

Madden-Julian Oscillation:

Recent Evolution, Current Status and Predictions



Update prepared by the Climate Prediction Center
Climate Prediction Center / NCEP
8 June 2020

Overview

- The robust Kelvin wave from last week has moved out and weakened.
- Low-level wind response to the Kelvin wave has been robust, but confined mostly to the northern tropics.
- Dynamical models forecast another Kelvin wave to form and circumnavigate the equator. Like the previous iteration, this Kelvin wave is forecast to be slow enough to project onto the RMM patterns.
- Substantive extratropical impacts from this Kelvin wave activity is unlikely, although tropical cyclogenesis odds will be locally elevated in the immediate wake of its passage.

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>

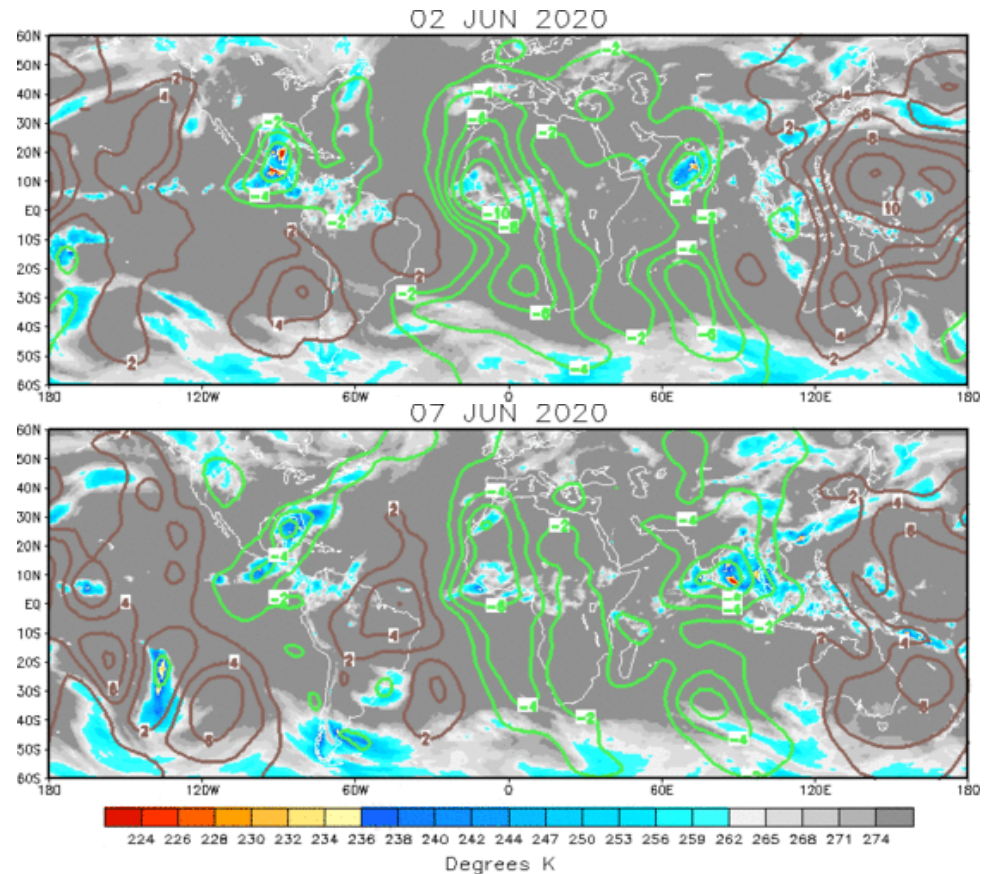
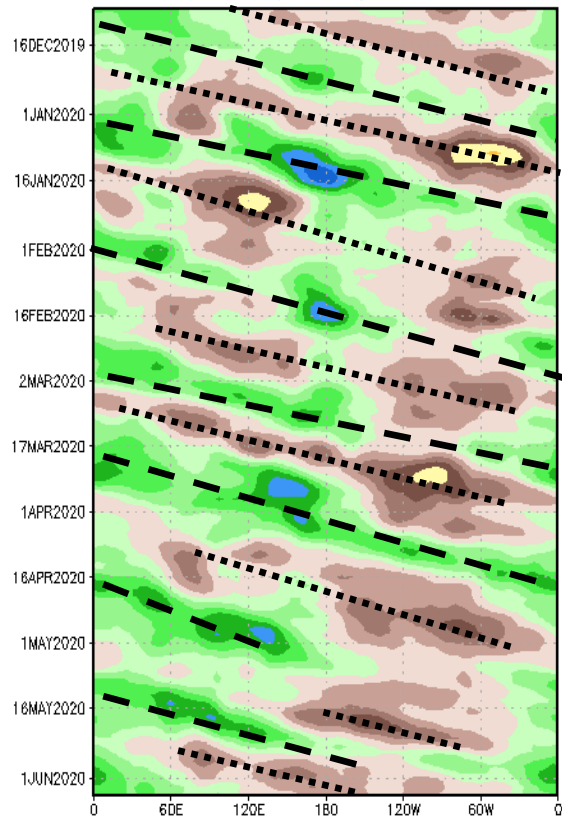
200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation).

Brown shades: Anomalous convergence (unfavorable for precipitation).

200-hPa Velocity Potential Anomaly: 5N-5S

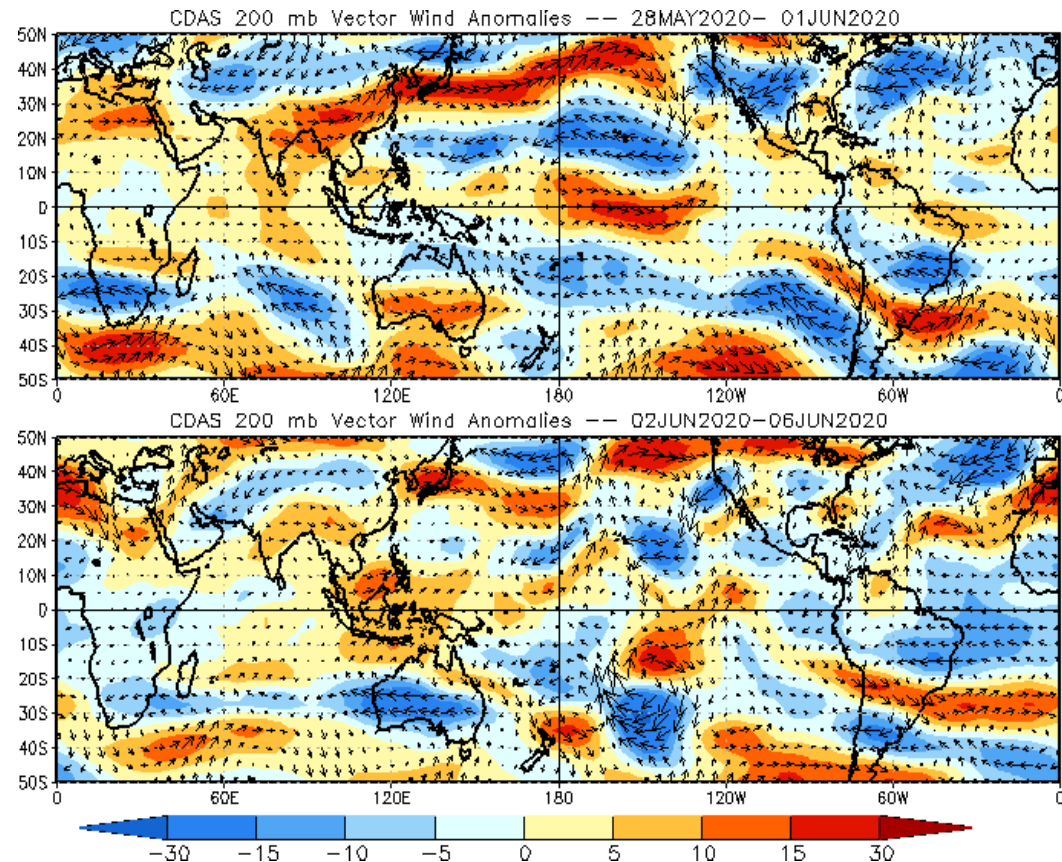
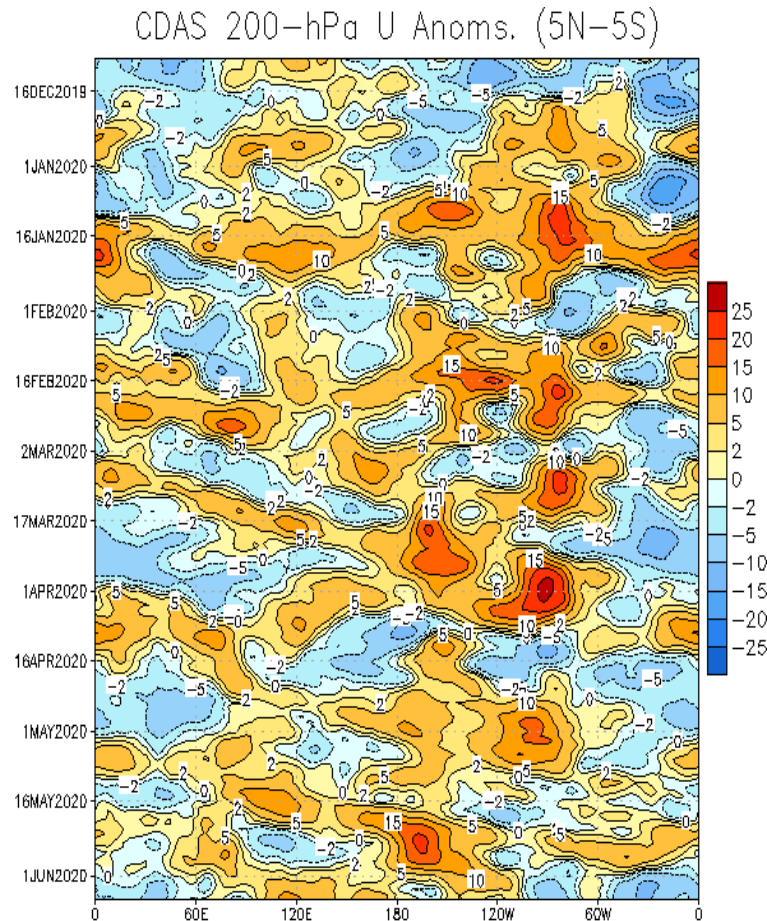
5-day Running Mean



- A Kelvin wave signal that projects on to RMM Phase 1 traversed the Western Hemisphere during the past week.
- Synoptic scale convection over North America and the Gulf of Mexico, including Tropical Storm Cristobal, added noise to an otherwise Wave-1 pattern anchored by the aforementioned tropical wave.

200-hPa Wind Anomalies

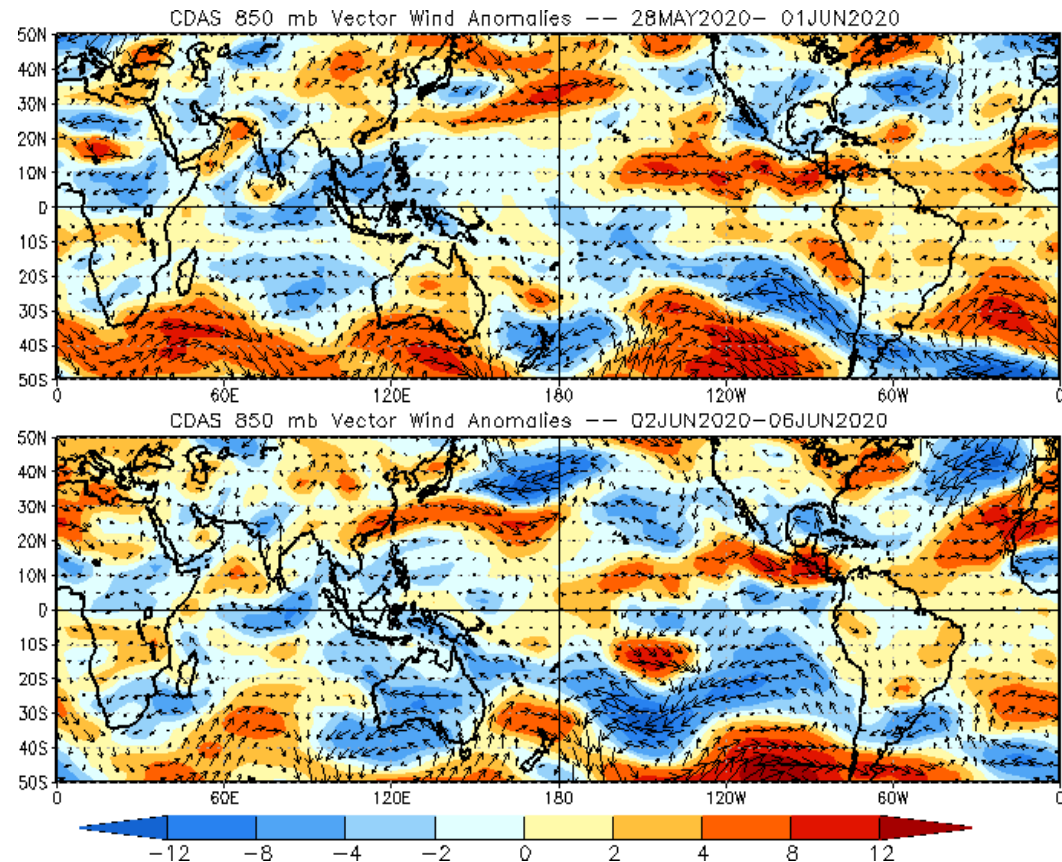
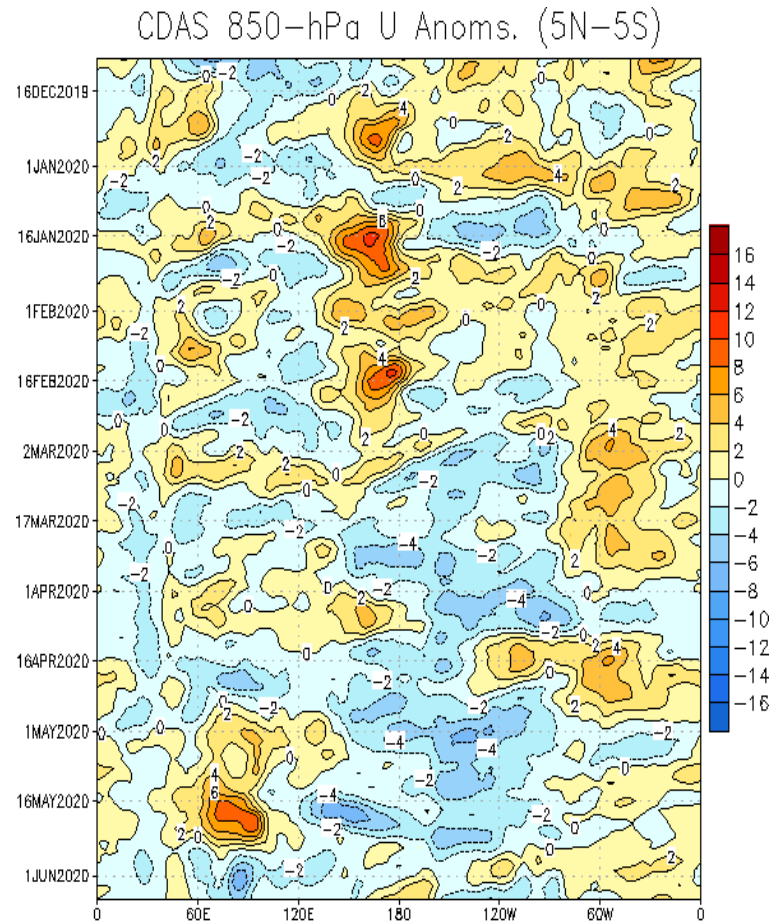
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- 200-hPa anomalous westerlies strengthened just east of the Date Line, with upper-level lows just north and south of the Equator over the central Pacific.
- Synoptic scale wave breaking over the North Pacific has resulted in a significant exchange of mass throughout the mid-latitudes and tropics.

850-hPa Wind Anomalies

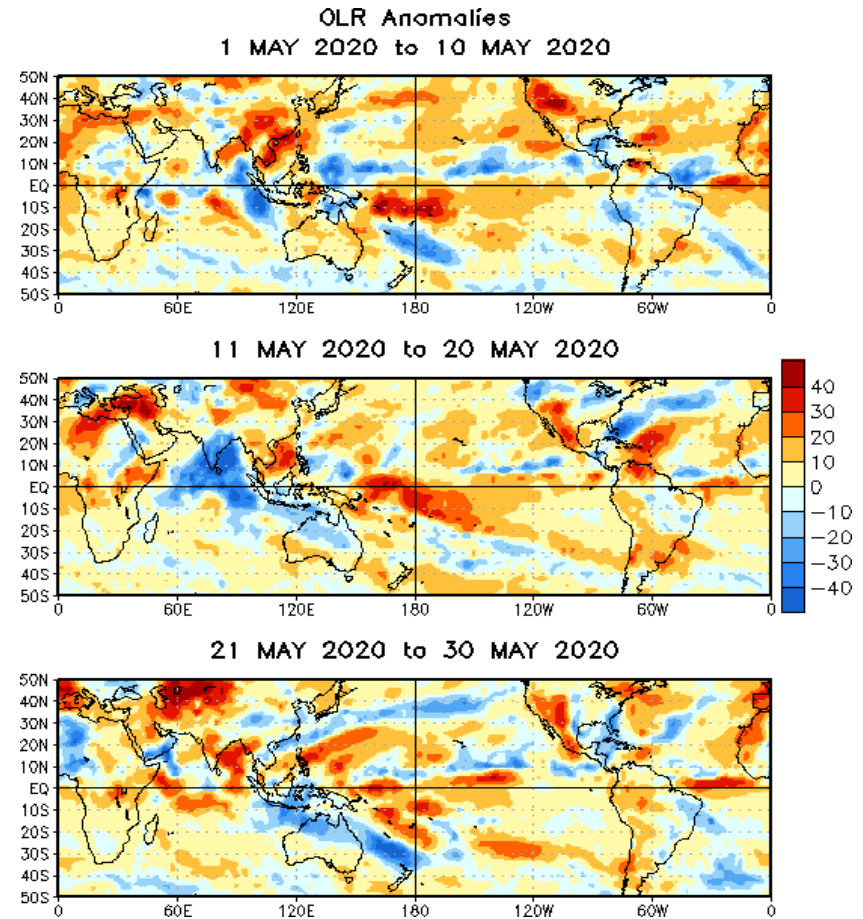
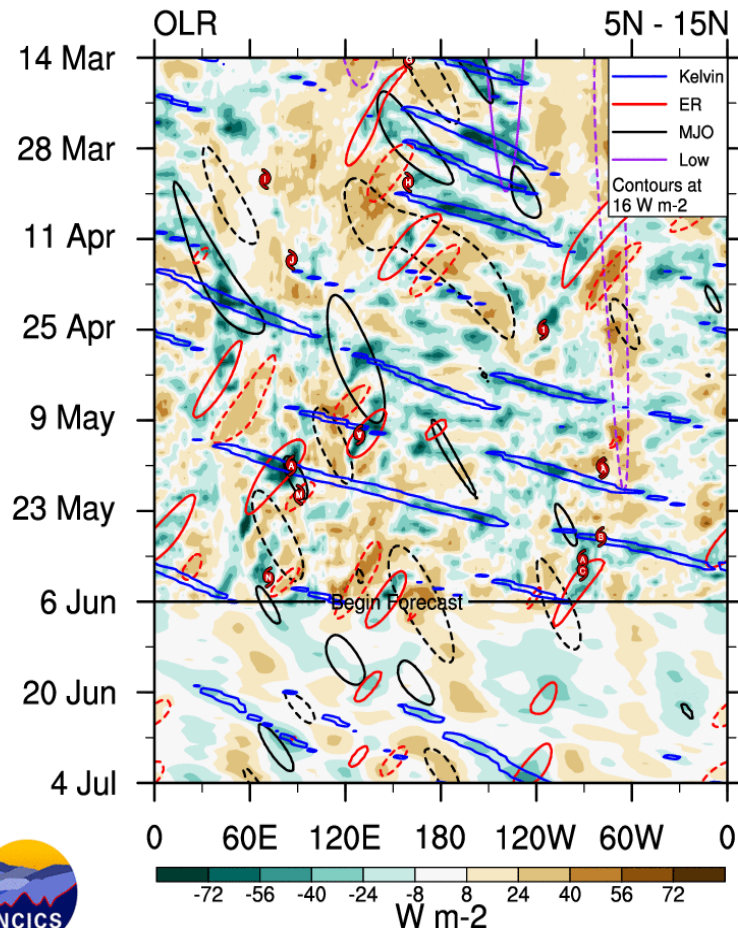
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- A robust Kelvin wave that crossed the Pacific is evident in the wind field, although the belt of westerlies is centered north of the Equator over the East Pacific.
- The enhanced trade winds over much of the Pacific basin have decreased since late May due to the Kelvin wave activity.

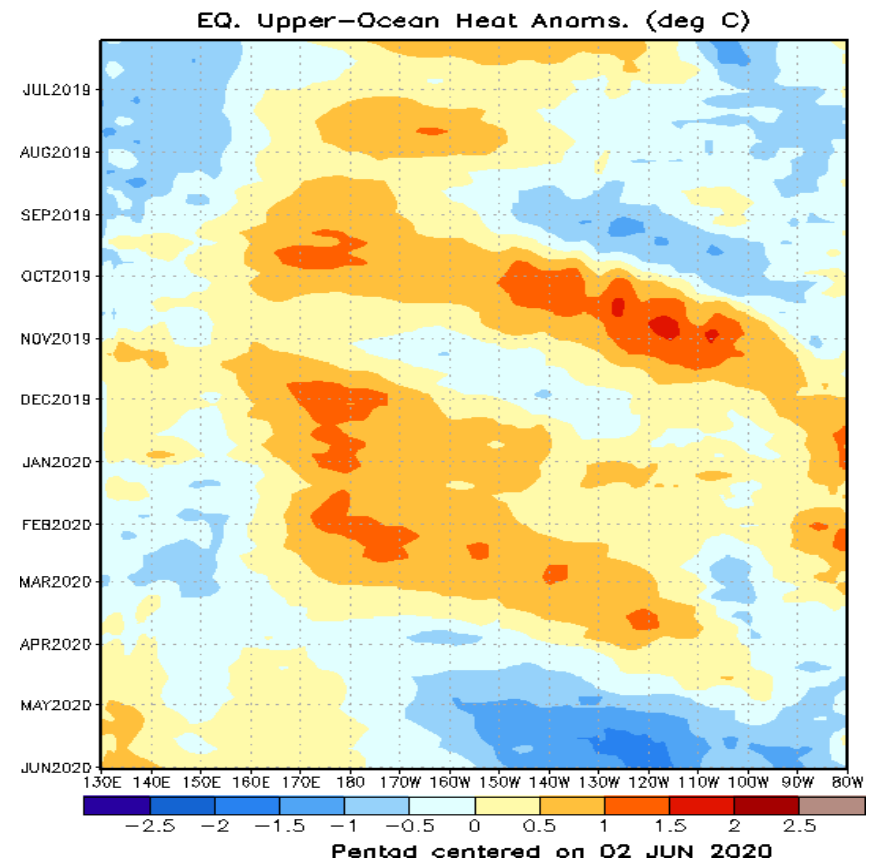
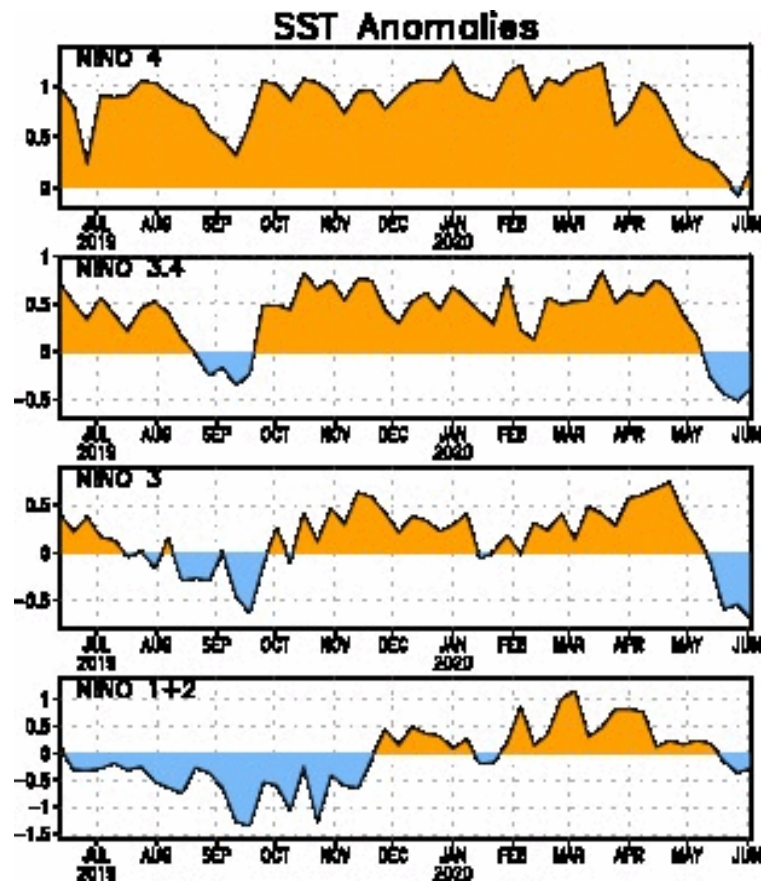
Outgoing Longwave Radiation (OLR) Anomalies

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



- Kelvin wave activity has weakened over the past couple of days.
- The OLR pattern is fairly noisy, but there are indications of activity that straddles the MJO/Kelvin wave spectrum forecast over the Indian Ocean and Western Pacific.

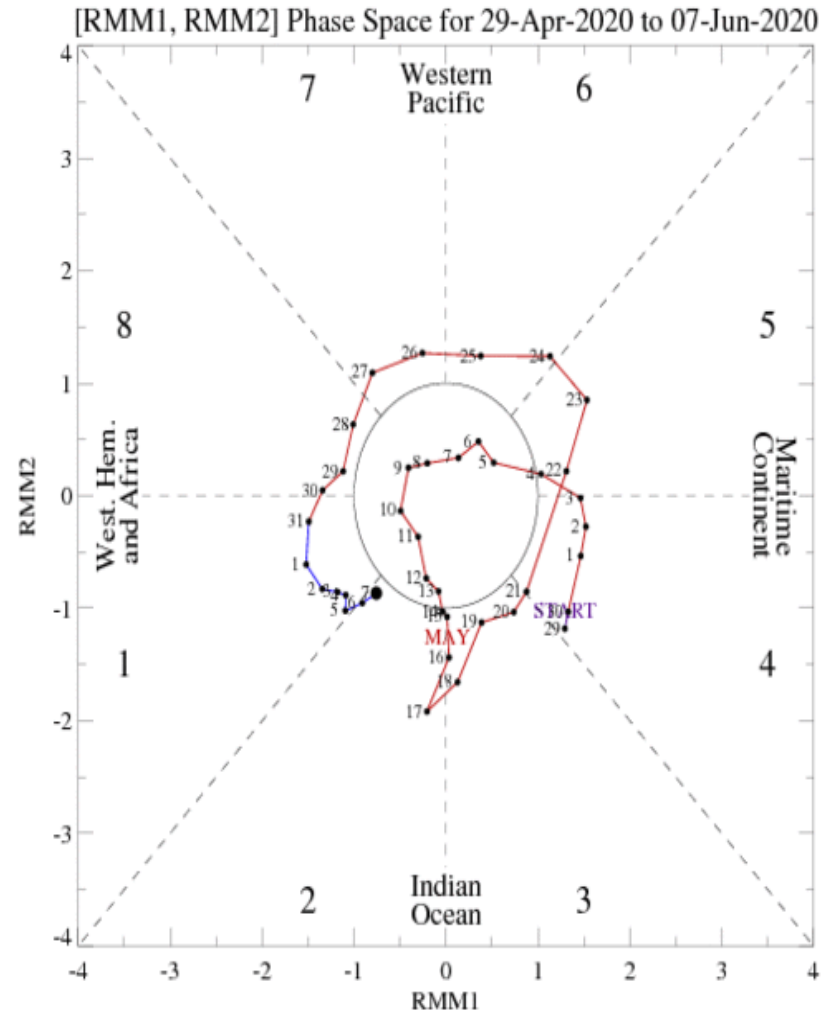
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Enhanced trade winds during May have generated an oceanic response, with negative upper-ocean heat content anomalies intensifying across much of the east-central Pacific.
- SST anomalies in the Niño 3.4 region have become negative for the first time since mid September 2019.
- SSTs are now below-average in all of the Niño basins with the exception of Niño 3.

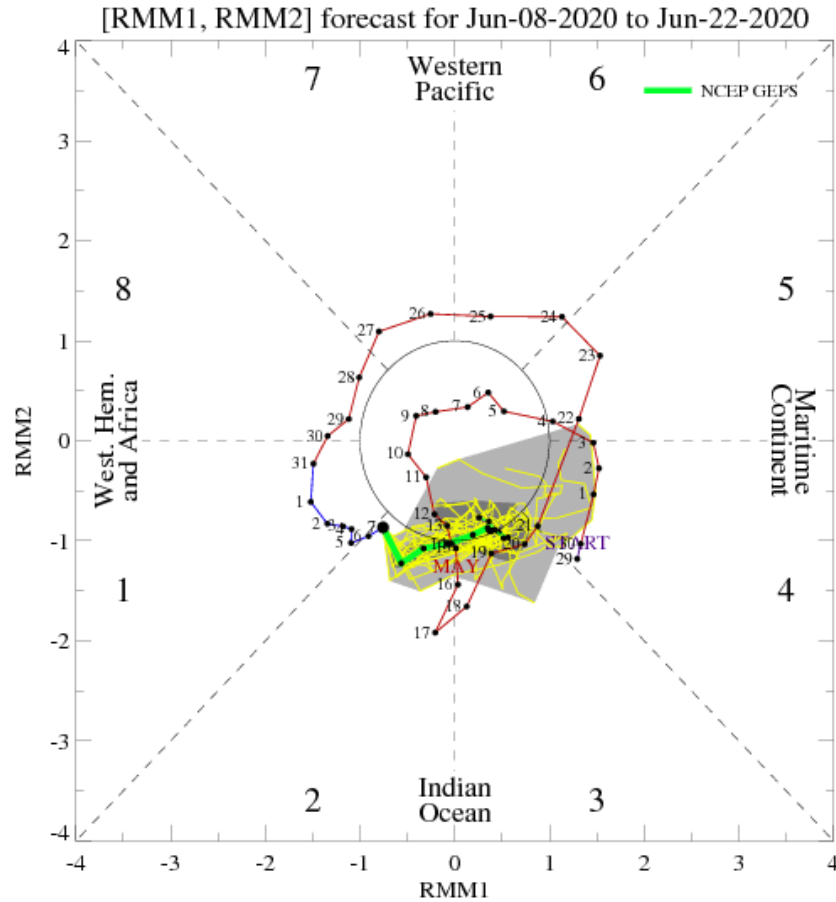
MJO Index: Recent Evolution

- The RMM index slowed while approaching the Indian Ocean over the course of the past week.
- The continued quick transition of the index is due to robust Kelvin wave activity, although Rossby wave activity over the Indian Ocean is slowing the signal (see OLR, 850-hPa winds, and 200-hPa winds on prior slides).
- Now that the Kelvin wave activity has weakened, the RMM index is near the unit circle.

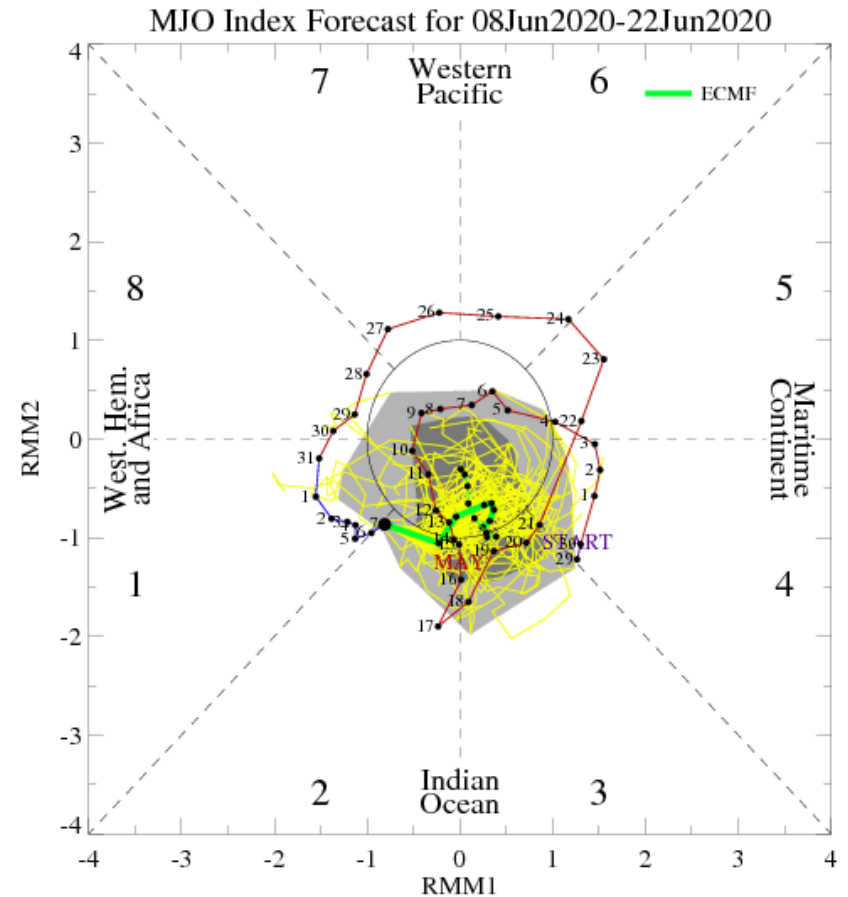


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



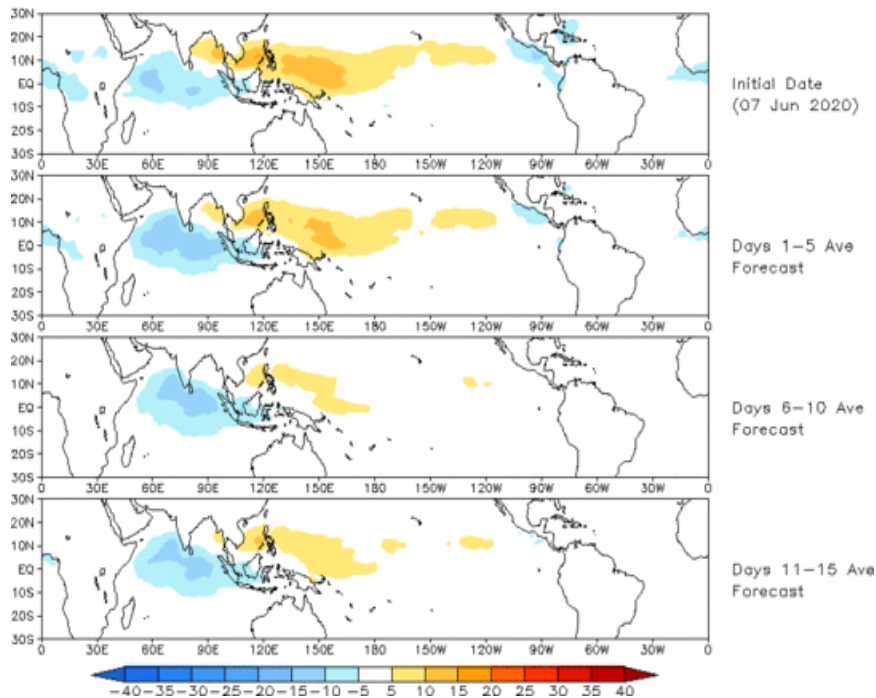
ECMWF Forecast

- Both models forecast a weak tropical wave signal that projects onto the RMM phase space over the Indian Ocean. This is more likely to be another Kelvin wave event than a robust MJO.

MJO: GEFS Forecast Evolution

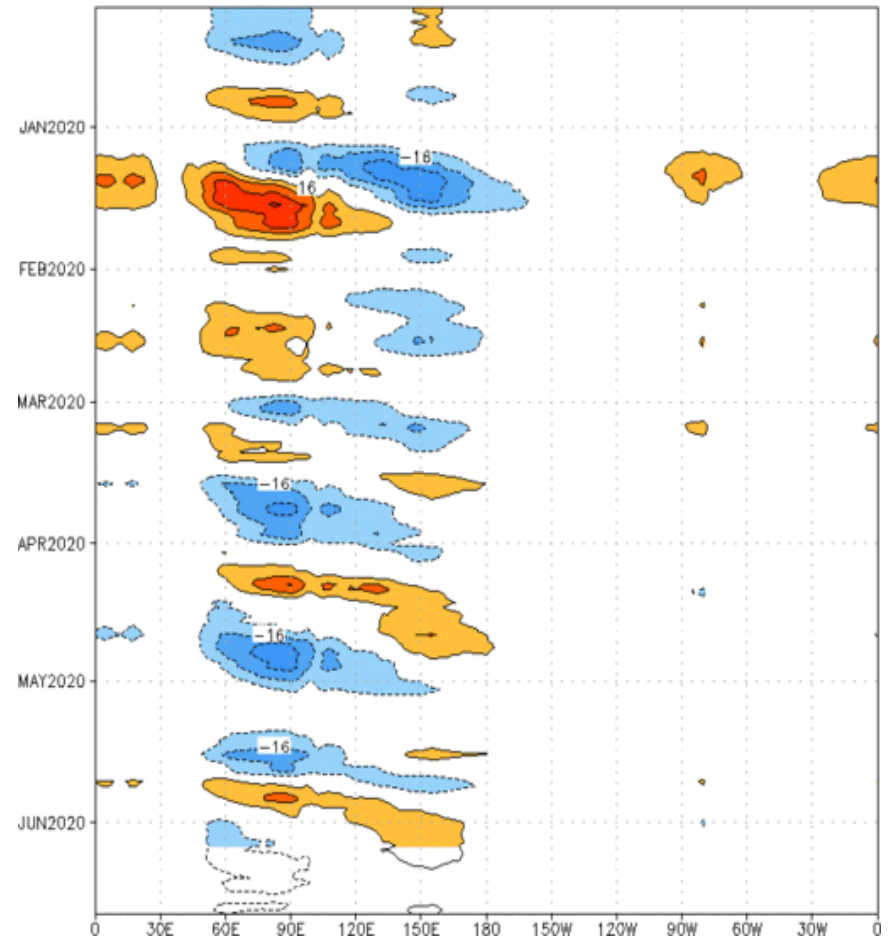
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

Prediction of MJO-related anomalies using GEFS operational forecast
Initial date: 07 Jun 2020
OLR



- The GEFS spatial patterns show a weakening and stationary OLR signal over the next two weeks.

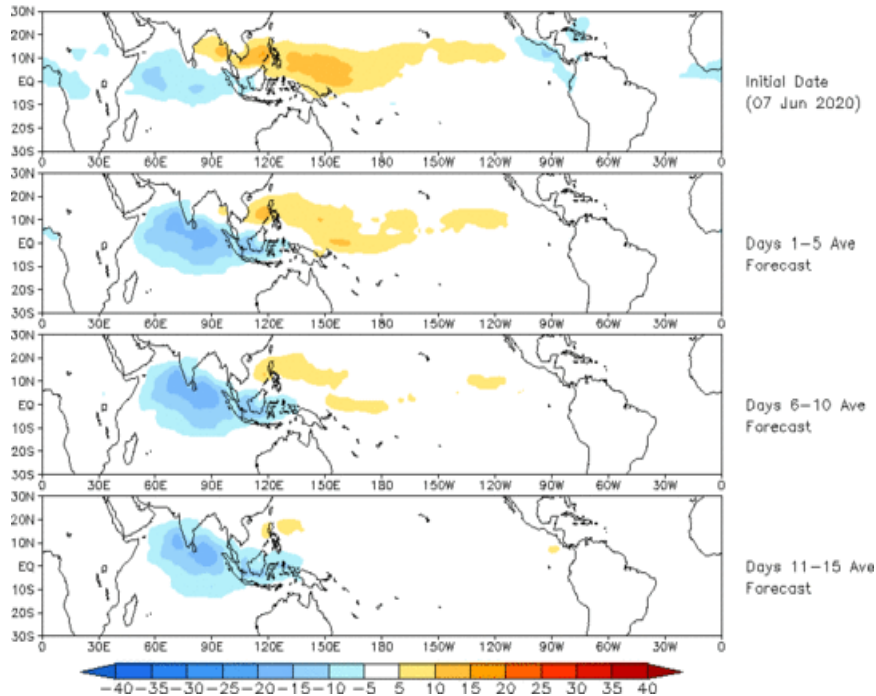
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [7.5°S, 7.5°N] ($\text{cint: } 4\text{Wm}^{-2}$) Period: 06–Dec–2019 to 06–Jun–2020
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days



MJO: Constructed Analog Forecast Evolution

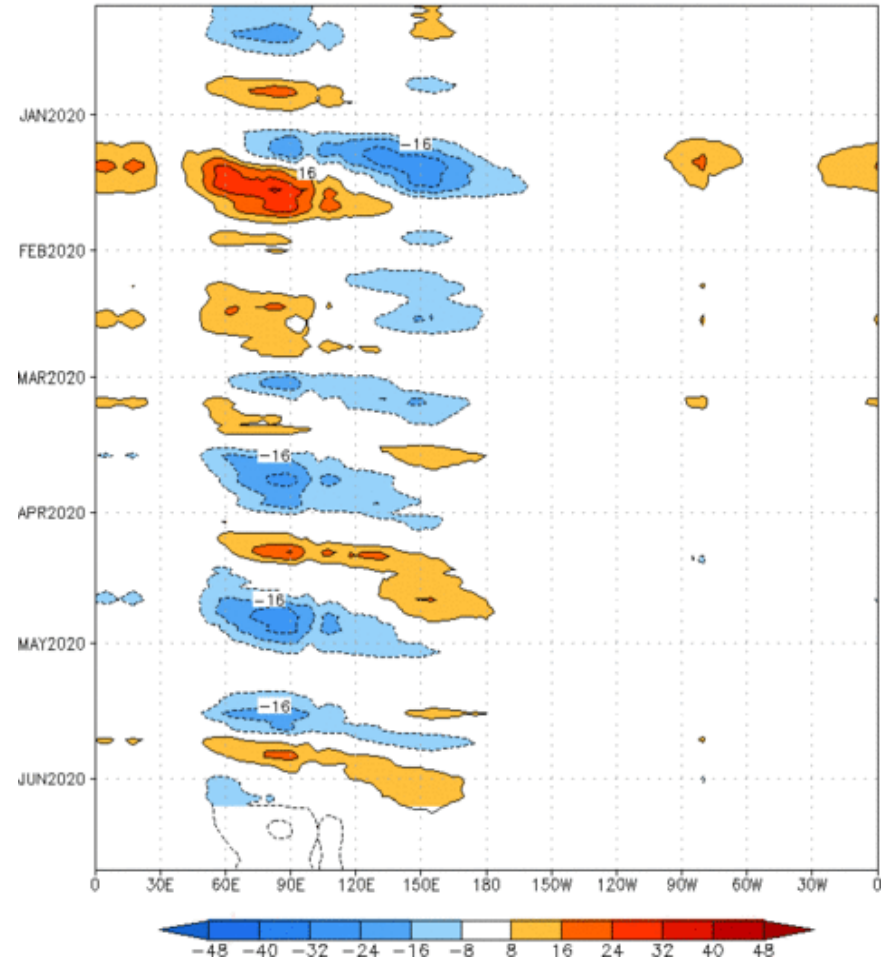
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

OLR prediction of MJO-related anomalies using CA model reconstruction by RMM1 & RMM2 (07 Jun 2020)



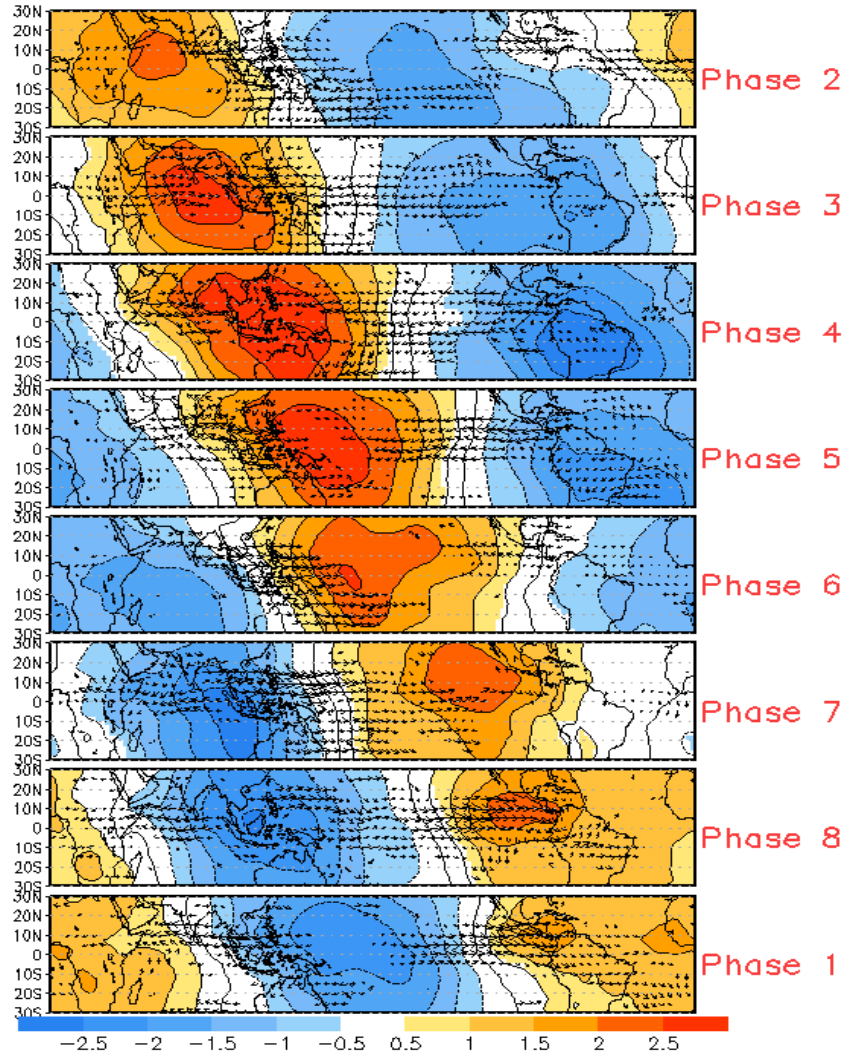
- The constructed analog forecast is similar to the GEFS, with slightly more emphasis on the enhanced convection over the Indian Ocean.

Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:07-Dec-2019 to 07-Jun-2020
The unfilled contours are CA forecast reconstructed anomaly for 15 days

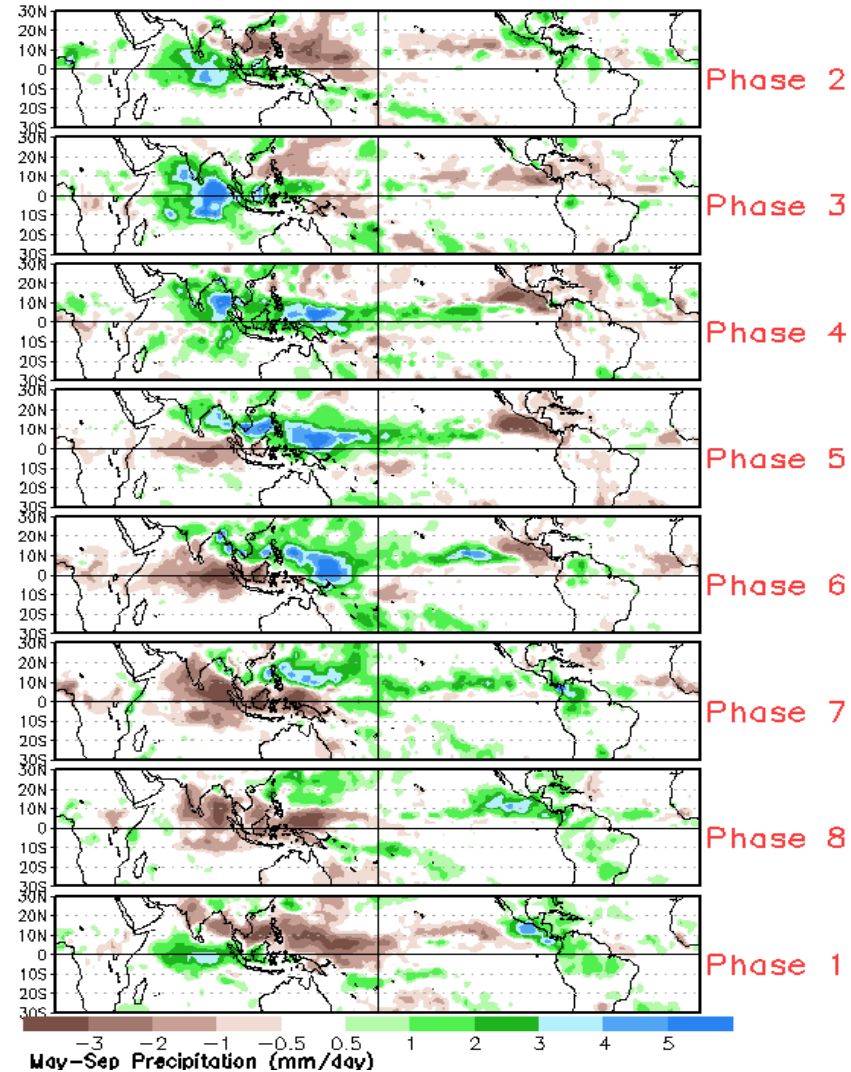


MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and
Wind Anomalies



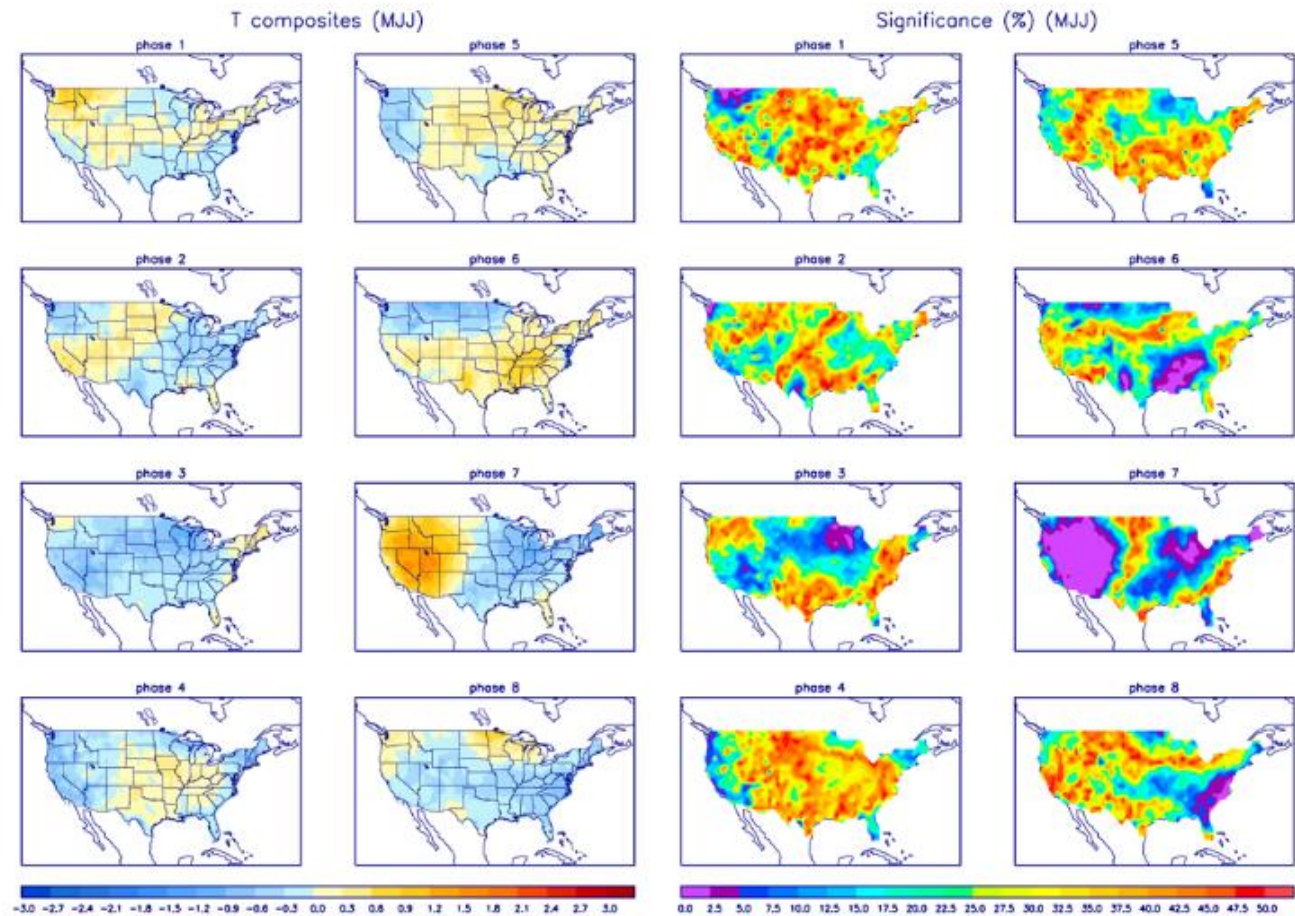
Precipitation Anomalies



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.

