

Madden-Julian Oscillation:

Recent Evolution, Current Status and Predictions



Update prepared by the Climate Prediction Center
Climate Prediction Center / NCEP
31 May 2021

Overview

- The enhanced phase of the MJO propagated to the West Pacific, but other modes including Rossby wave activity over the West Pacific and enhanced trades associated with the decaying La Niña interfered with the intraseasonal signal.
- A robust Kelvin wave is crossing the Atlantic basin, but is unlikely to help induce early season tropical cyclone activity.
- The tropical convective pattern would favor potential tropical cyclogenesis over both the West and East Pacific basins over the next two weeks.

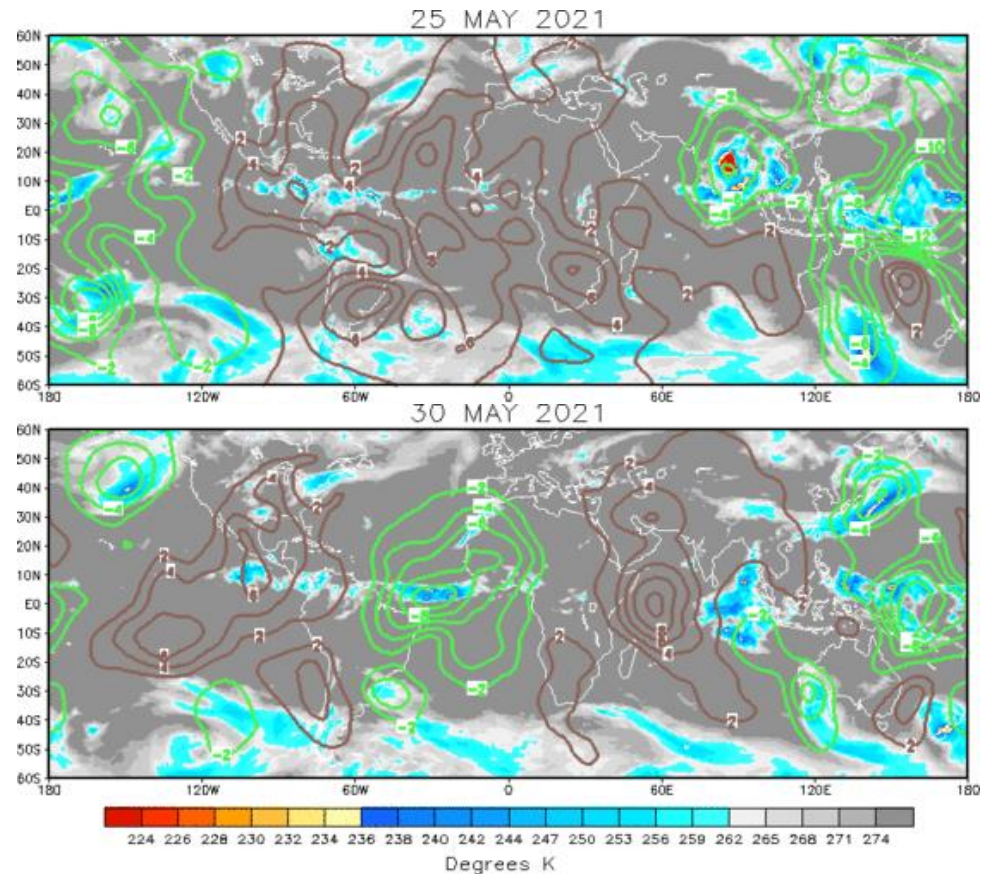
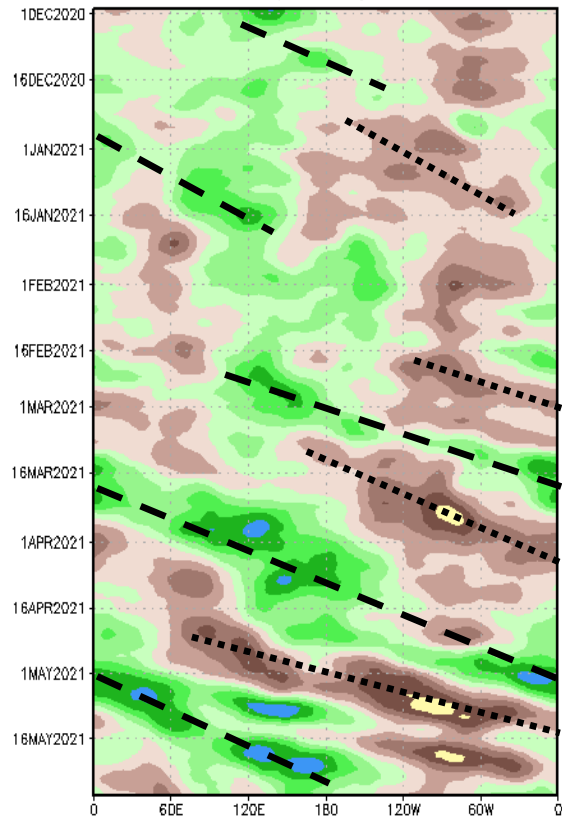
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation).

Brown shades: Anomalous convergence (unfavorable for precipitation).

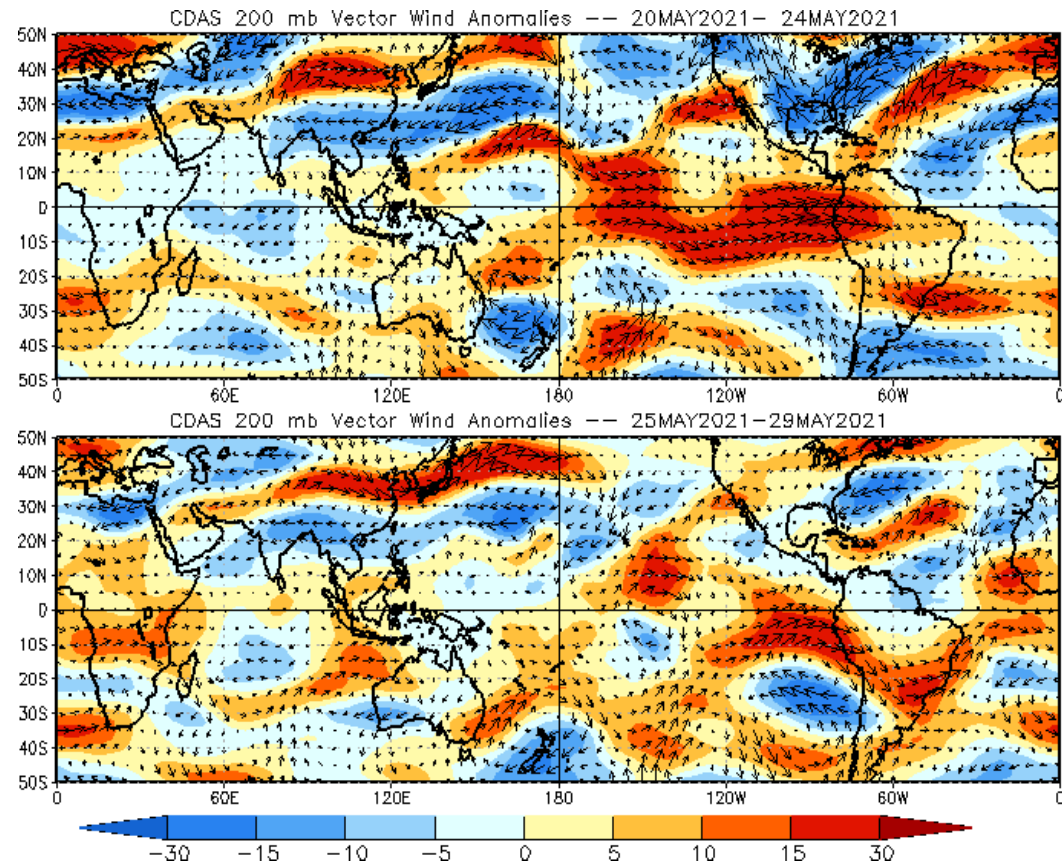
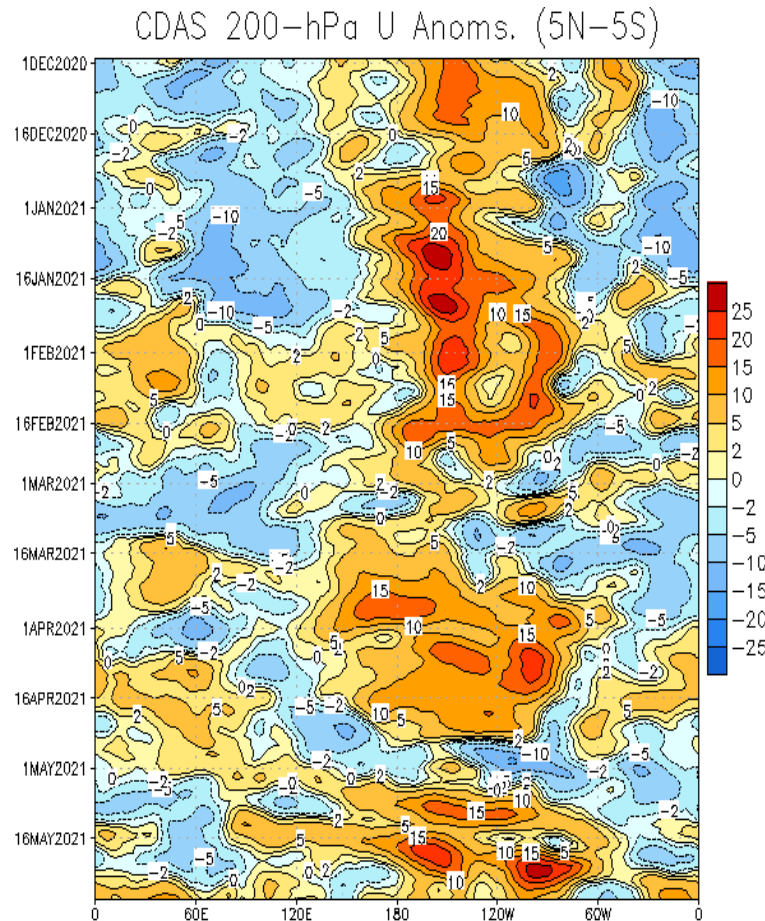
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- The upper-level enhanced MJO envelope propagated from the Maritime Continent to the West Pacific during late May, with a reduced amplitude and zonal extent.
- A Kelvin wave crossing the Atlantic produced a robust upper-level response with a similar magnitude to the MJO.

200-hPa Wind Anomalies

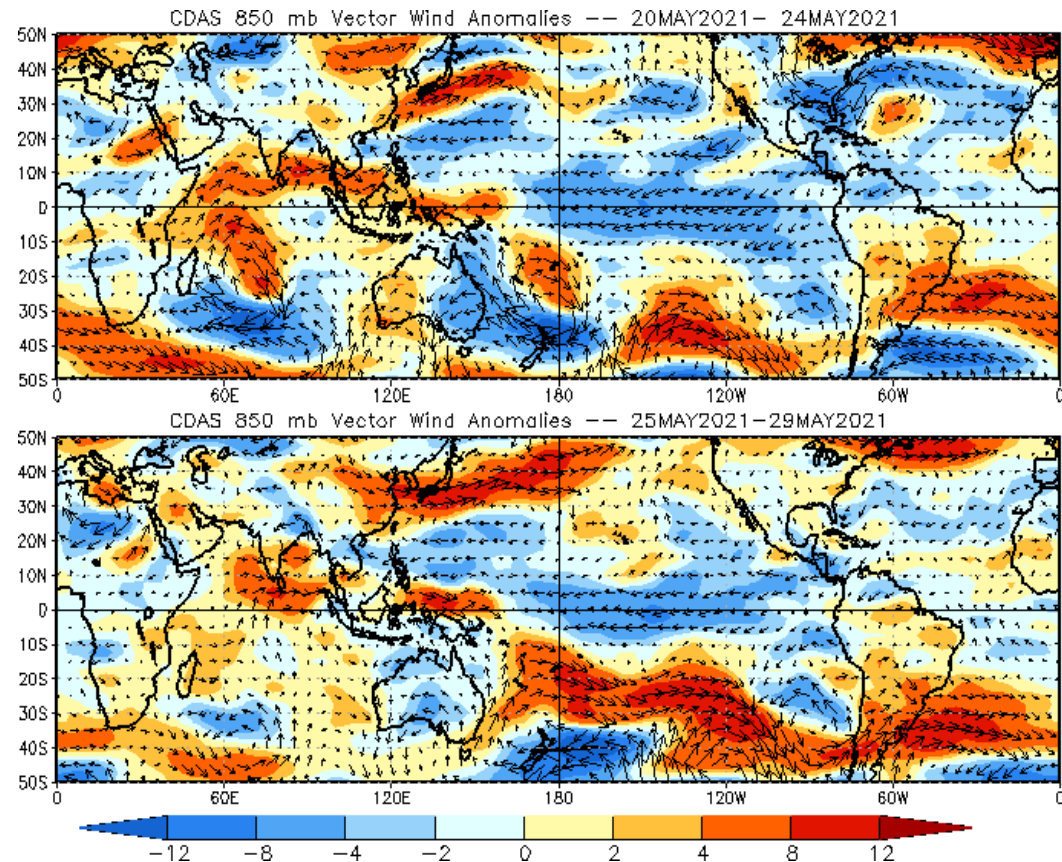
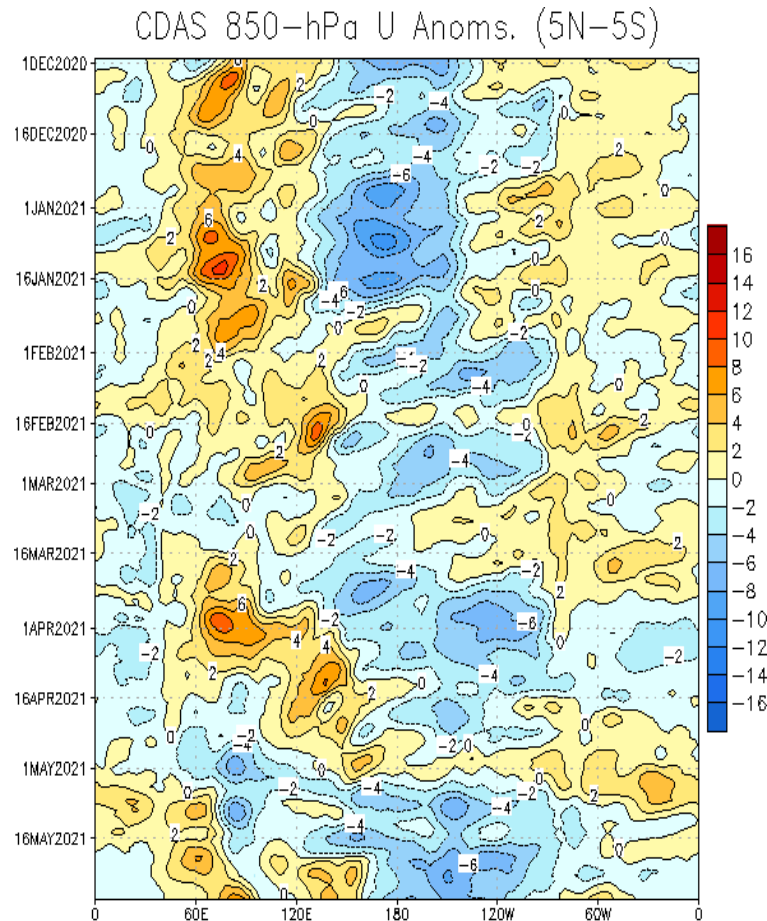
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Weak divergence is evident over the West Pacific, but extratropical wavebreaking onto the tropical Pacific appears to be limiting the eastern extent of the MJO-driven envelope.
- The overall pattern is more disorganized than it was during mid-May.

850-hPa Wind Anomalies

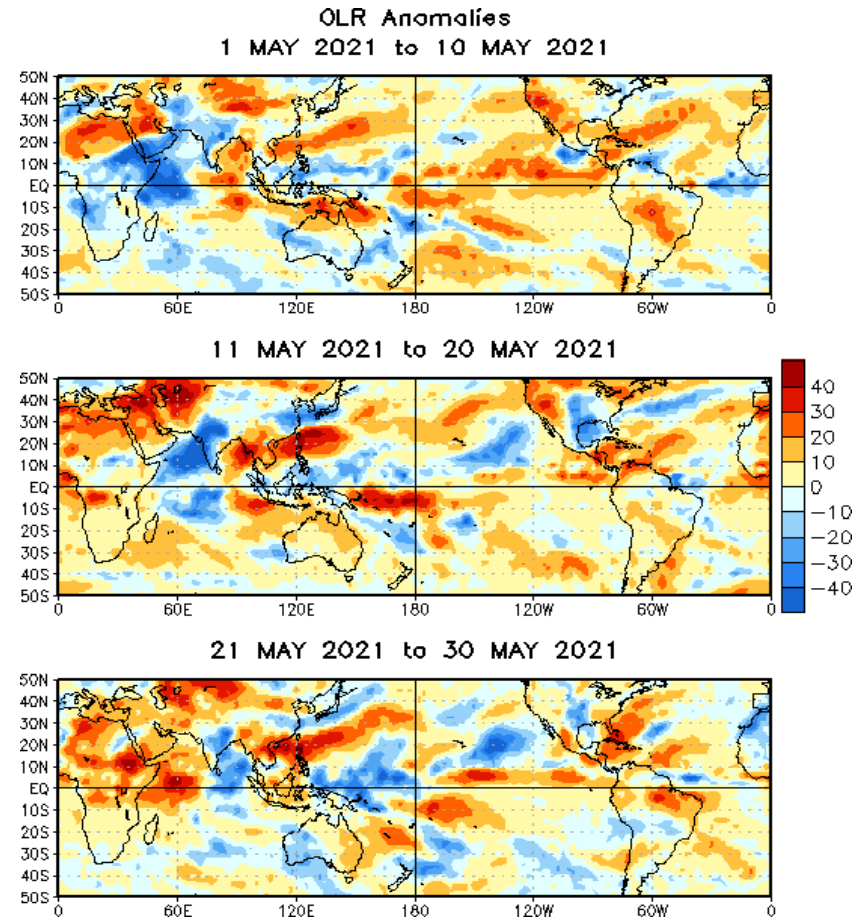
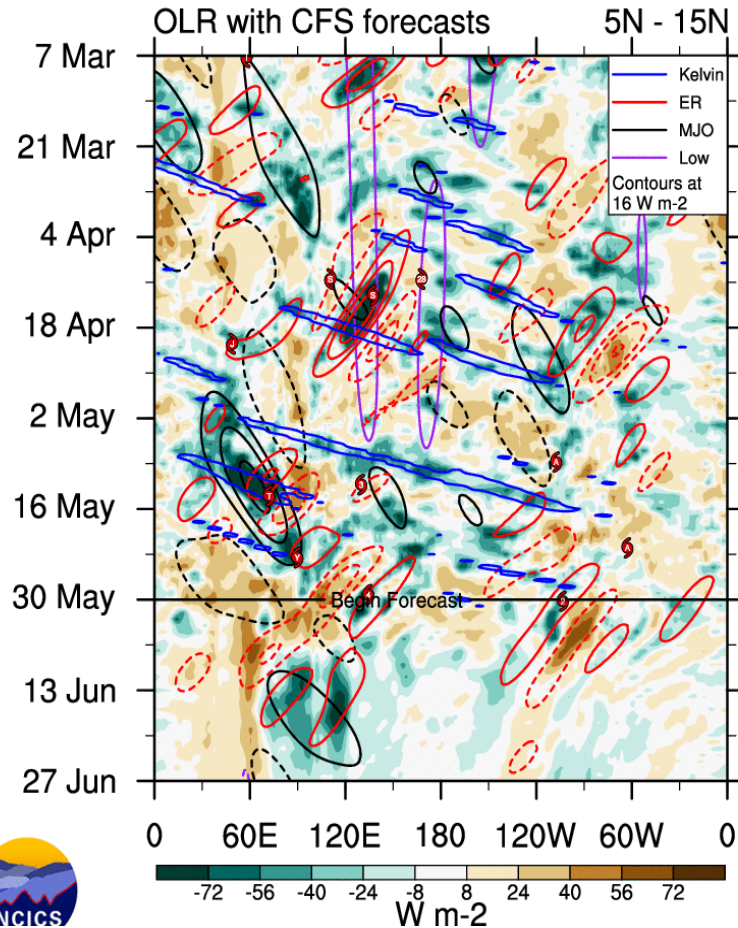
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Limited eastward propagation of the low-level westerly anomalies is evident, suggesting a weaker MJO projection, though the SPCZ region has intensified.
- Enhanced trades persist across the Equatorial Pacific despite the demise of La Niña, and may be destructively interfering with the MJO.

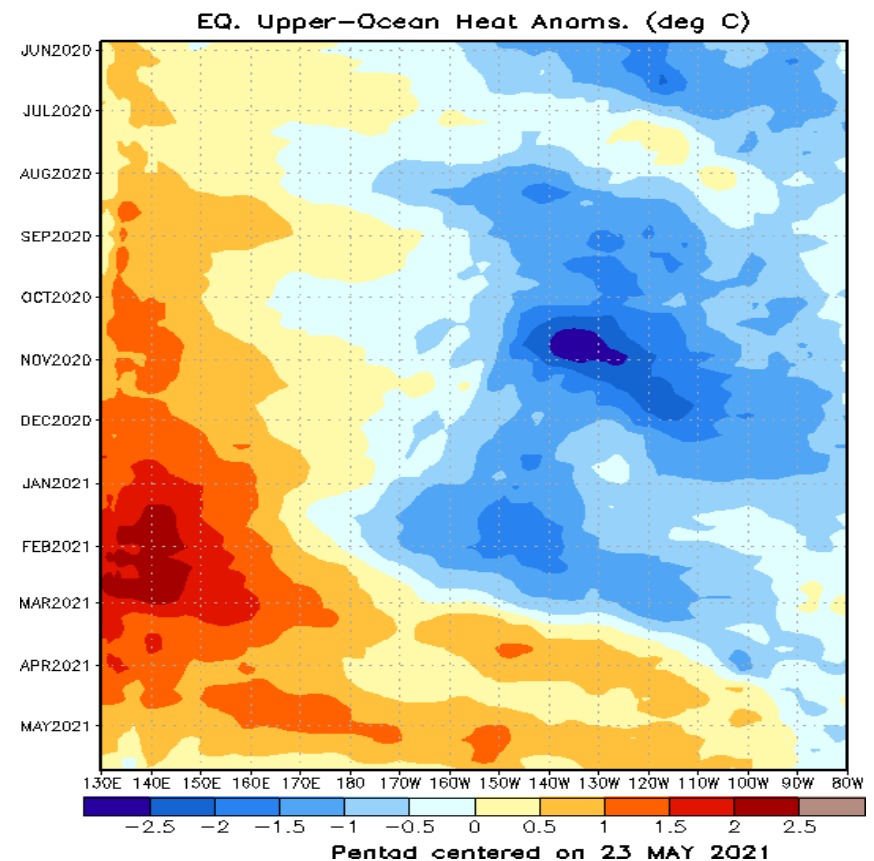
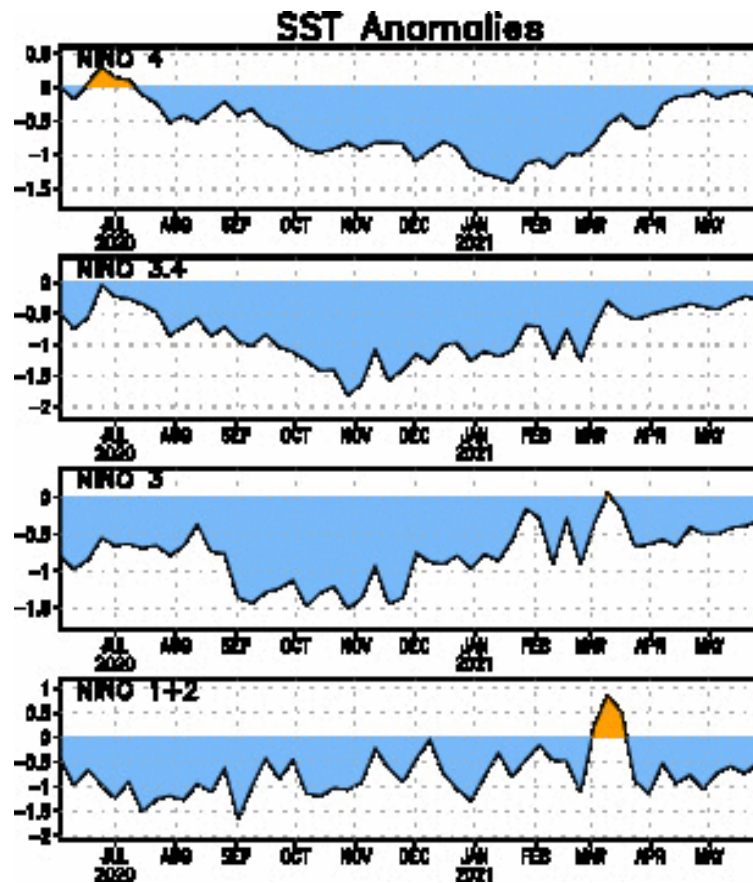
Outgoing Longwave Radiation (OLR) Anomalies

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



- Convective anomalies increased over the West Pacific, but the Hovmöller analysis shows influence from Rossby wave activity.
- A Kelvin wave crossing the East Pacific in mid-May may have provided a favorable environment for the formation of Tropical Depression Two-E.

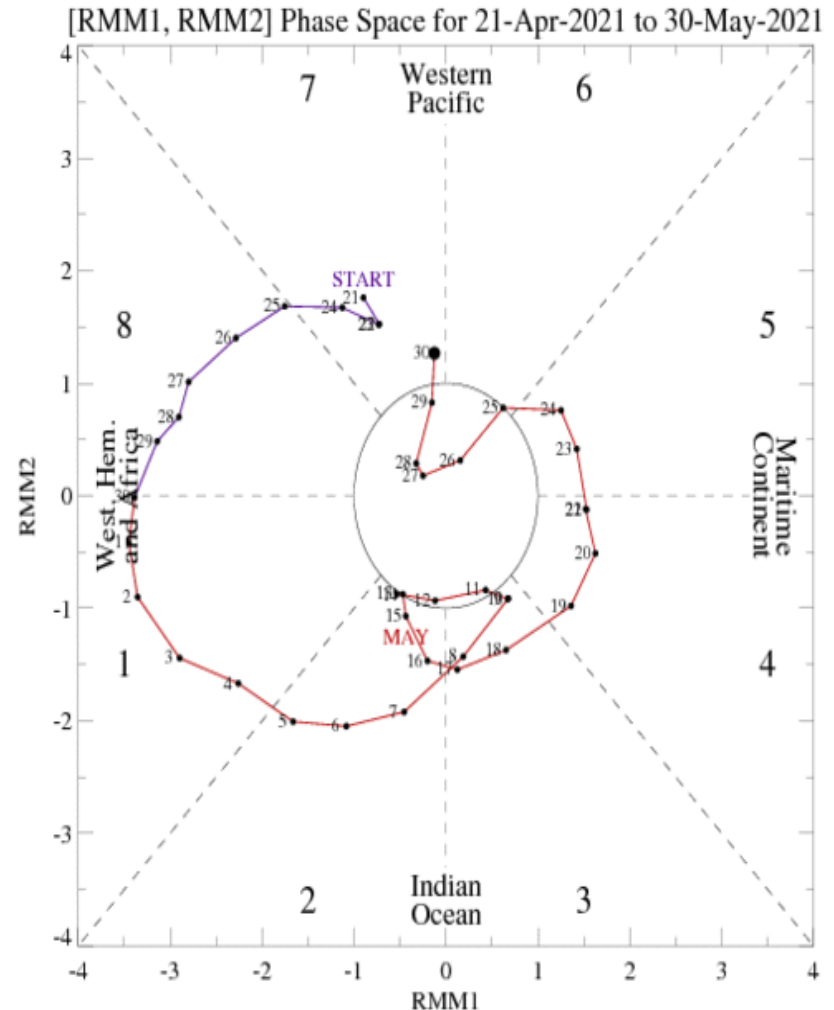
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- 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 generally remain below-normal, although the vertically-integrated heat content suggests any cold water is extremely shallow.

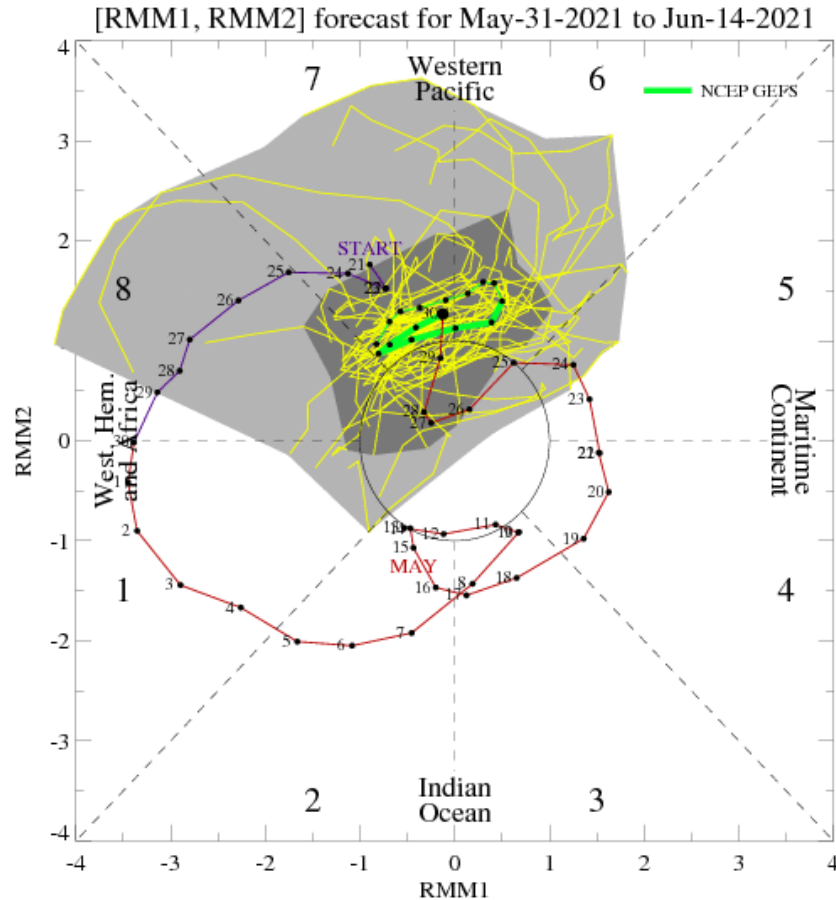
MJO Index: Recent Evolution

- The RMM index looped westward from May 10 to 15, due to an equatorial Rossby wave over the Indian Ocean.
- The MJO propagated eastward from the Indian Ocean to the Maritime Continent during mid to late May.
- More recently, Rossby wave interference brought the index inside the unit circle, but the signal has re-amplified over the West Pacific.

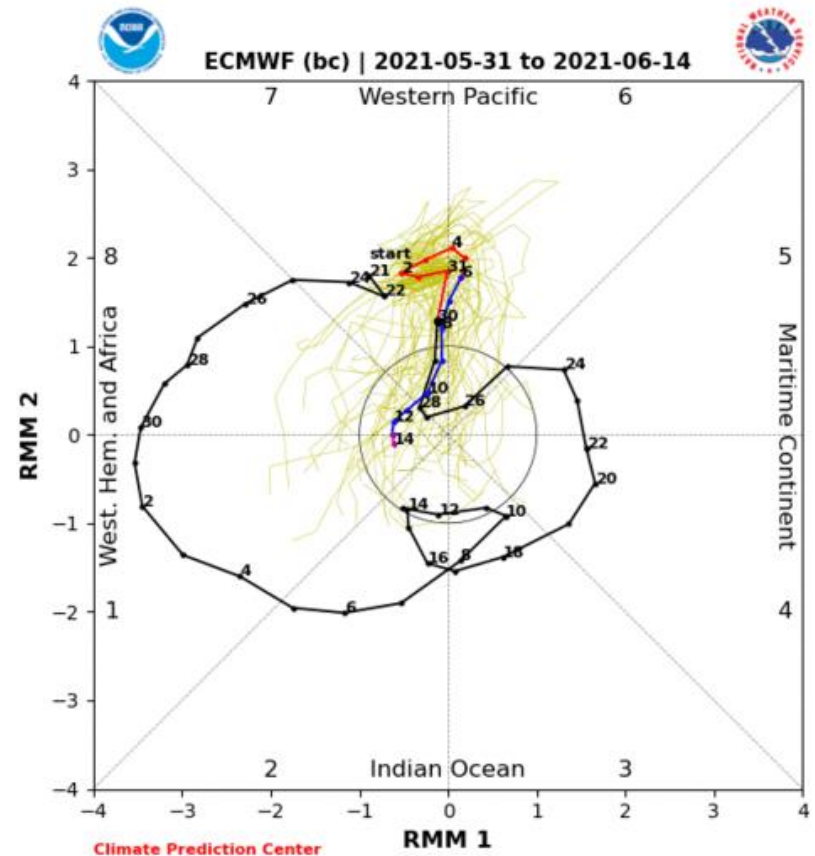


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



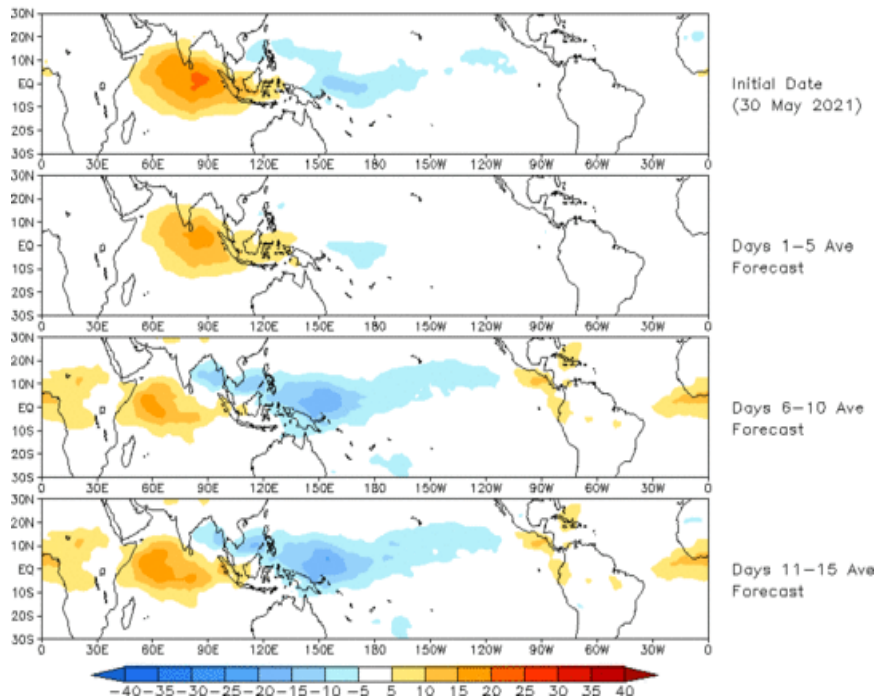
ECMWF Forecast

- The GFS ensemble mean depicts a loop over the West Pacific consistent with Rossby wave interference. The ECMWF is similar, but with a greater amplitude over the West Pacific in Week-1.
- During Week-2, the GEFS ensemble members diverge, with some members showing considerable West Pacific amplification and others showing a weaker signal. The ECMWF favors more rapid eastward propagation of a weaker signal.

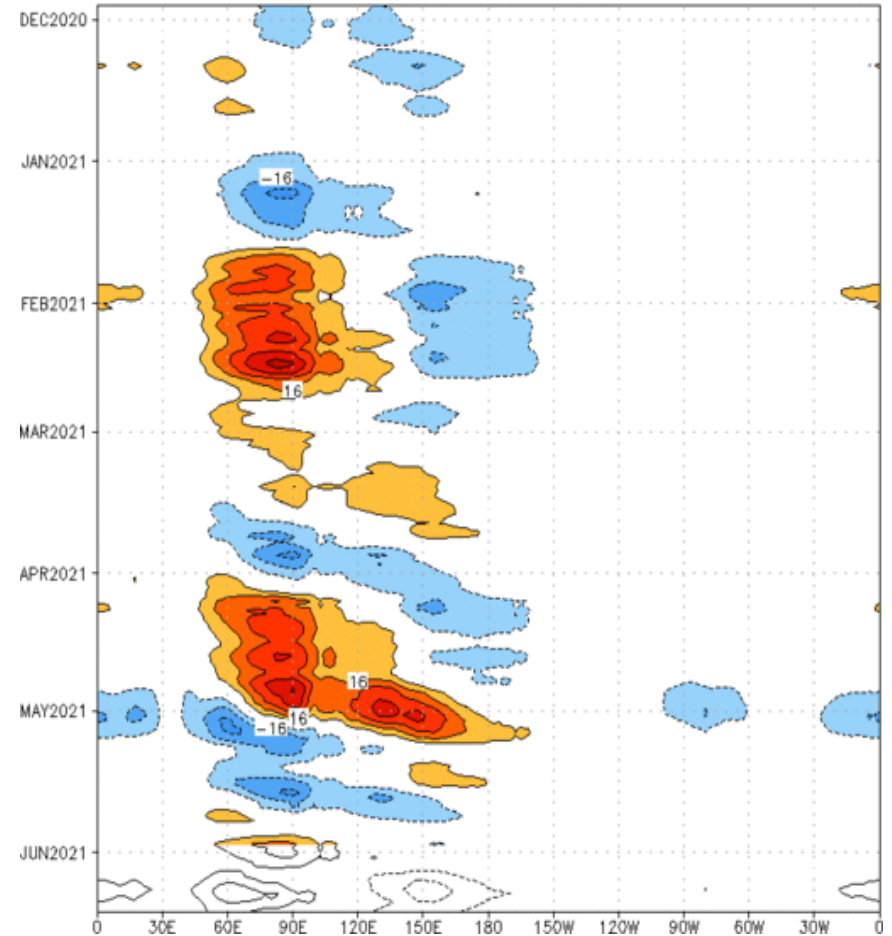
MJO: GEFS Forecast Evolution

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: 30 May 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: 28-Nov-2020 to 30-May-2021
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

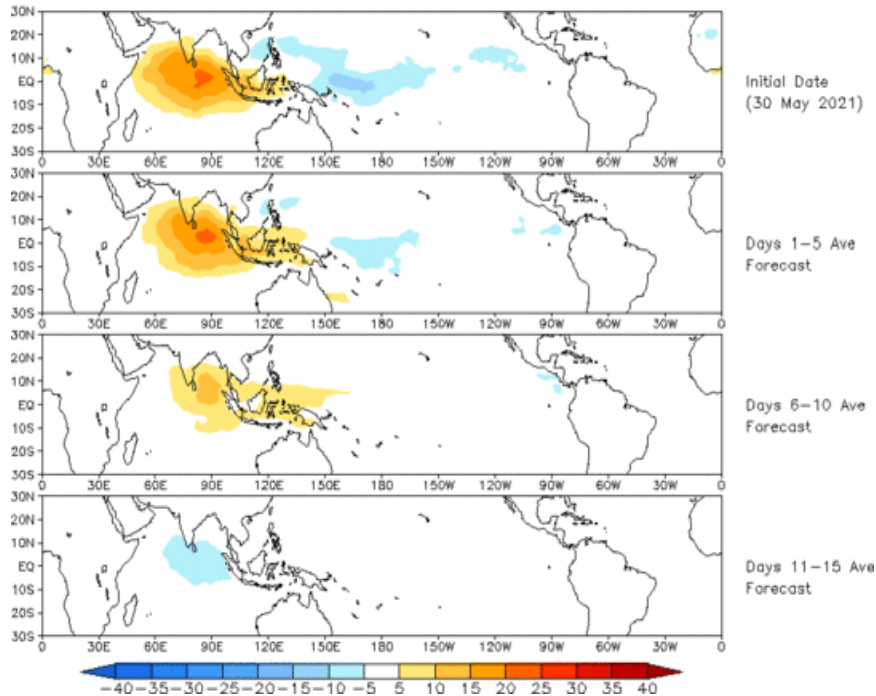


- The GEFS RMM-based OLR anomaly forecast shows an intensifying West Pacific signal during Week-2.

MJO: Constructed Analog Forecast Evolution

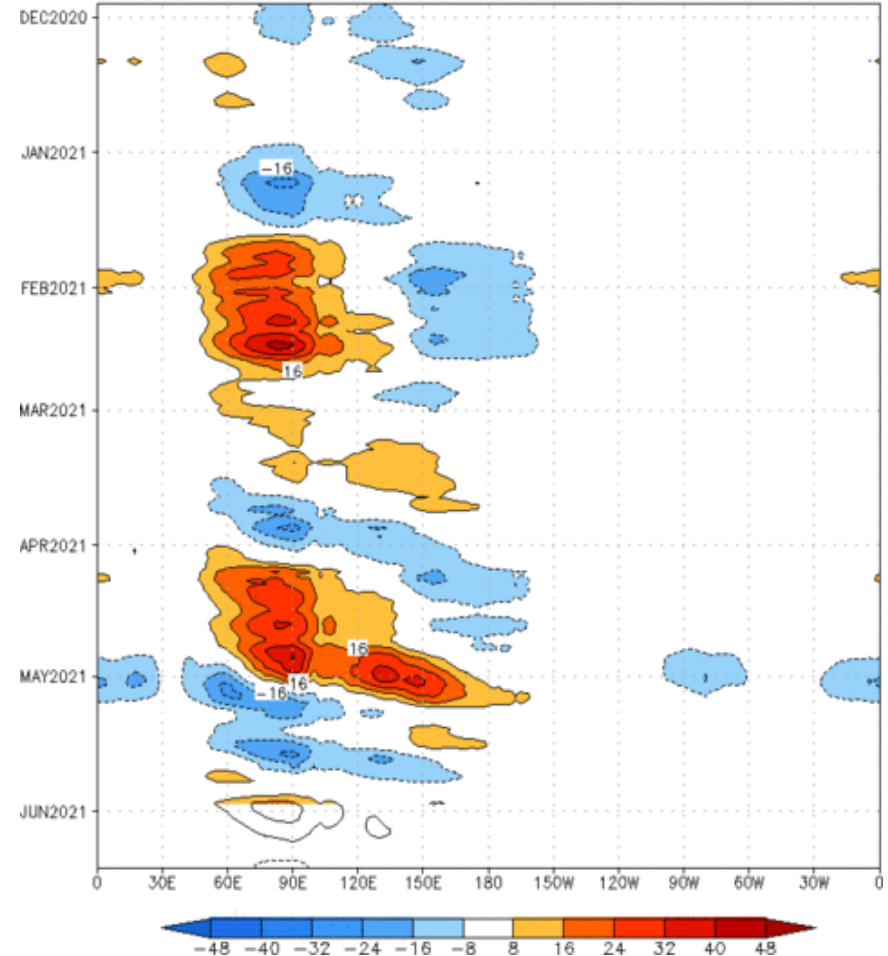
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

OLR prediction of MJO-related anomalies using CA model reconstruction by RMM1 & RMM2 (30 May 2021)



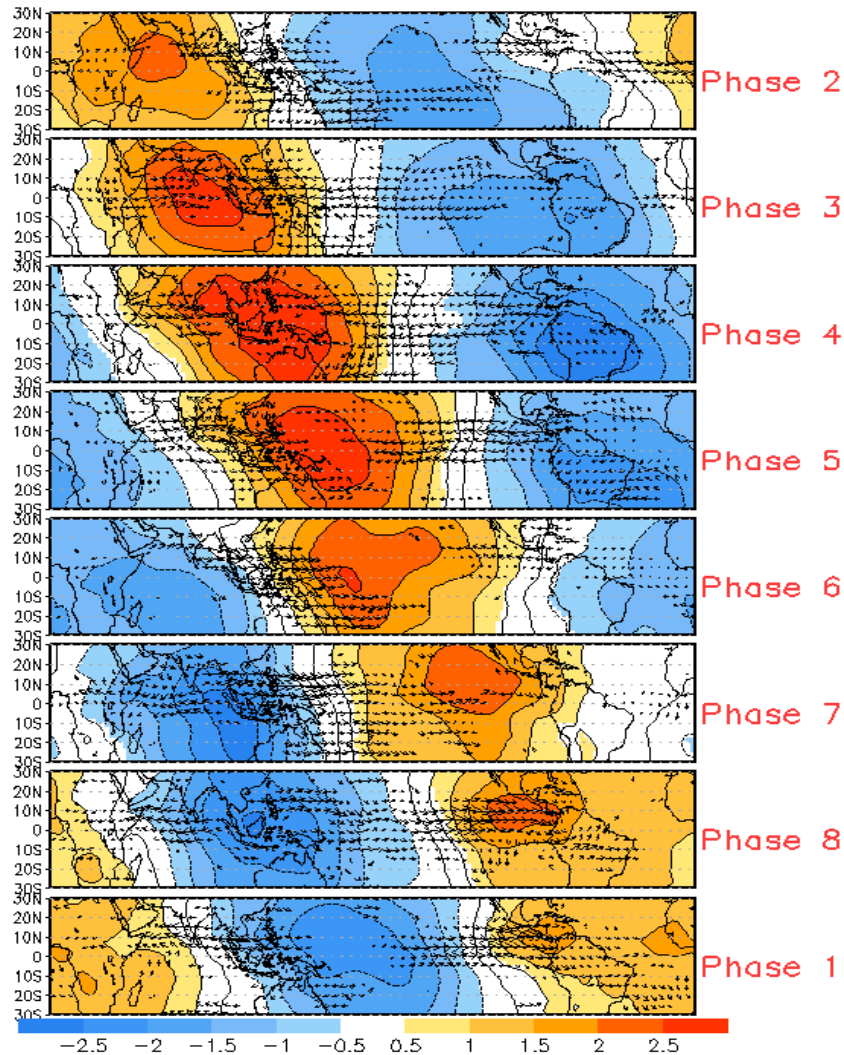
- The constructed analog forecast depicts faster eastward propagation, but weakens the amplitude of the signal through the two-week period.

Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:28–Nov–2020 to 30–May–2021
The unfilled contours are CA forecast reconstructed anomaly for 15 days

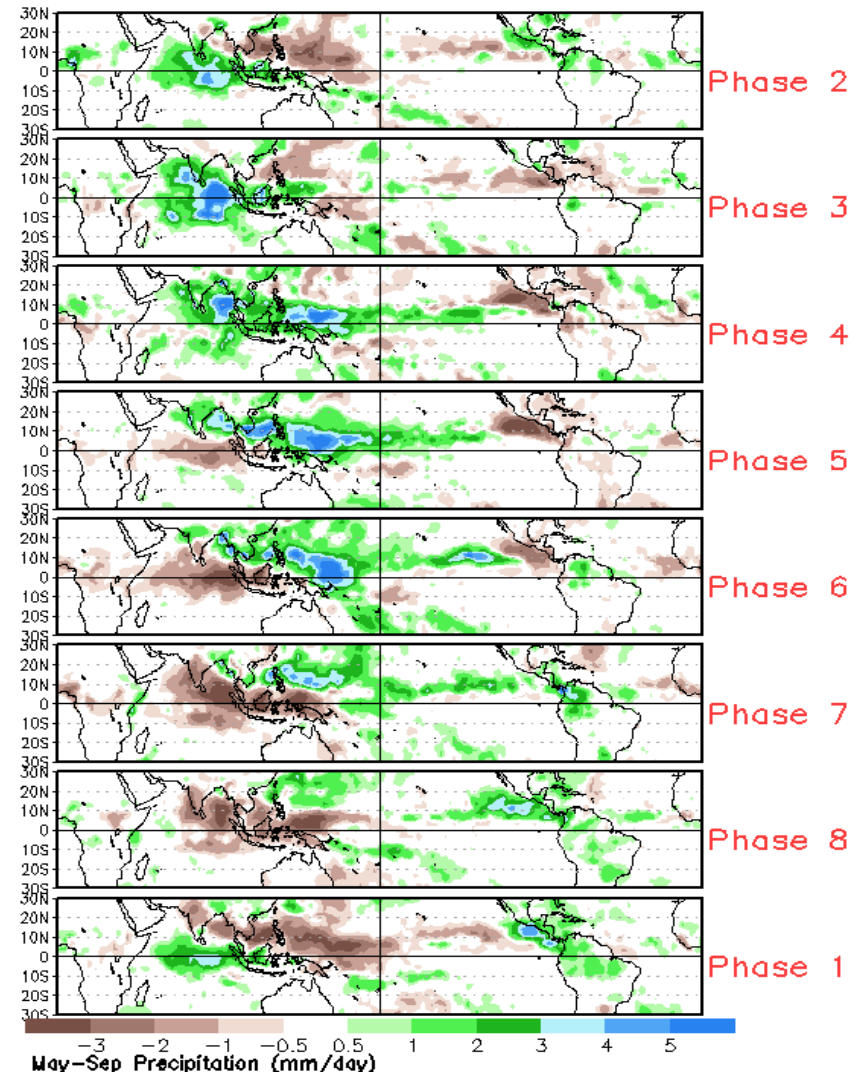


MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and
Wind Anomalies



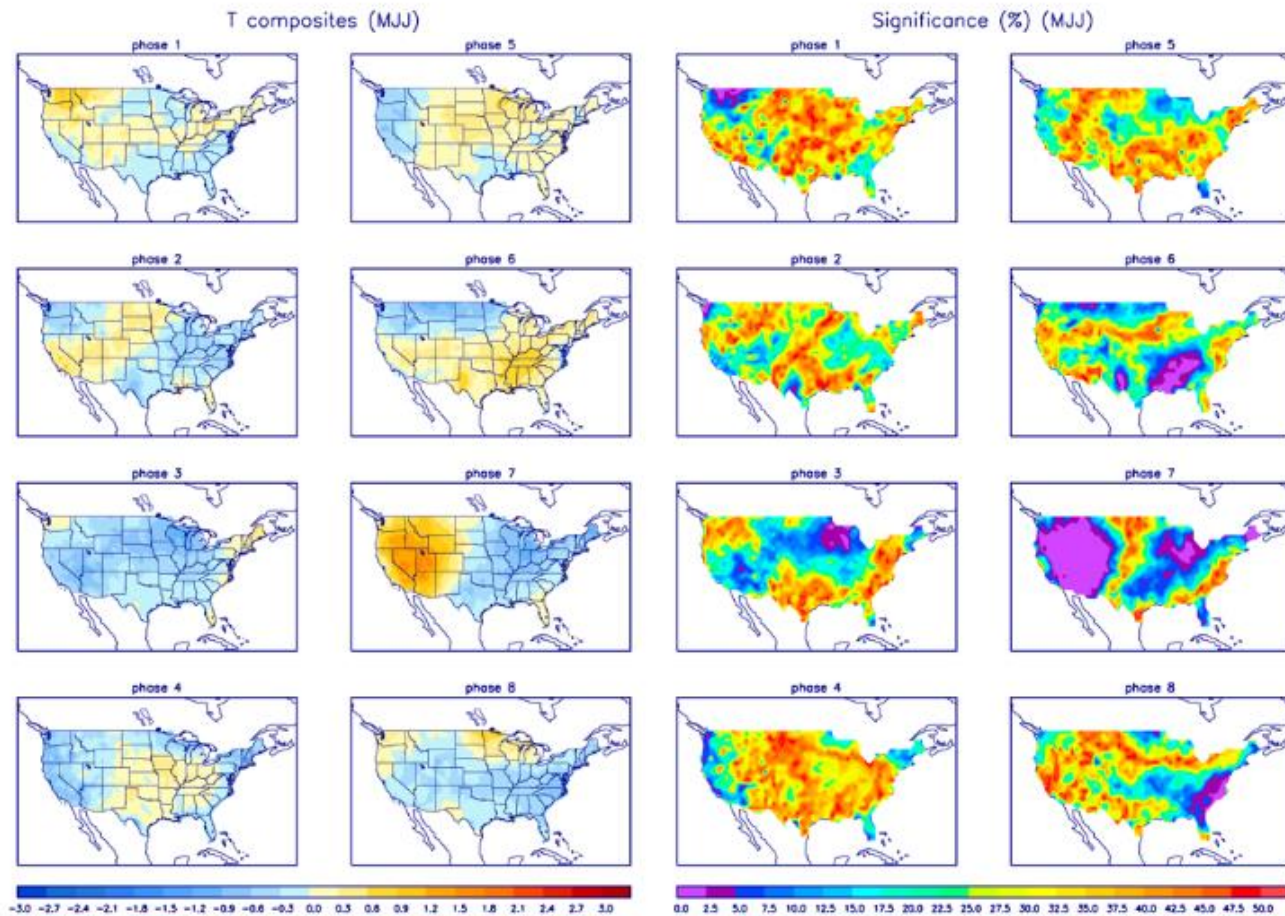
Precipitation Anomalies



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.

