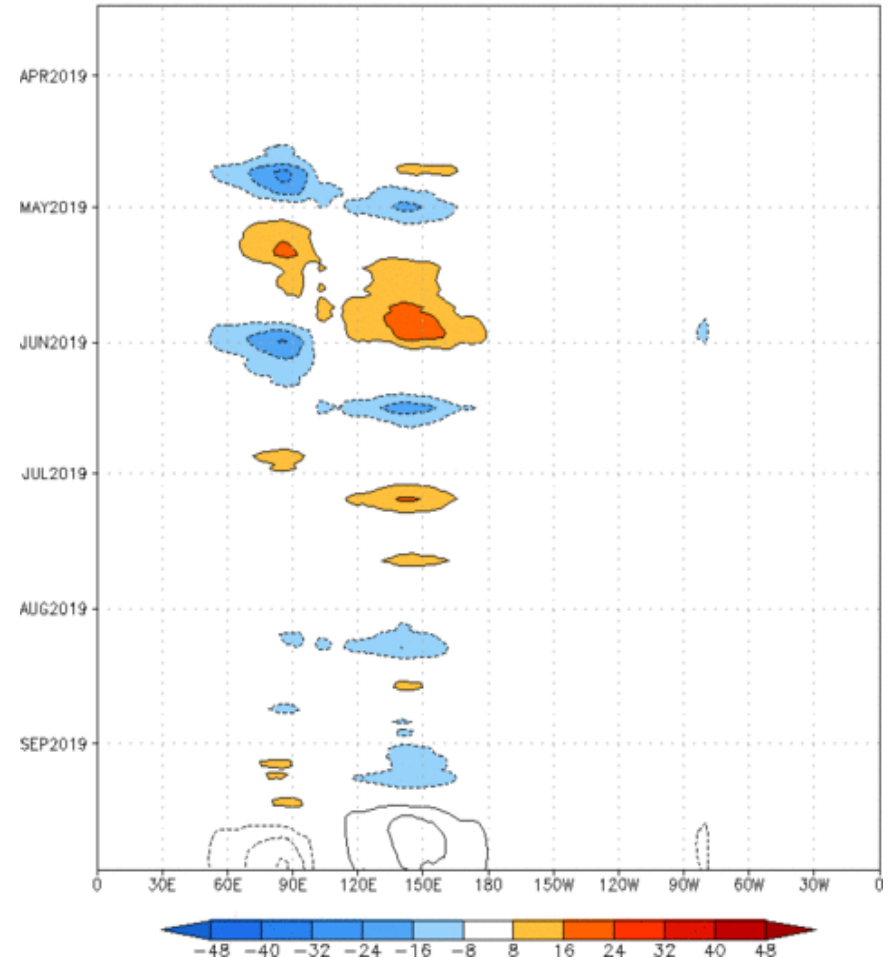
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

OLR prediction of MJO-related anomalies using CA model reconstruction by RMM1 & RMM2 (15 Sep 2019)



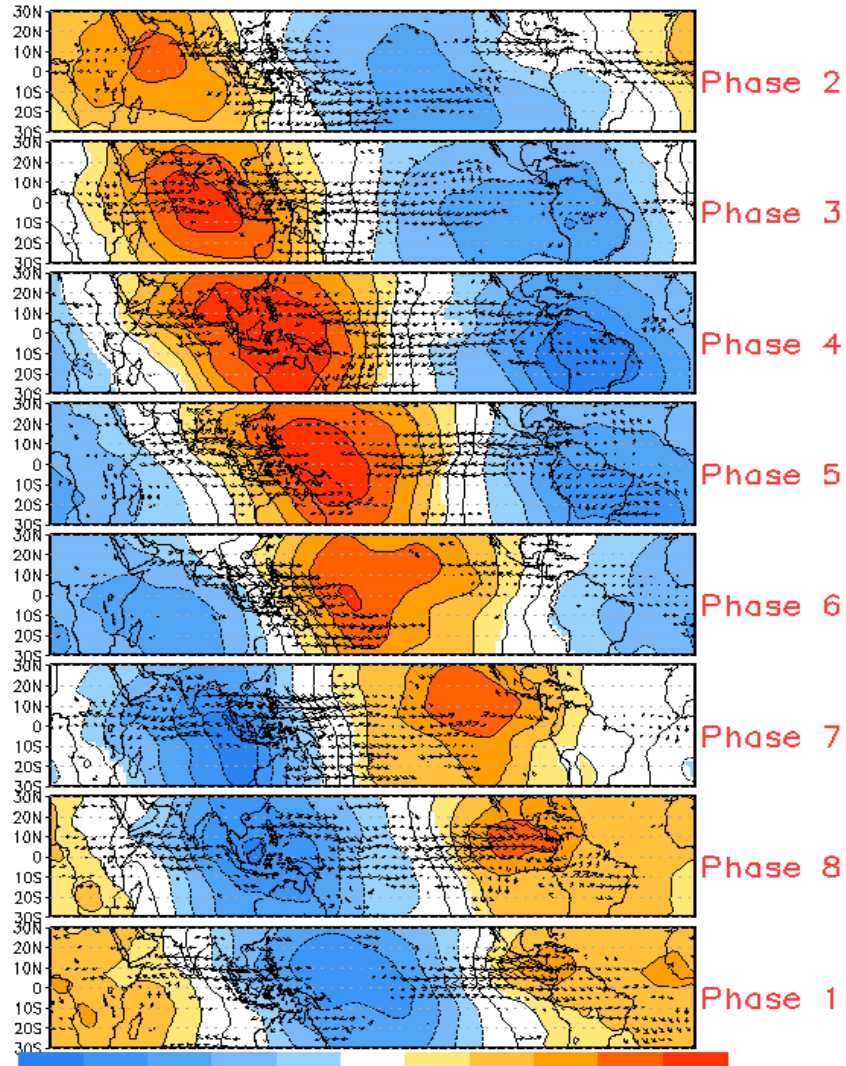
- The constructed analog is similar to the GEFS, but includes developing a stronger enhanced convection signal over the Indian Ocean.
- This is more typical of a “normal” MJO event than the GEFS forecast.

Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:16-Mar-2019 to 15-Sep-2019
The unfilled contours are CA forecast reconstructed anomaly for 15 days

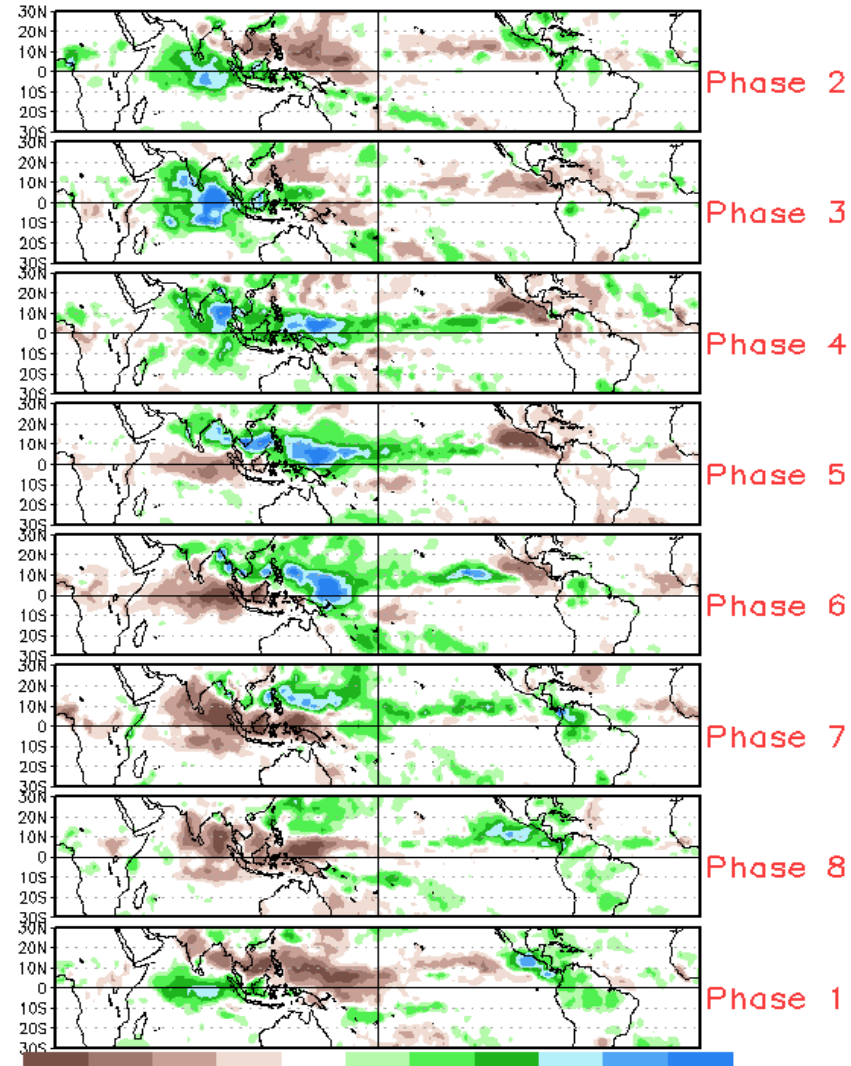


MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and
Wind Anomalies



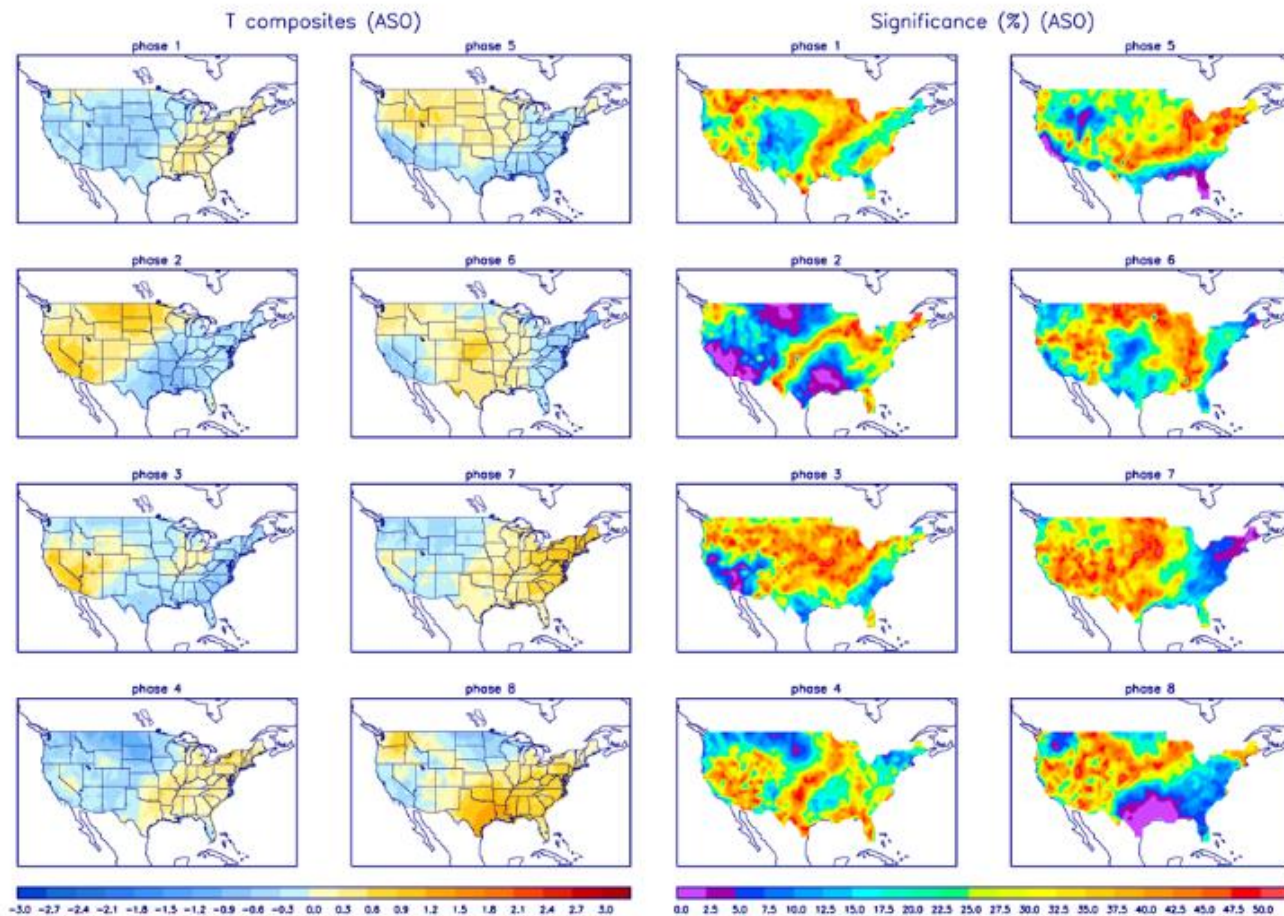
Precipitation Anomalies



MJO: CONUS Composite Maps by RMM Phase - 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 (red) shades show negative (positive) anomalies respectively.

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



MJO: CONUS Composite Maps by RMM Phase - Temperature

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. Purple shades indicate areas in which the anomalies are significant at the 95% or better confidence level.

