

Madden-Julian Oscillation:

Recent Evolution, Current Status and Predictions



Update prepared by the Climate Prediction Center
Climate Prediction Center / NCEP
7 June 2021

Overview

- RMM indices indicate the enhanced phase of the MJO remains over the West Pacific, where it has encountered destructive interference with Rossby wave activity and enhanced trades associated with a decaying La Niña over the equatorial Pacific since late May.
- There is fair consensus in the dynamical models favoring eastward propagation of the MJO at a low amplitude through the Western Hemisphere during week-1, with increasing uncertainty with respect to its strength and evolution during the week-2 period.
 - The active phase of the MJO is likely to contribute to TC activity across the eastern Pacific and western Atlantic through mid-June.
 - The interaction of Kelvin and Rossby wave activity forecast in the Eastern Hemisphere also favors TC formation over the western Pacific and northern Indian Ocean.

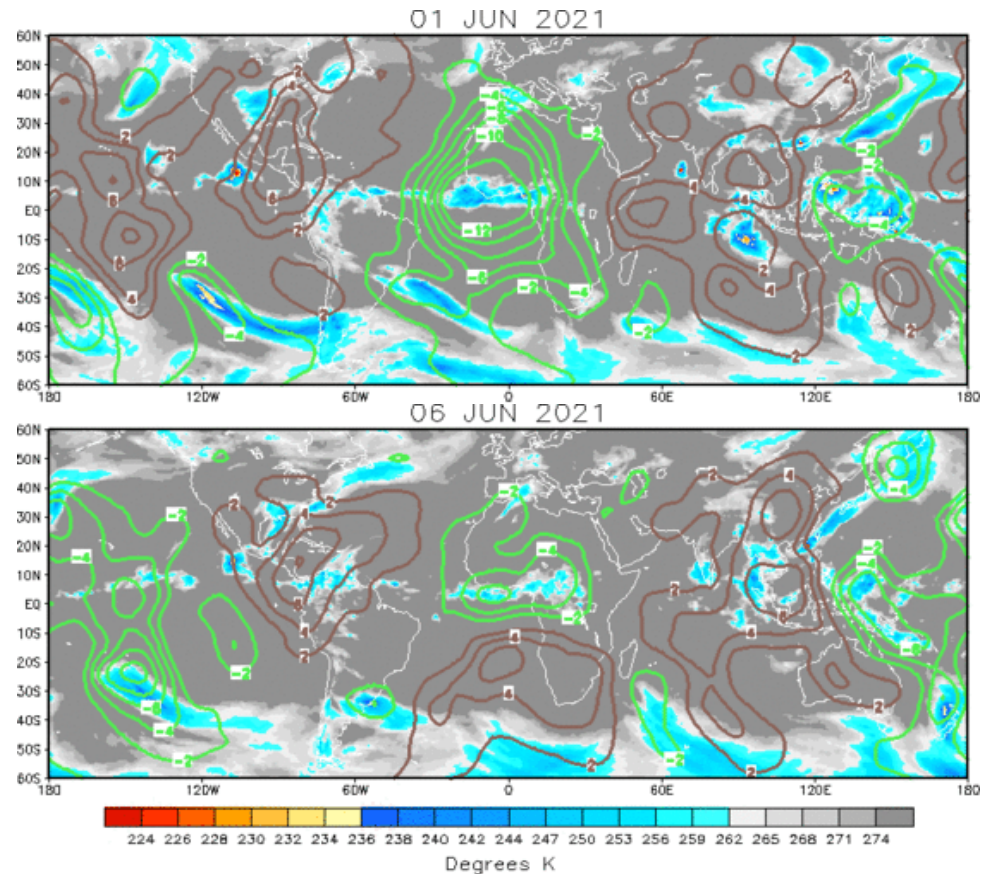
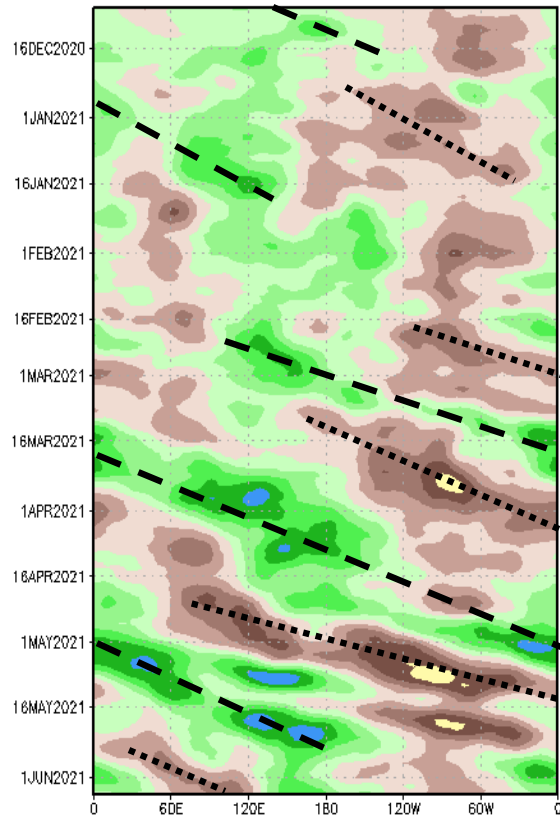
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation).

Brown shades: Anomalous convergence (unfavorable for precipitation).

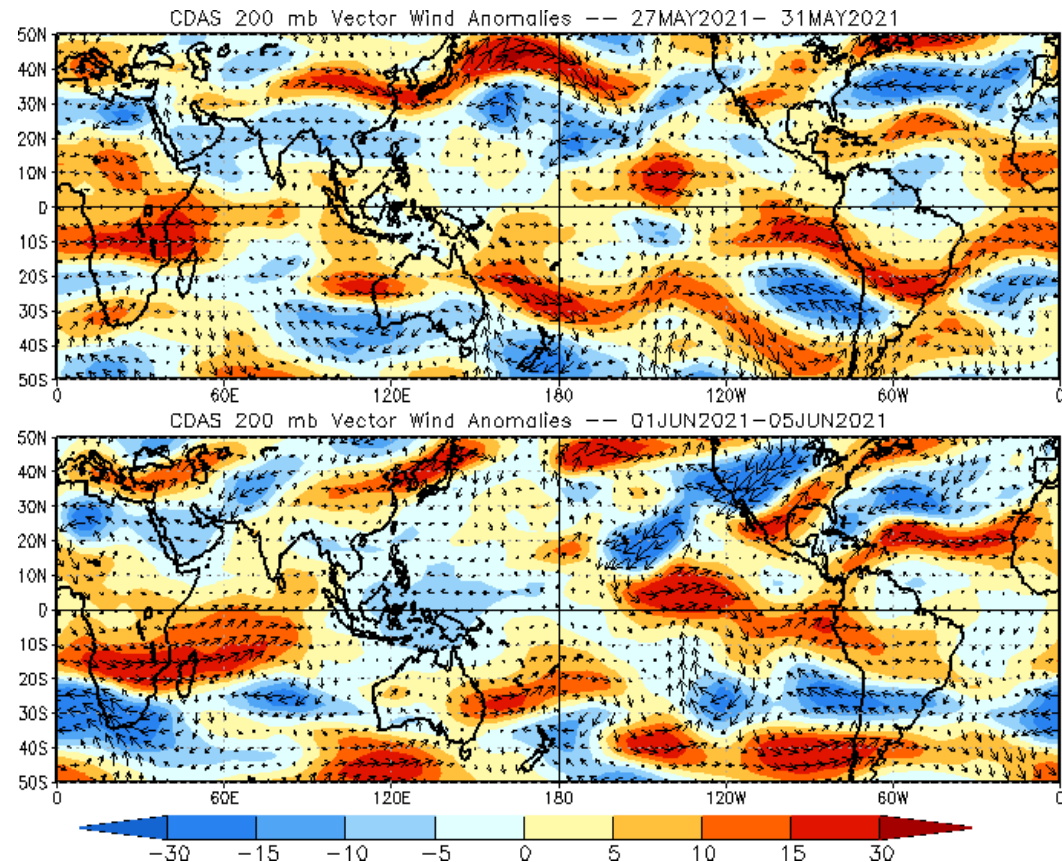
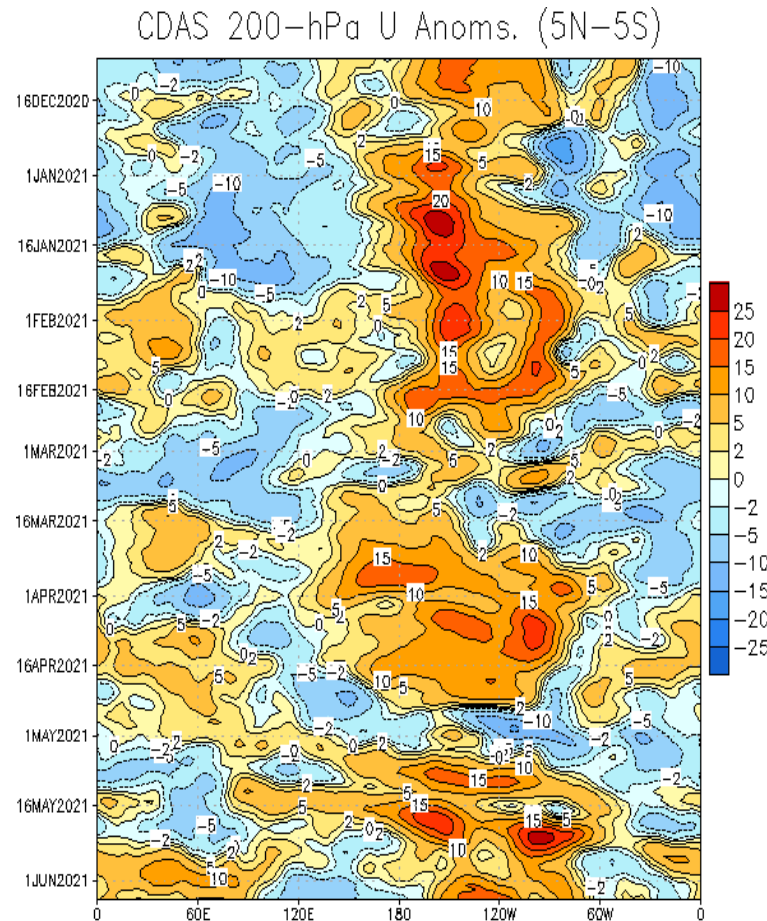
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- As the enhanced phase of the MJO propagated into the West Pacific during late May, there has since been little eastward propagation of the convective envelope.
- A wave-2 pattern remains evident, with upper-level divergence anomalies likely tied to a quasi-stationary MJO and a Kelvin wave currently over Africa.

200-hPa Wind Anomalies

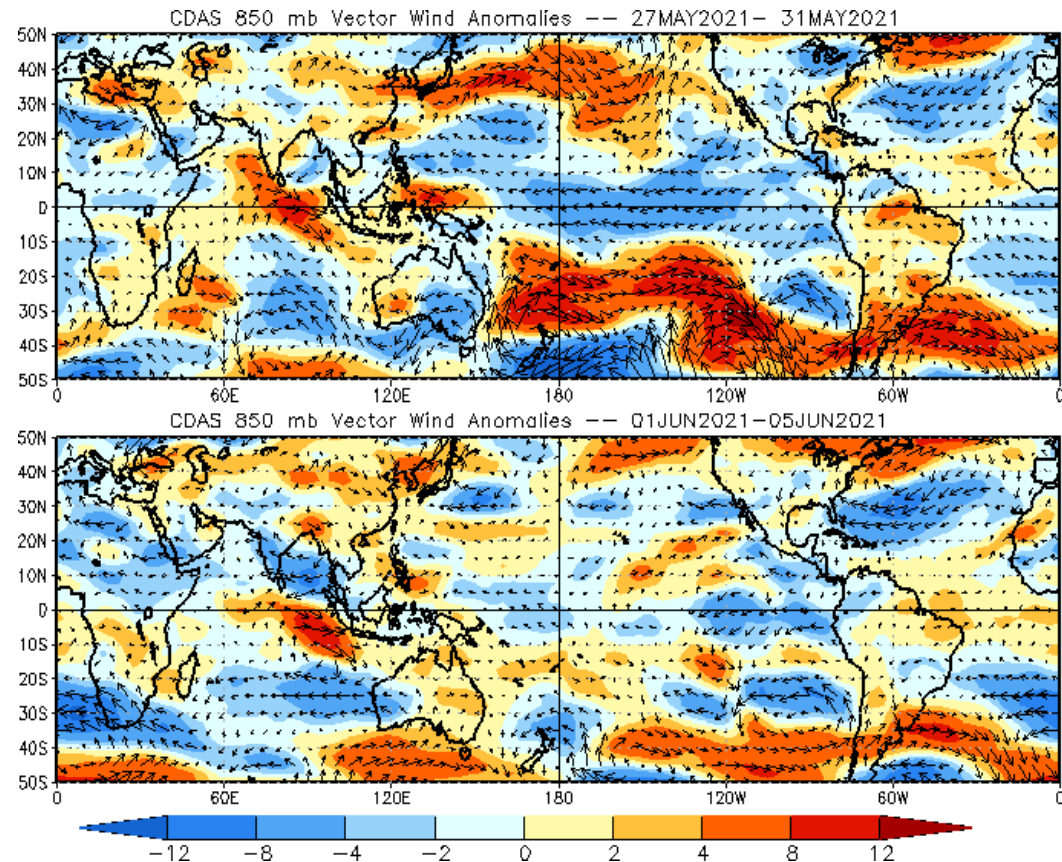
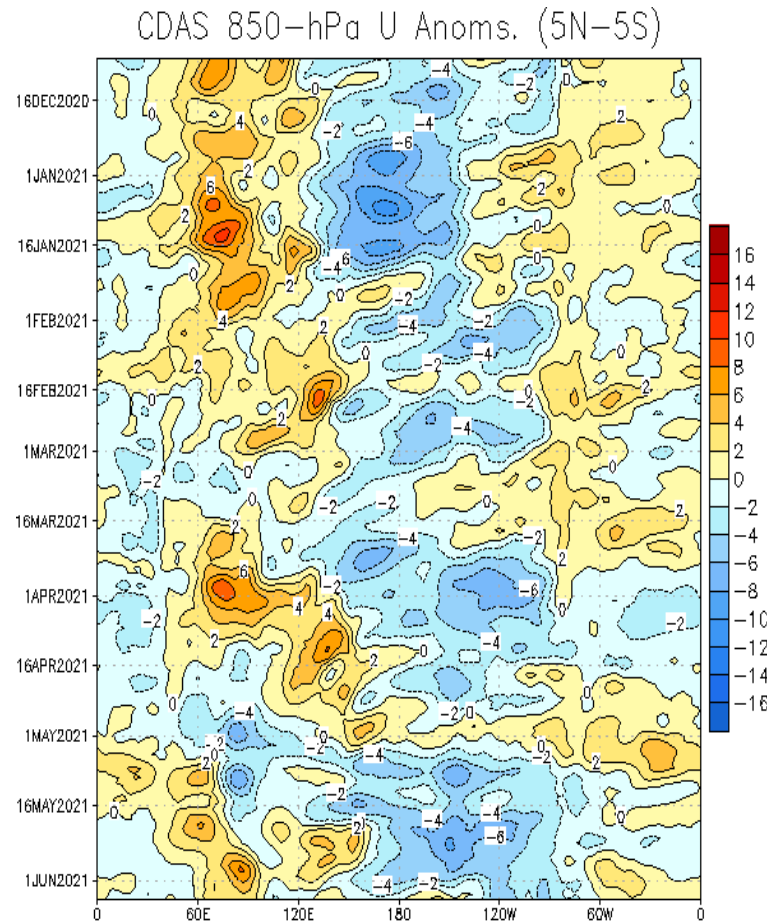
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- The most recent upper level zonal wind field appears better organized compared to late May, which reveals stronger divergence (convergence) aloft near the Date Line (Maritime Continent).
- Stronger westerlies are observed to the west of 120°E along the equator, reinforced by a pair of anomalous anticyclonic circulations in both Hemispheres over the eastern Pacific.

850-hPa Wind Anomalies

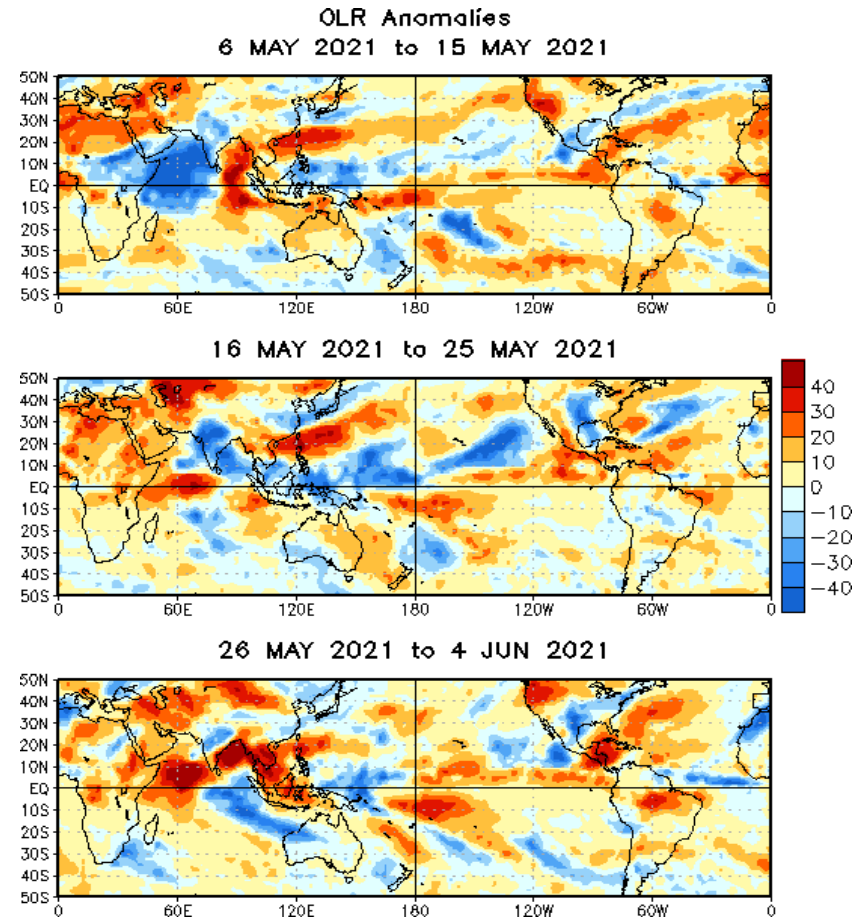
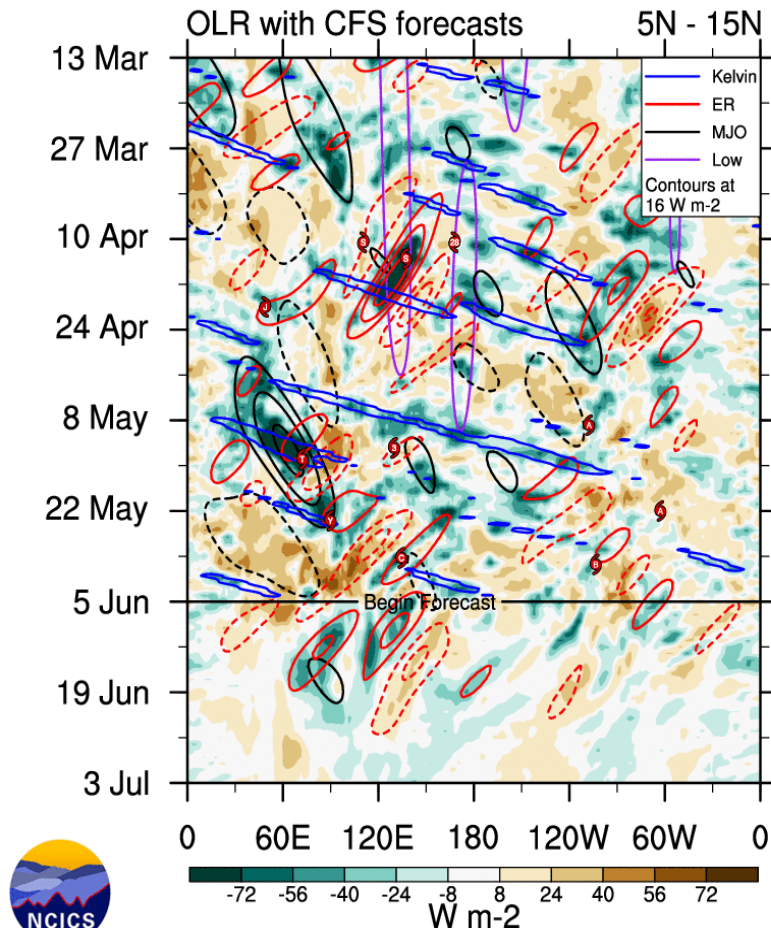
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Consistent with the velocity potential anomalies, the eastward propagation of anomalous low-level westerlies has been limited since late May; however, the recent relaxation of the enhanced trades over the equatorial Pacific suggests destructive interference between the MJO and the weakening La Niña.

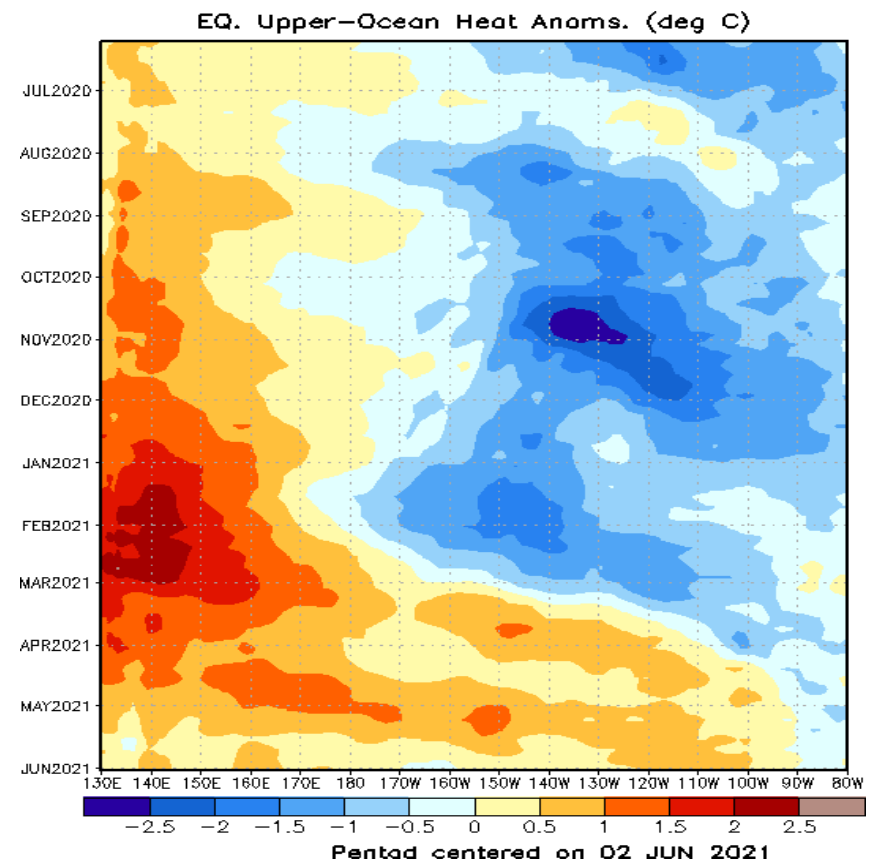
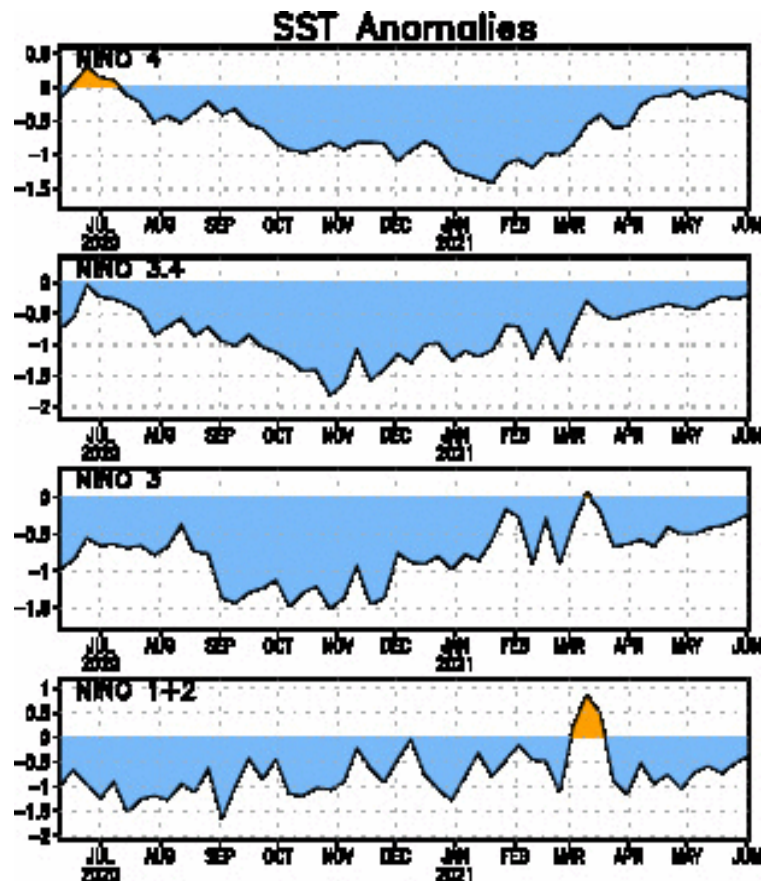
Outgoing Longwave Radiation (OLR) Anomalies

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



- Following the enhancement of convection associated with a pair of tropical cyclones near India during May, suppressed conditions have prevailed across the northern Indian Ocean and Maritime Continent.
- Rossby wave activity is analyzed in the forecast favoring the return of enhanced convection and possible tropical cyclone development over the Indian Ocean and West Pacific.

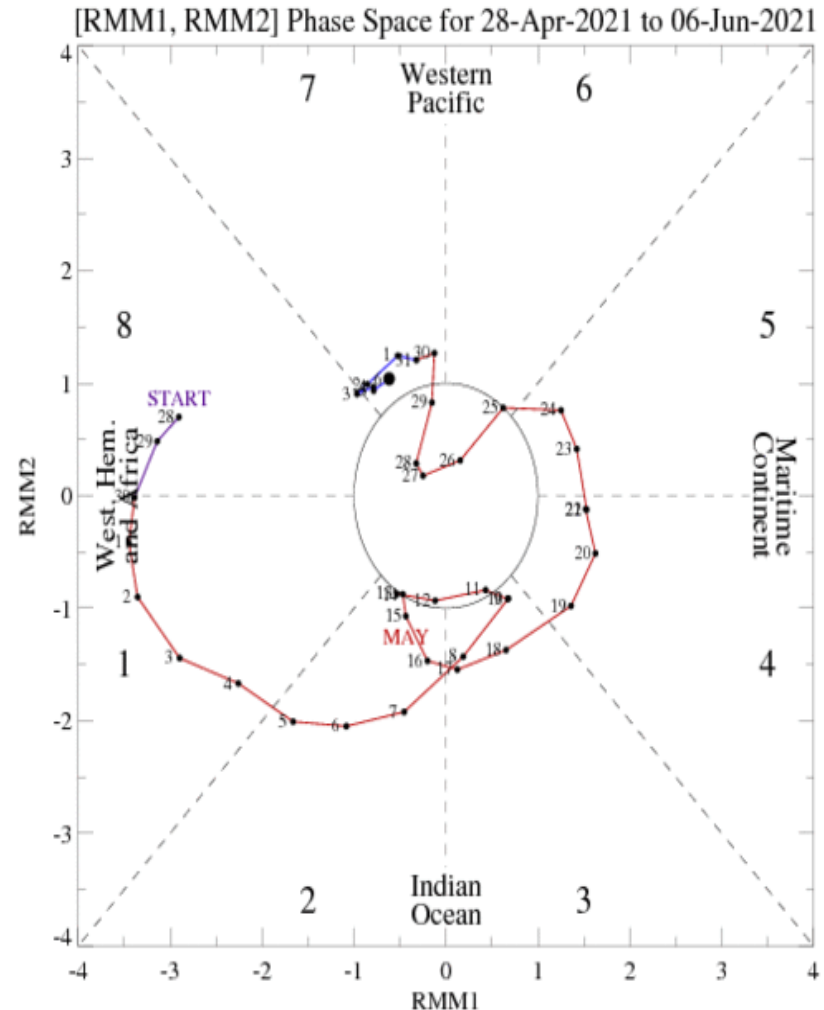
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Upper-ocean heat content is above-normal along the equator for areas west of 90°W as a result of multiple downwelling oceanic Kelvin waves since March.
- Niño indices still remain below-normal, although the vertically-integrated heat content suggests any cold water is extremely shallow.

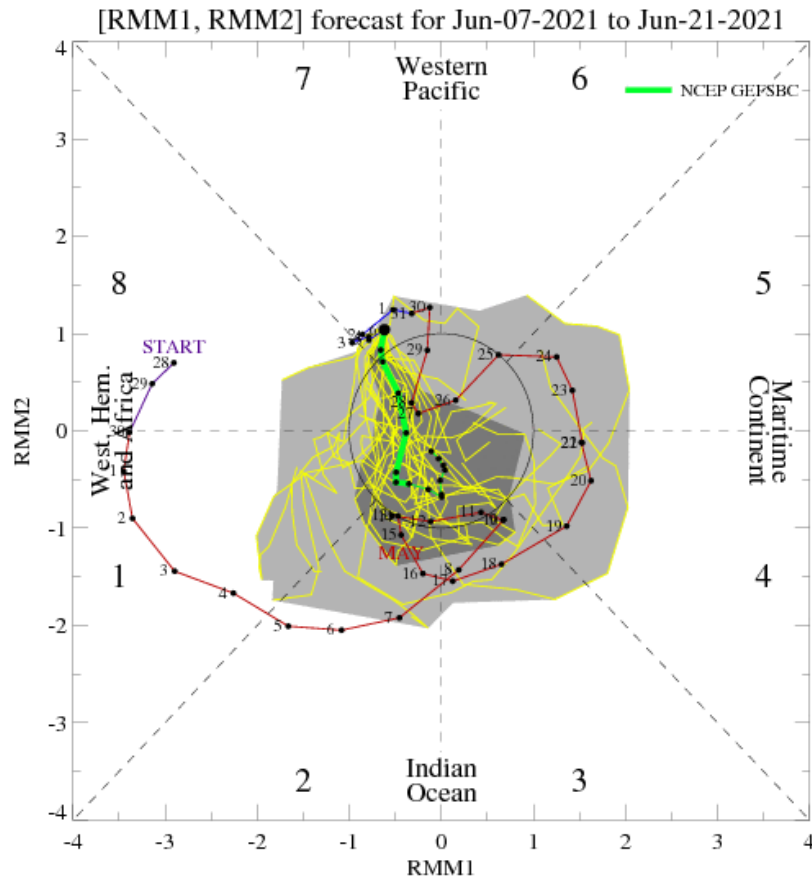
MJO Index: Recent Evolution

- Following Rossby wave interference which brought the RMM index inside the unit circle, the intraseasonal signal re-amplified over the West Pacific but has remained quasi-stationary in Phase 7 since early June.

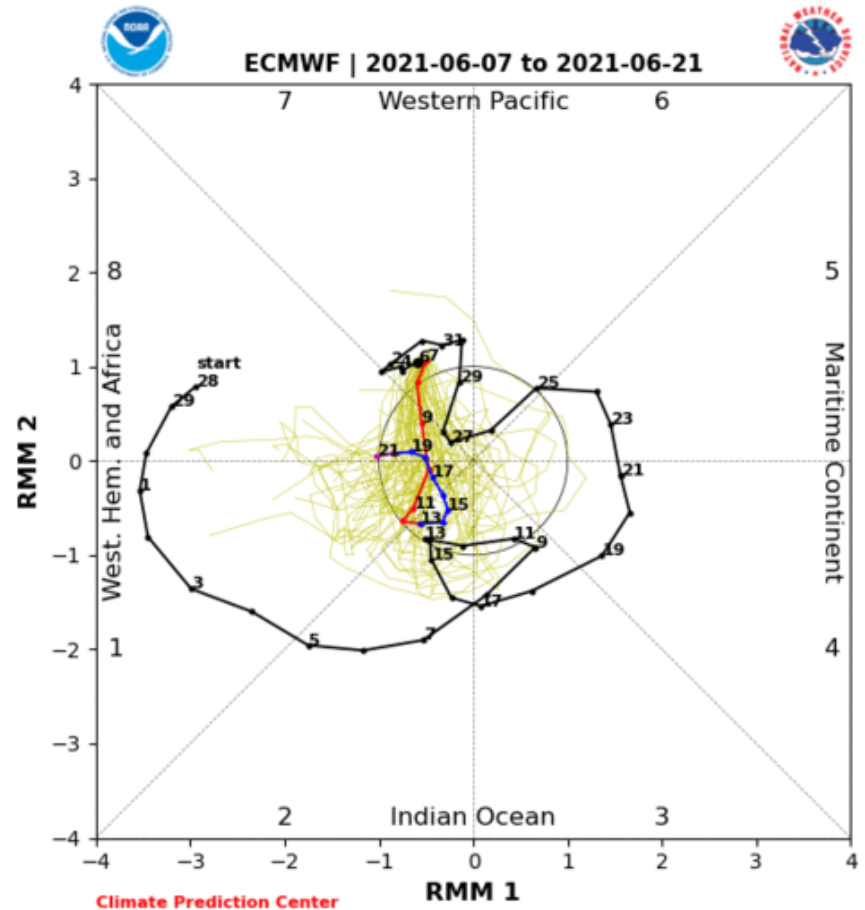


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



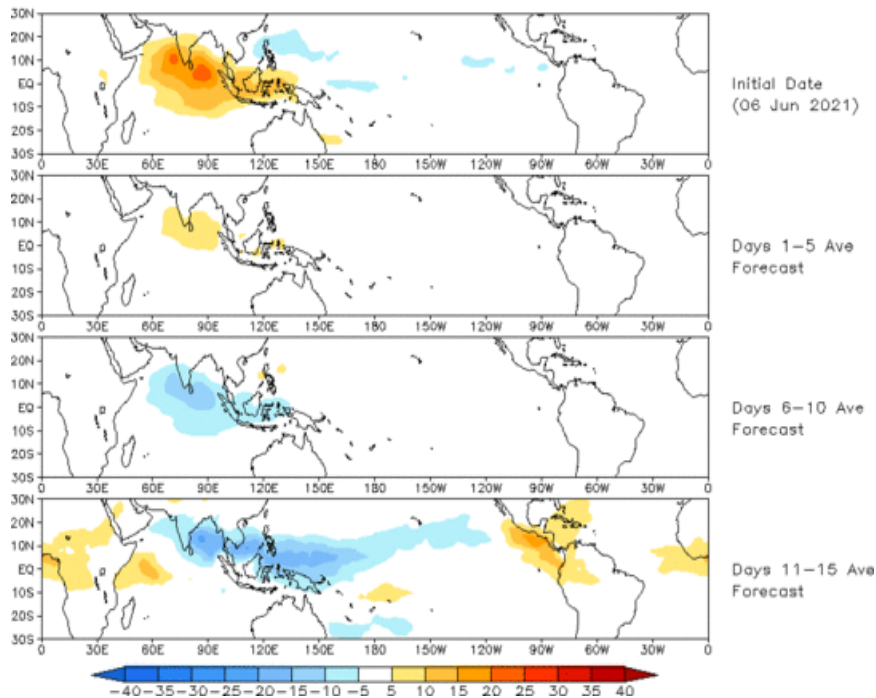
ECMWF Forecast

- Both the GEFS and ECWMF favor the continued eastward propagation of the MJO through the Western Hemisphere at a lower amplitude, with mean RMM values remaining within the unit circle during the next two weeks. There are several ensemble members which depict a reamplification of the signal over phases 1 and 2 through mid-June.

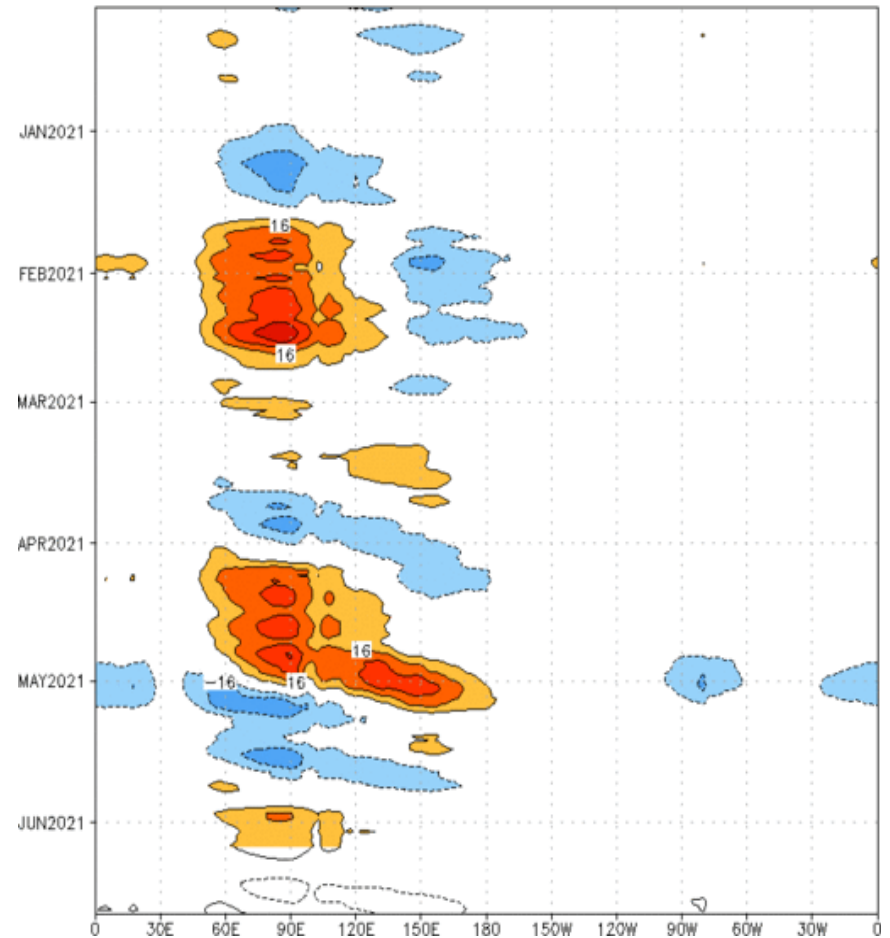
MJO: GEFS Forecast Evolution

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: 06 Jun 2021
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [$7.5^{\circ}\text{S}, 7.5^{\circ}\text{N}$] ($\text{cint: } 4\text{Wm}^{-2}$) Period: 05-Dec-2020 to 06-Jun-2021
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

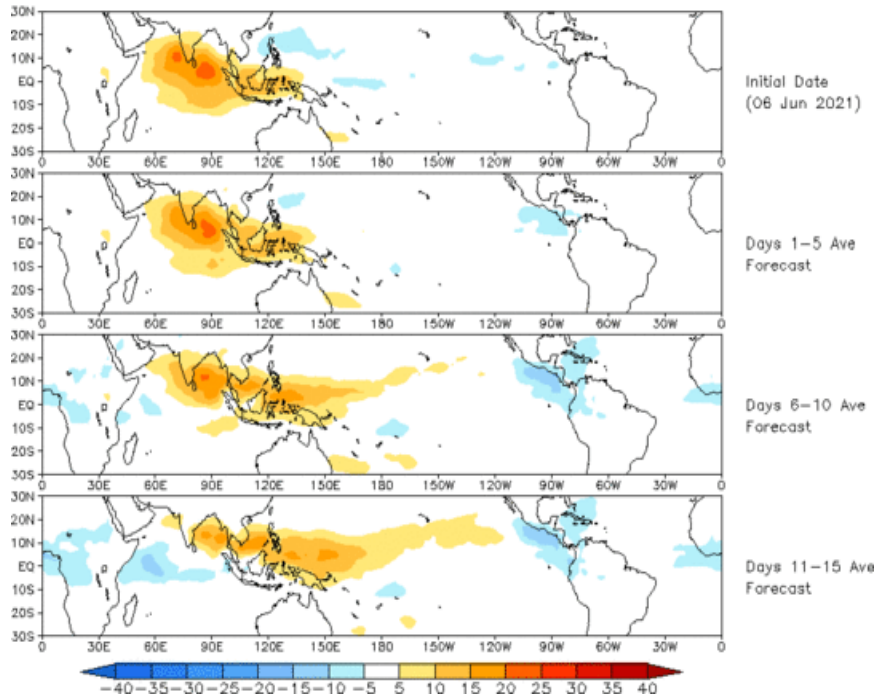


- The GEFS RMM-based OLR anomaly forecast favors a reversal of the convective pattern over the Indian Ocean and Maritime Continent, with suppressed conditions developing across the tropical Americas during week-2.

MJO: Constructed Analog Forecast Evolution

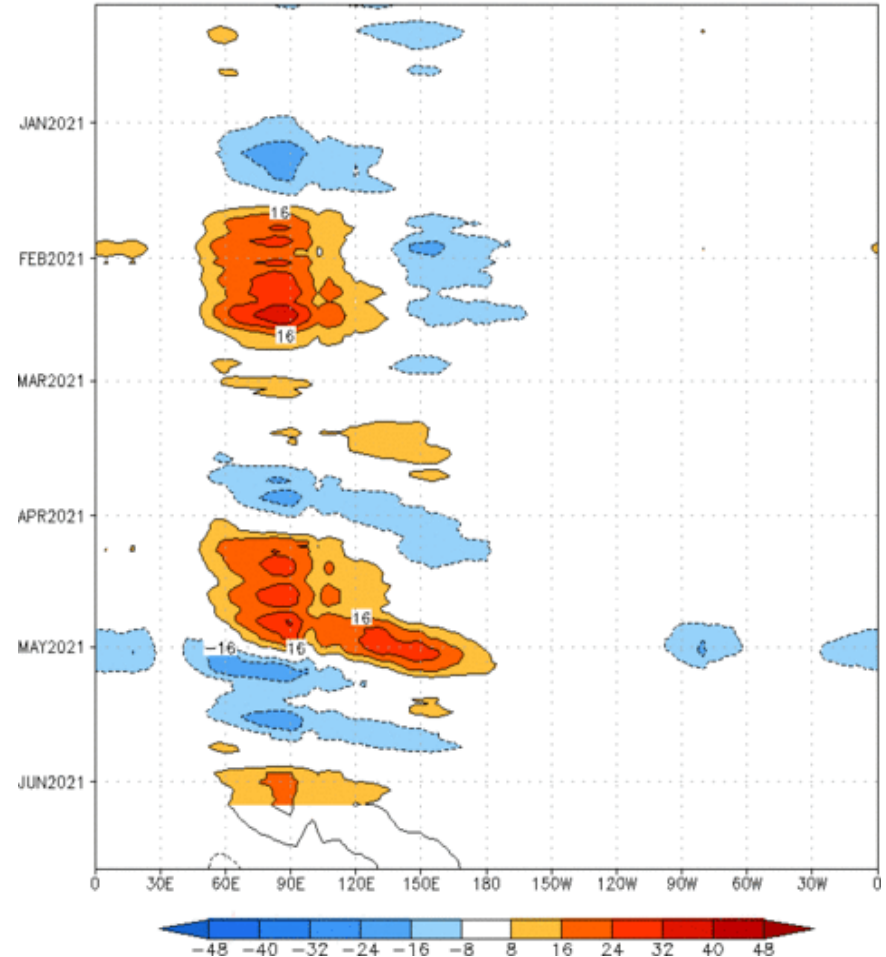
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

OLR prediction of MJO-related anomalies using CA model reconstruction by RMM1 & RMM2 (06 Jun 2021)



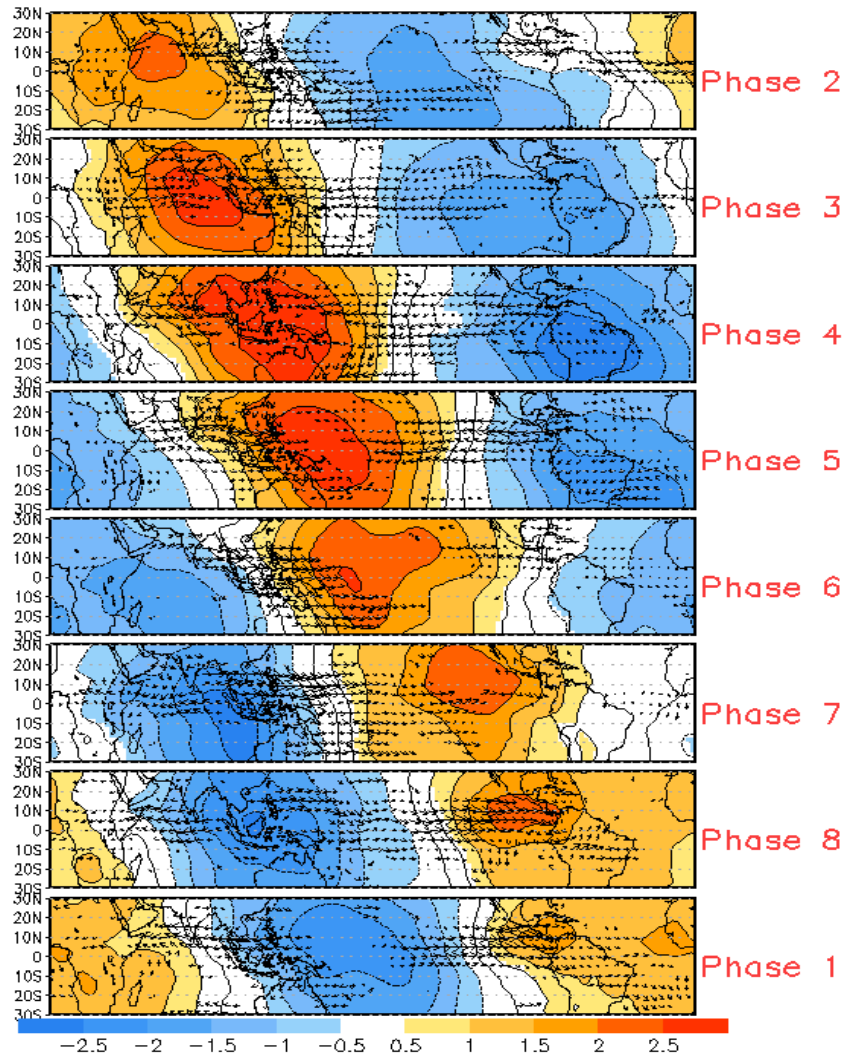
- The constructed analog forecast depicts a more canonical MJO, favoring eastward propagation of the convective pattern, but at a weak amplitude during the next two weeks.

Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:05-Dec-2020 to 06-Jun-2021
The unfilled contours are CA forecast reconstructed anomaly for 15 days

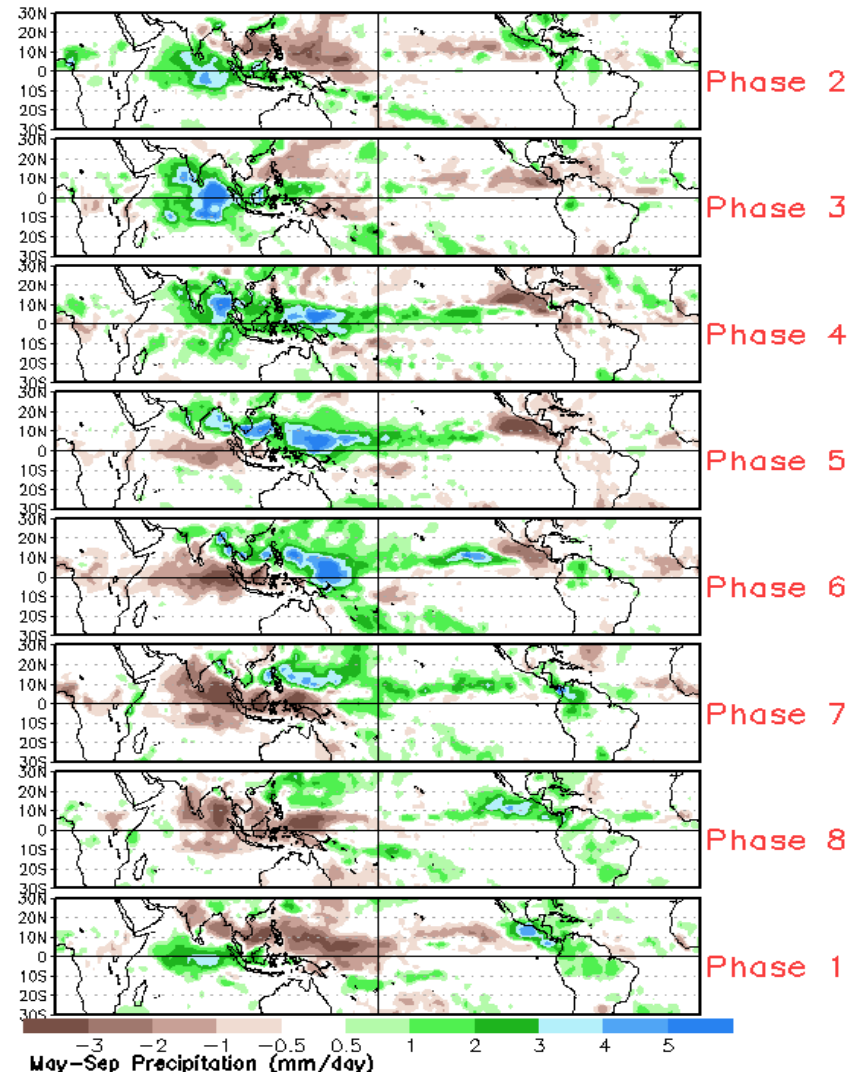


MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and
Wind Anomalies



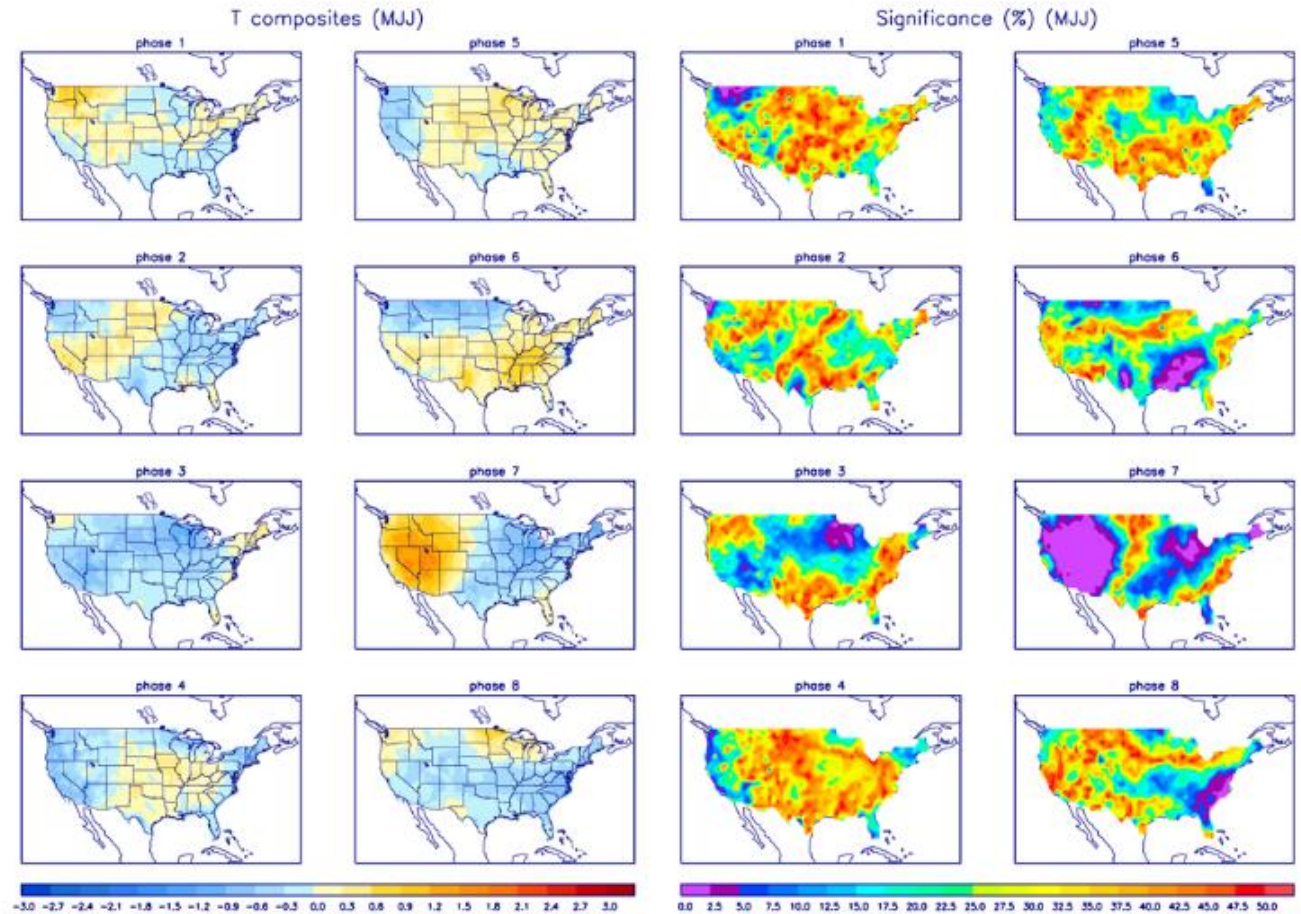
Precipitation Anomalies



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.

