

Madden-Julian Oscillation:

Recent Evolution, Current Status and Predictions



Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
11 July 2022

Overview

- What was robust MJO activity with clear eastward propagation last week has slowed down and weakened as the convective envelope moved over the Maritime Continent.
- A MJO enhanced phase over the Maritime Continent is constructively interfering well with La Niña conditions, and is likely contributing to an increase in the trade wind regime across the tropical Pacific.
- Dynamical model MJO index forecasts are mixed, with the GEFS depicting a weakening and incoherent MJO signal, while the ECMWF favors a re-emergence of MJO activity over Africa late in the forecast period.
- MJO activity over the Maritime Continent is typically associated with a reduction in tropical cyclone (TC) activity across both the East Pacific and Atlantic basins, although the East Pacific has nonetheless has seen continued TC activity.

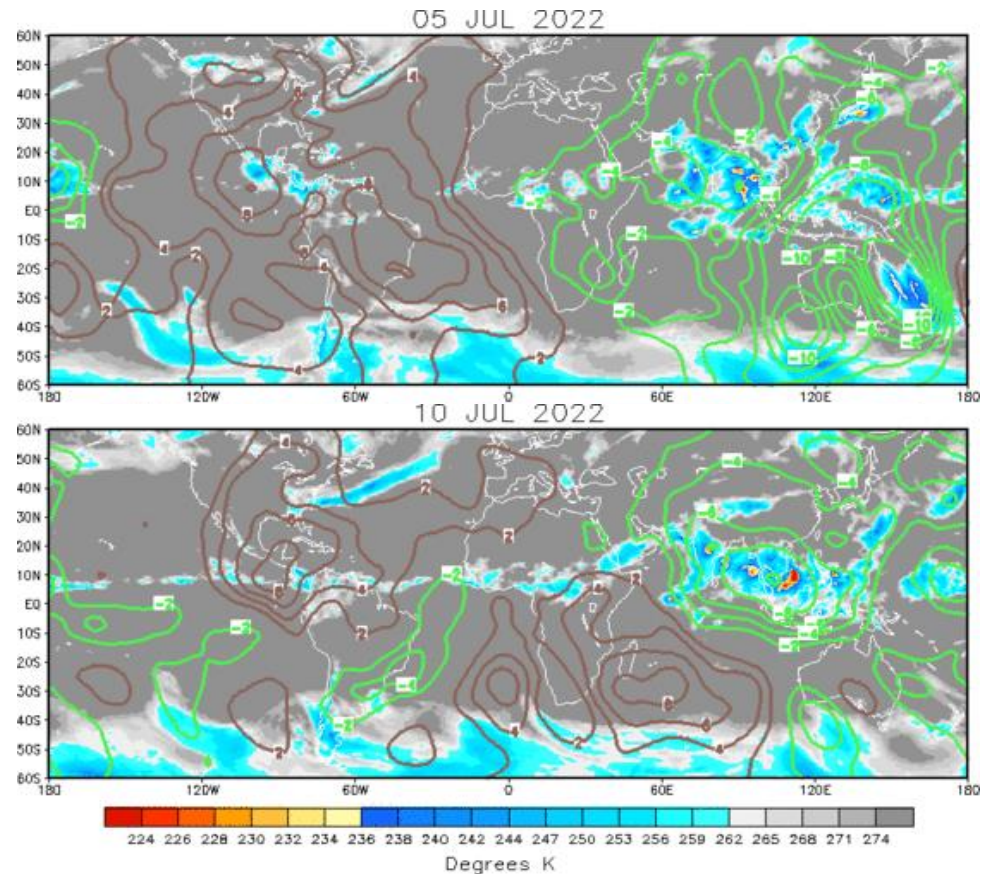
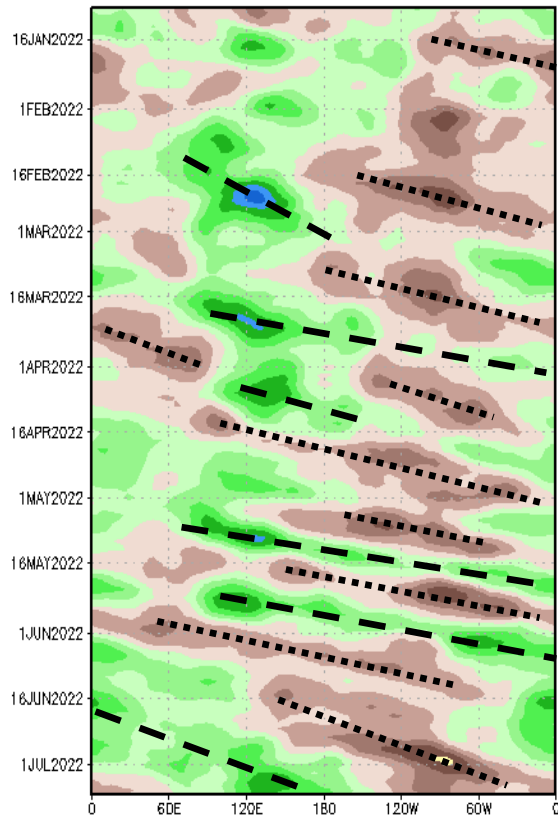
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

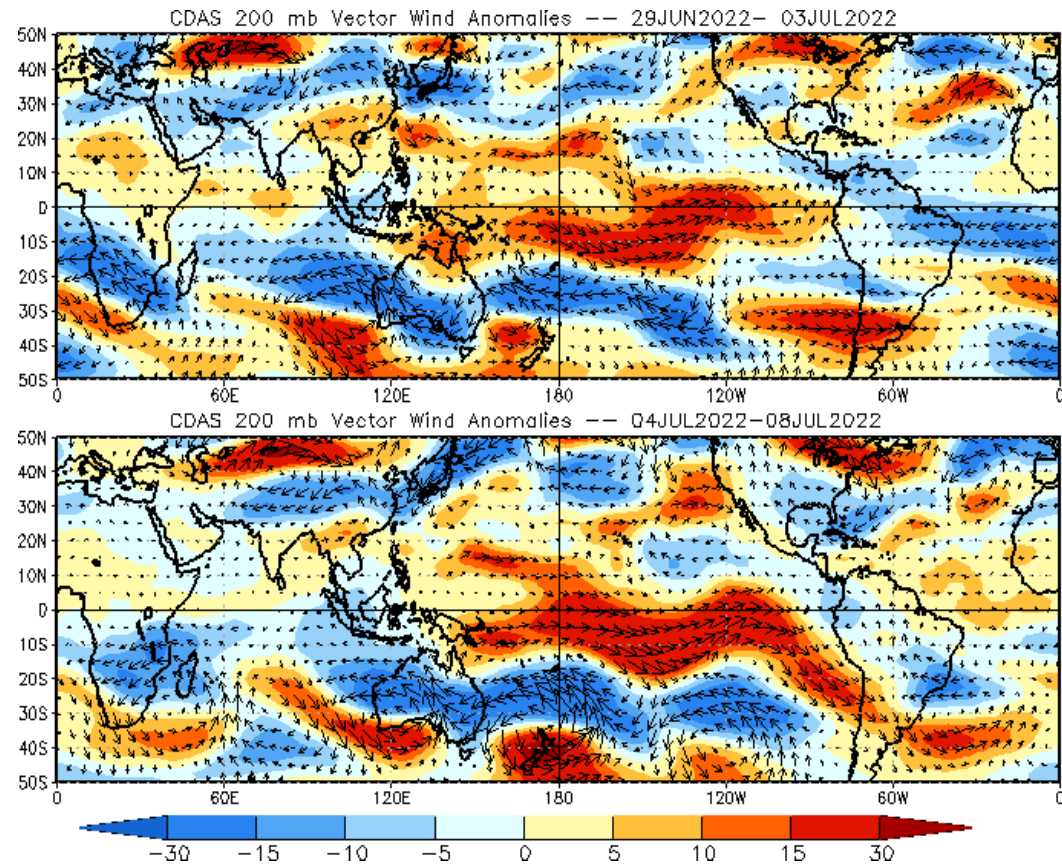
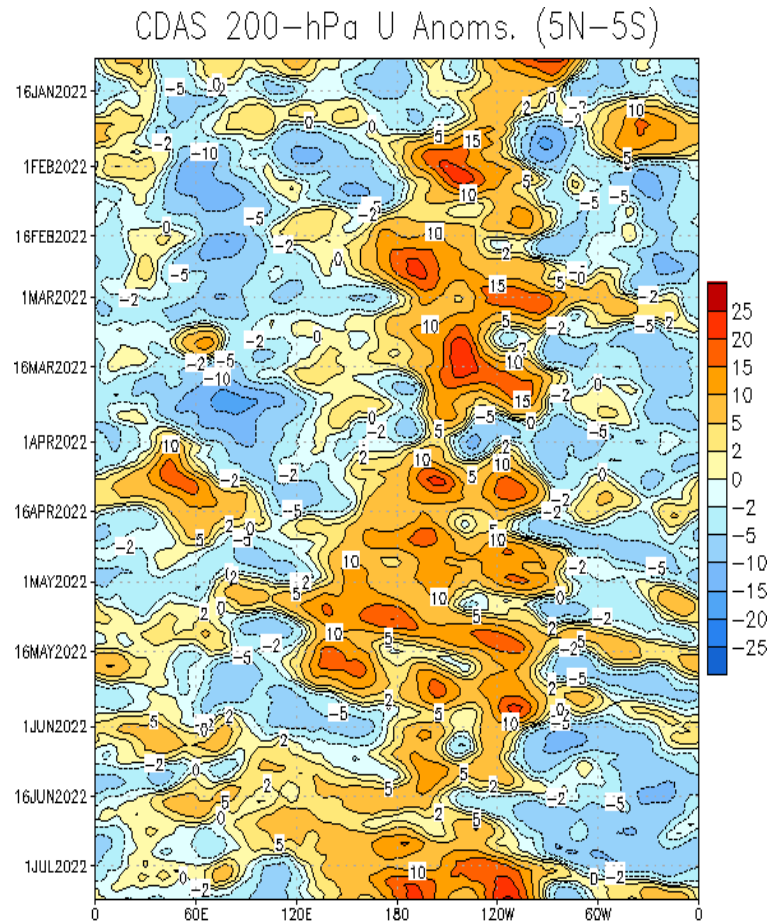
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- The second half of June saw a transition from a regime dominated by Kelvin wave activity to a slower phase speed of eastward propagation more reminiscent of MJO activity.
- Eastward propagation of the enhanced convective envelope continues, although the clear wave-1 pattern seen a week ago is becoming slightly less coherent.

200-hPa Wind Anomalies

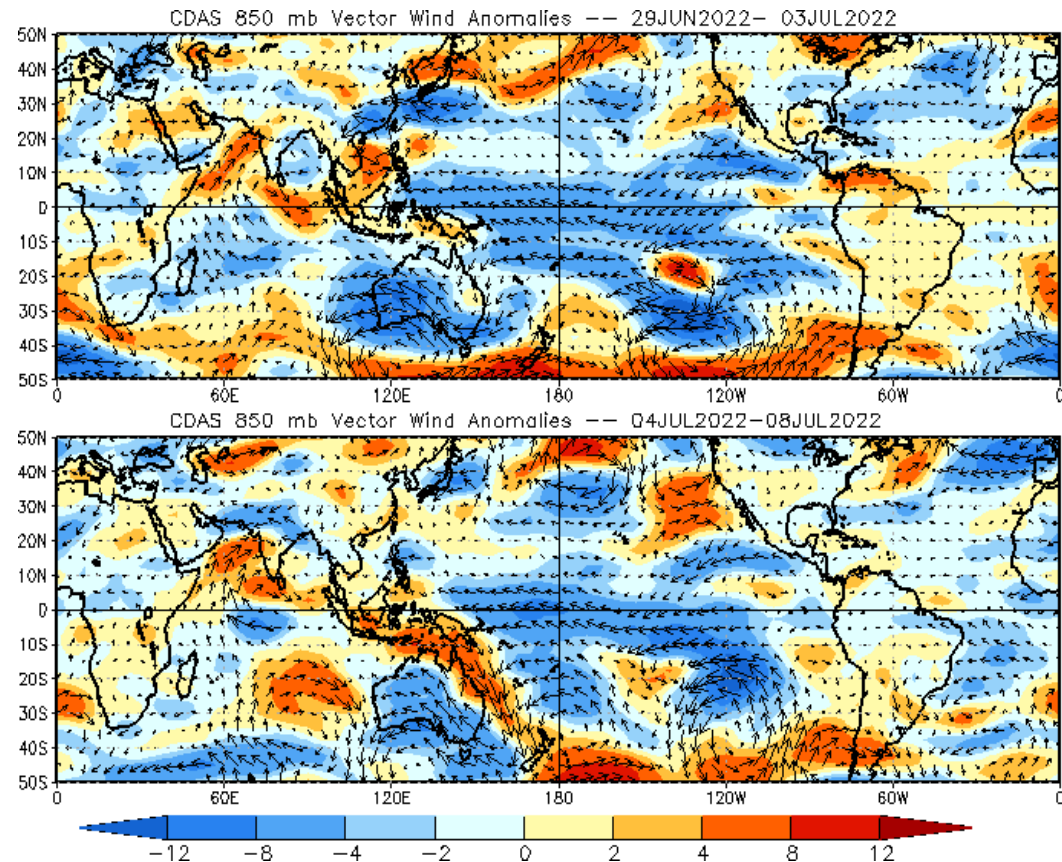
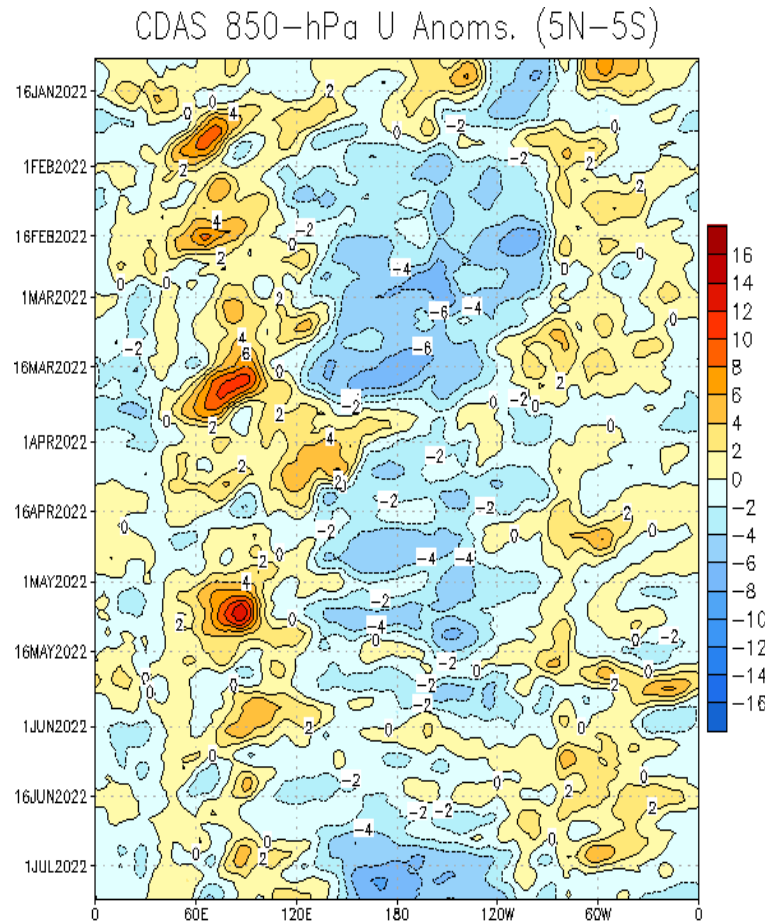
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Anomalous westerlies have strengthened considerably and shifted eastward in the last week, consistent with the recent robust MJO activity.
- Enhanced Walker circulation due to La Nina conditions is evident and currently constructively interfering with MJO.

850-hPa Wind Anomalies

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

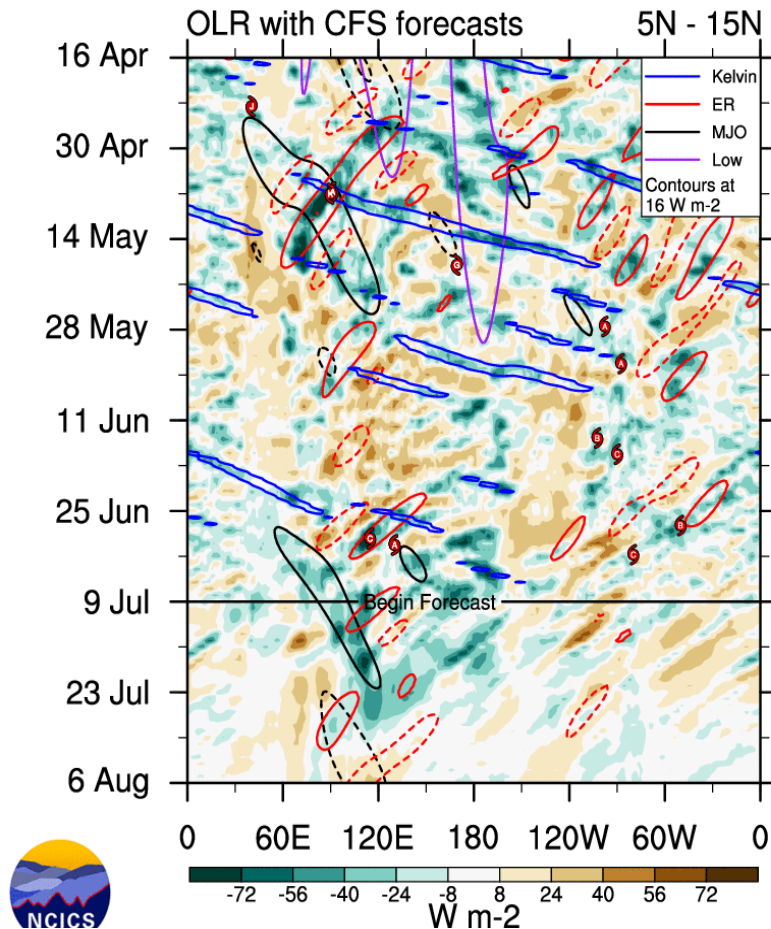


- Consistent with the idea of constructive interference between the MJO and ENSO, strongly enhanced trades have overspread almost the entire Pacific basin and have even intensified over the last week.
- Anomalous westerlies typically associated with MJO activity are not as noticeable as one might expect given the recent strong MJO signal.

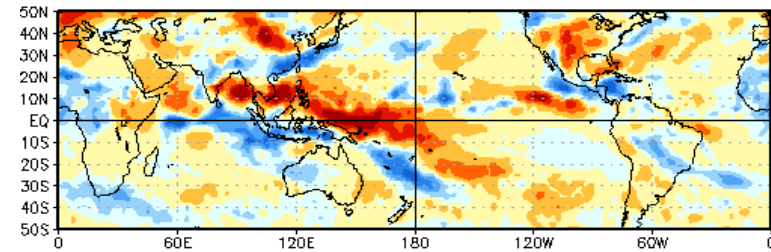
Outgoing Longwave Radiation (OLR) Anomalies

Green shades: Anomalous convection (wetness)

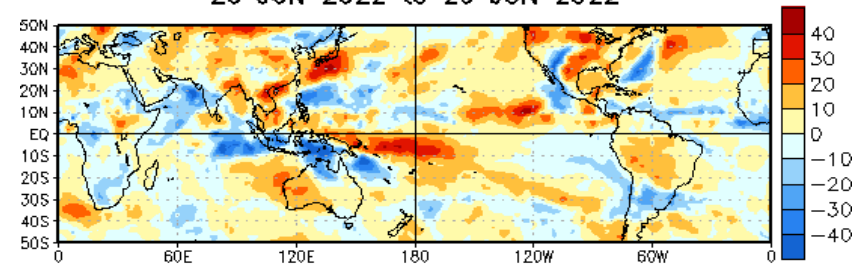
Brown shades: Anomalous subsidence (dryness)



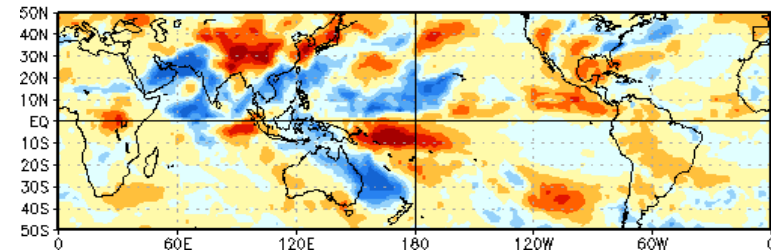
OLR Anomalies
10 JUN 2022 to 19 JUN 2022



20 JUN 2022 to 29 JUN 2022

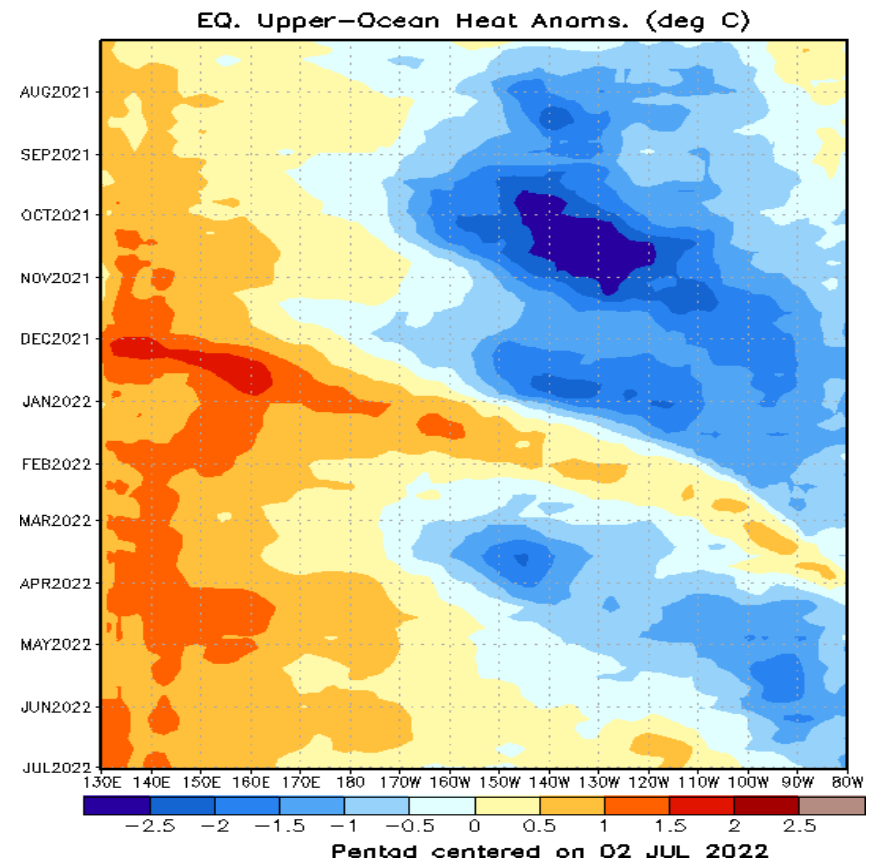
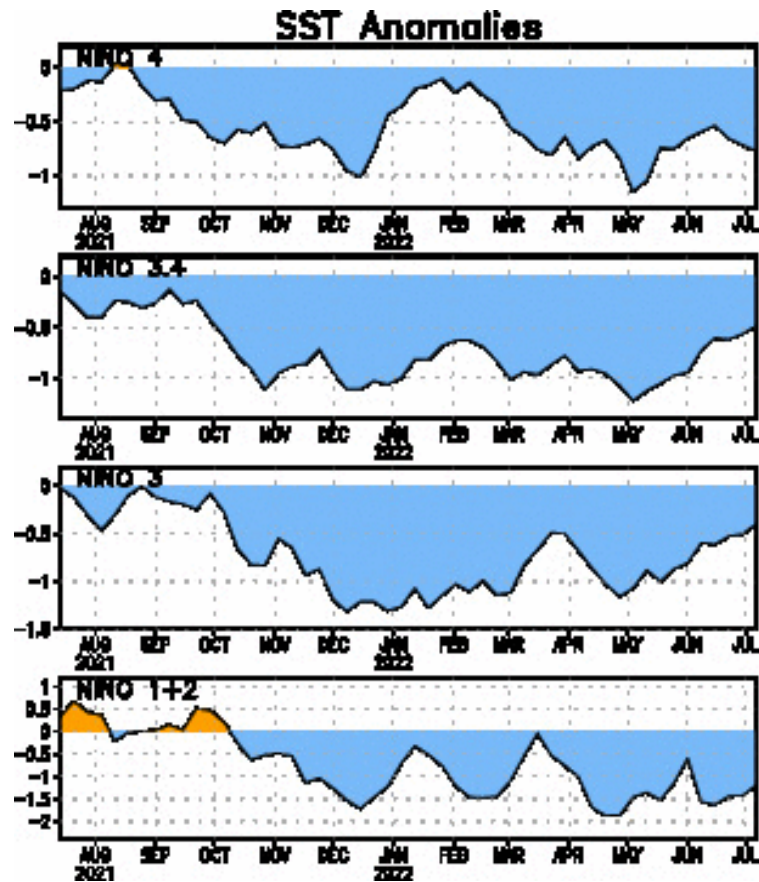


30 JUN 2022 to 9 JUL 2022



- Widespread suppressed convection along the equator west of the Date Line and into southeast Asia has diminished over the last month and is now shifted south of the Equator and much reduced in its westward extent.
- CFS forecasts indicate continued enhanced convection in the Maritime Continent and Western Pacific, with plentiful Rossby wave activity.

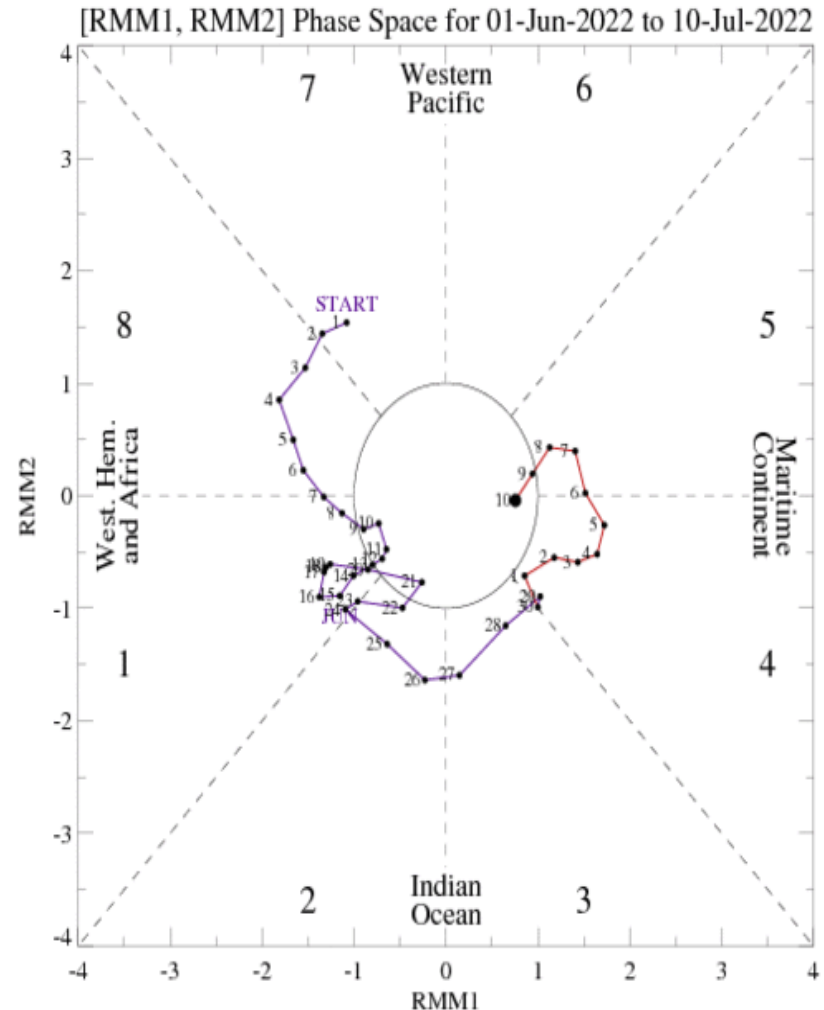
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Cold SST anomalies in the western Niño regions are becoming weaker, likely due to a downwelling Kelvin wave initiated by persistent robust Kelvin wave activity during May and early June.
- Strong trade winds are likely to increase upwelling, which in turn should weaken the positive upper-ocean heat anomalies brought about by the downwelling Kelvin wave.

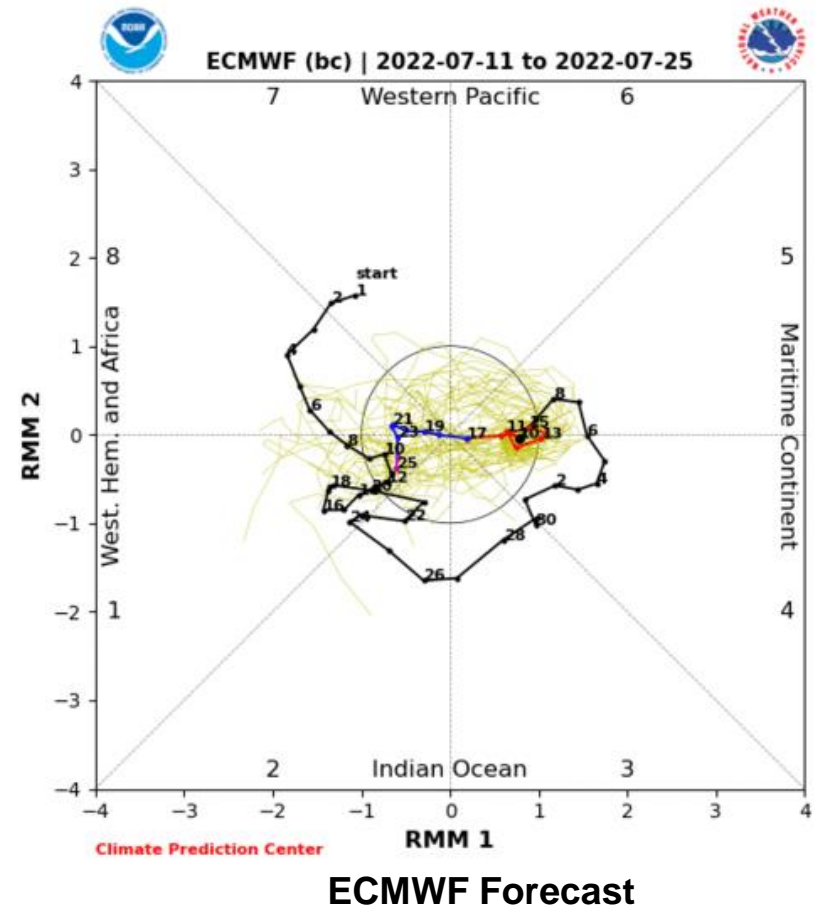
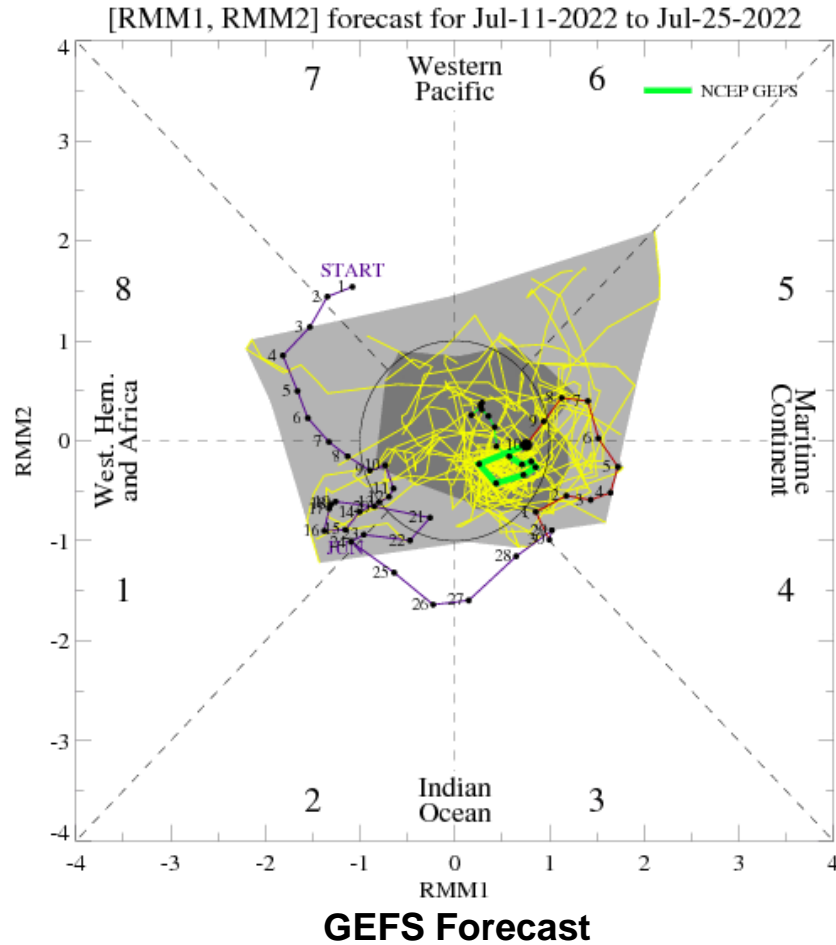
MJO Index: Recent Evolution

- Rapid eastward propagation of the RMM index started in late June but slowed down substantially and has stalled when the signal reached the Maritime Continent.
- Amplitude of the RMM signal has decreased as well, dropping into the unit circle in recent days.



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

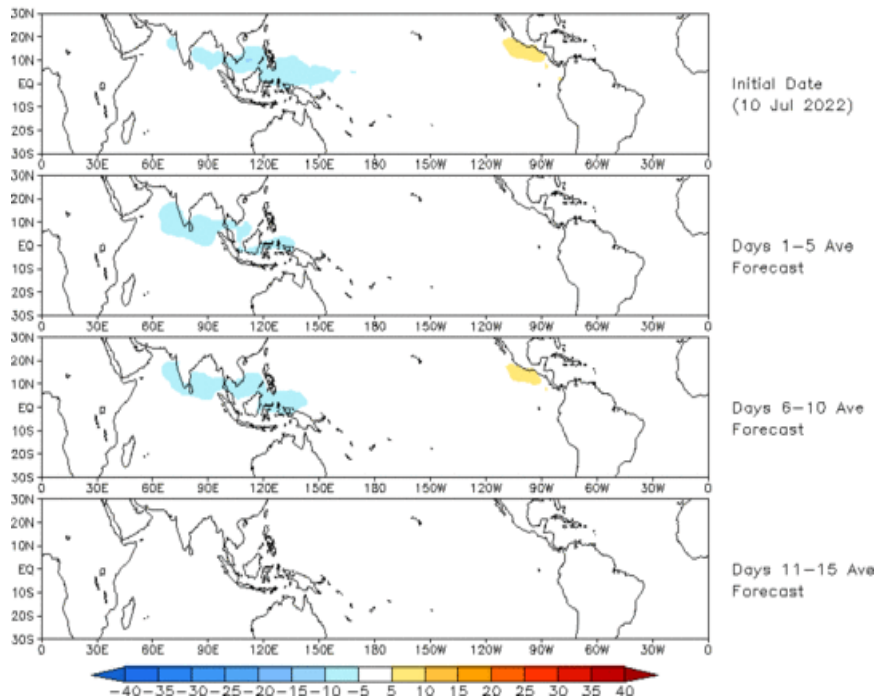


- The GEFS and ECMWF depict very different evolution of the MJO-based RMM index. GEFS ensemble members show a very wide spread, with the ensemble mean wandering around within the unit circle and eventually propagating eastward with very weak signal.
- ECMWF ensemble members are much more coherent, depicting a rapid weakening of the current MJO event, followed by a re-emergence of MJO activity over Africa during the week-2 period.

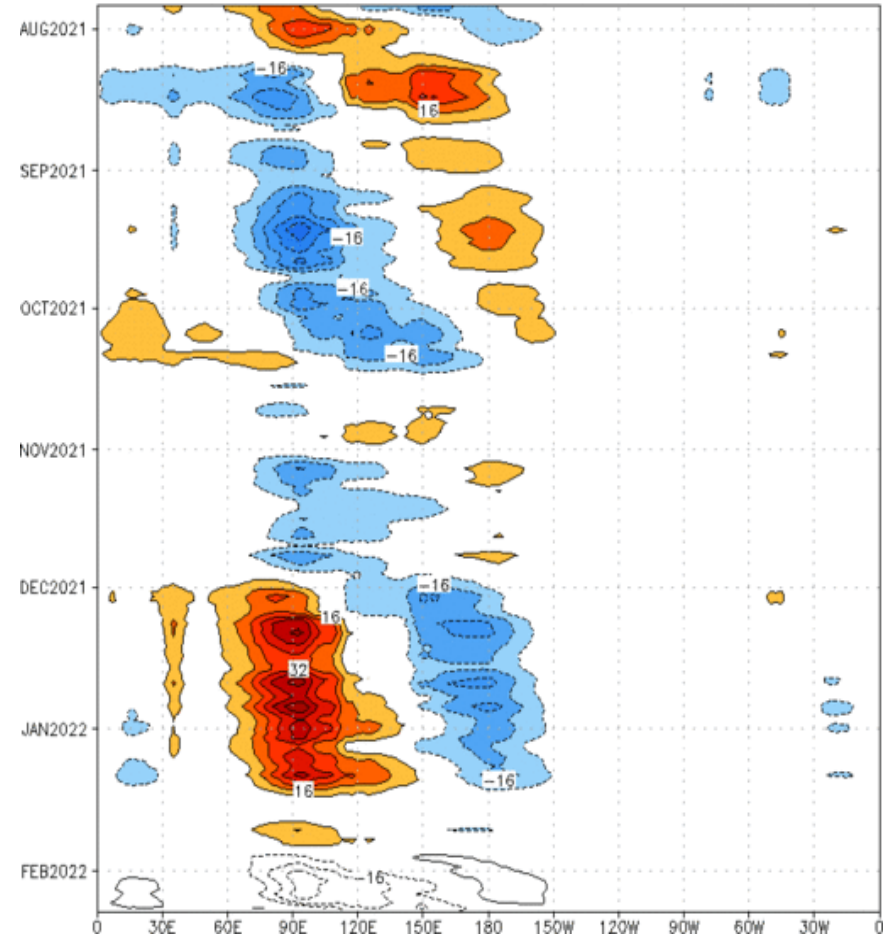
MJO: GEFS Forecast Evolution

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: 10 Jul 2022
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: 27-Jul-2021 to 26-Jan-2022
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

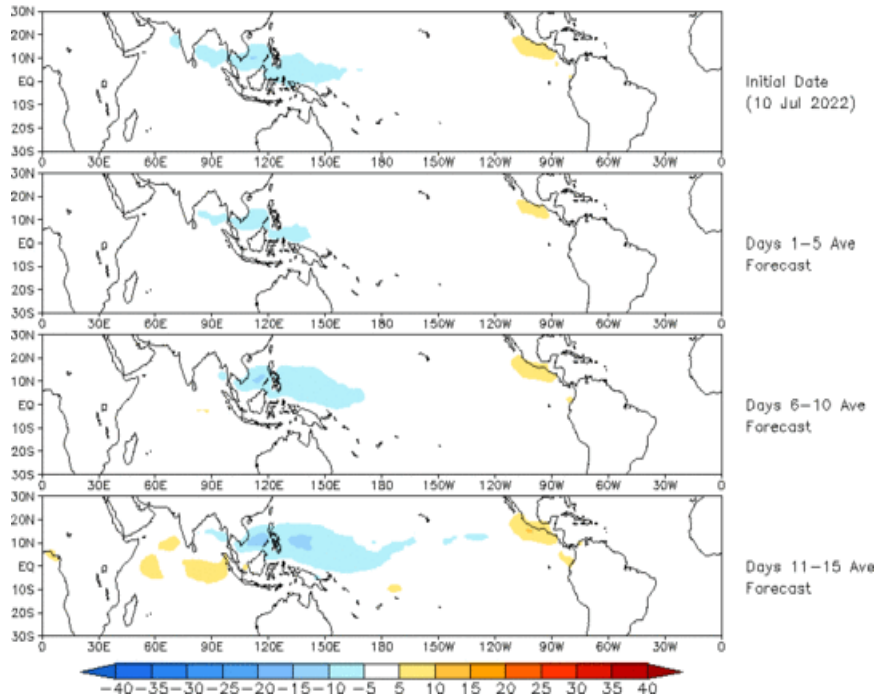


- The GEFS RMM-index based OLR anomaly field depicts a nearly stationary area of enhanced convection over the Indian Ocean and Maritime Continent that fades away in the week-2 time frame.

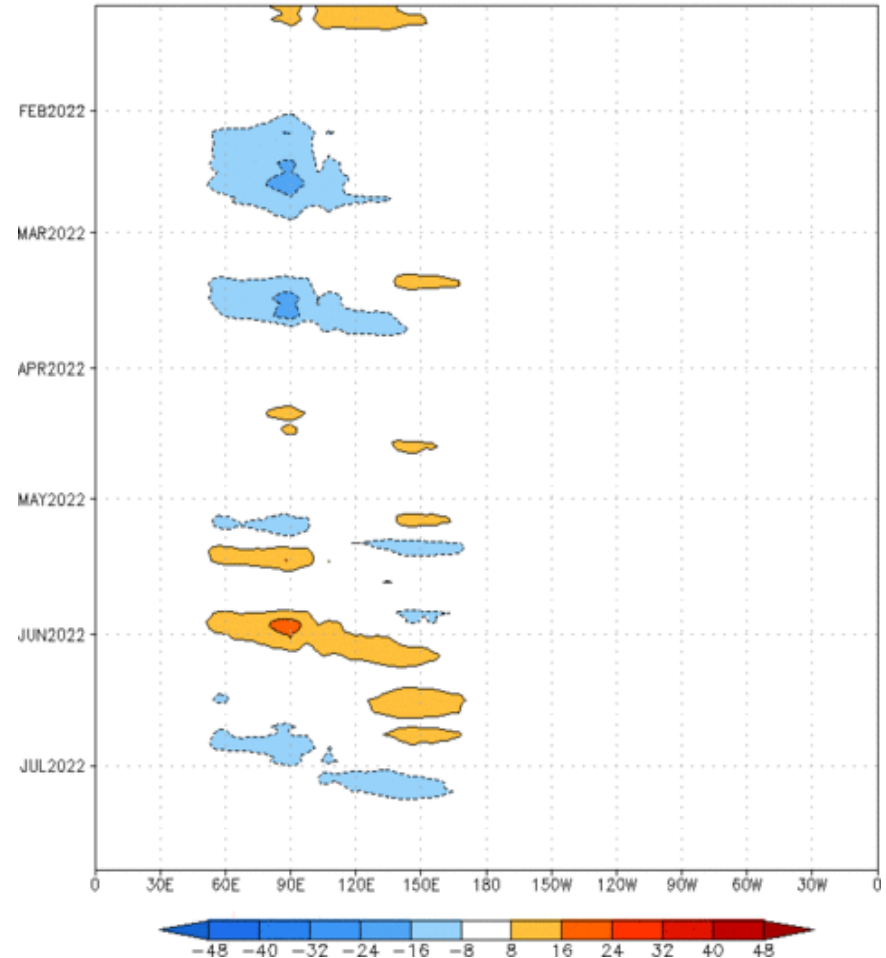
MJO: Constructed Analog Forecast Evolution

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 (10 Jul 2022)



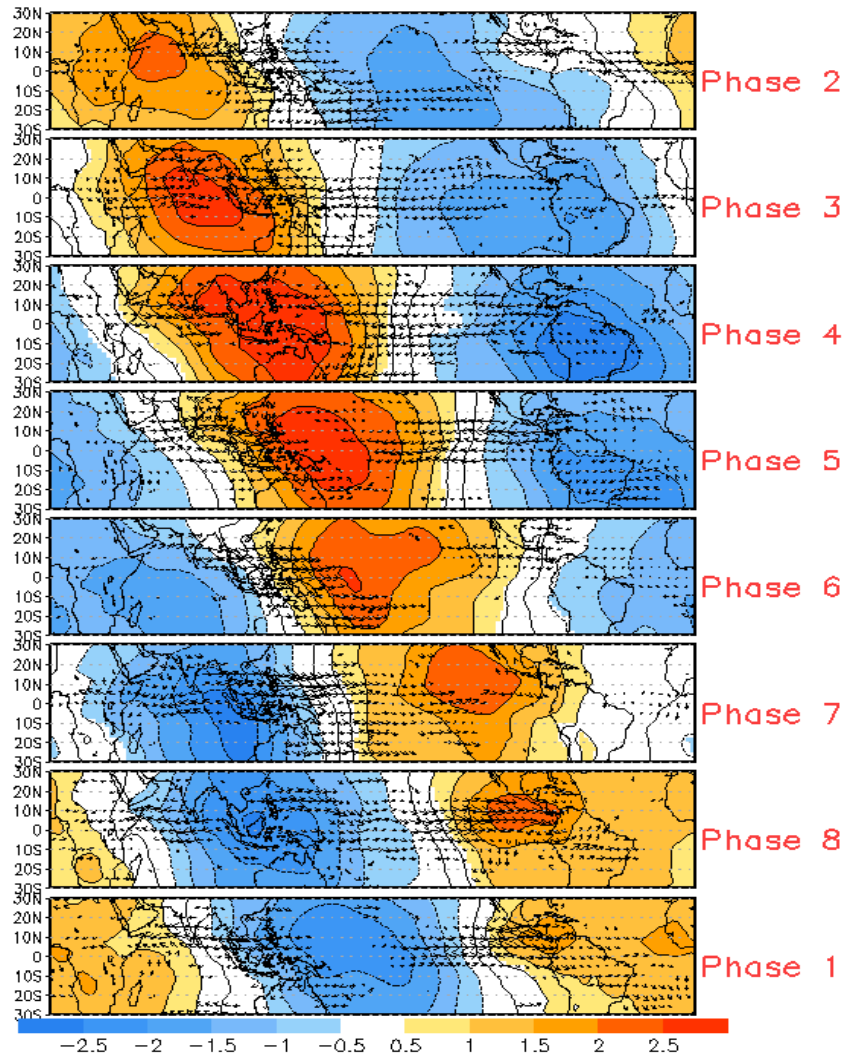
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S, 7.5°N] (cont: 4Wm⁻²) Period: 08-Jan-2022 to 10-Jul-2022
The unfilled contours are CA forecast reconstructed anomaly for 15 days



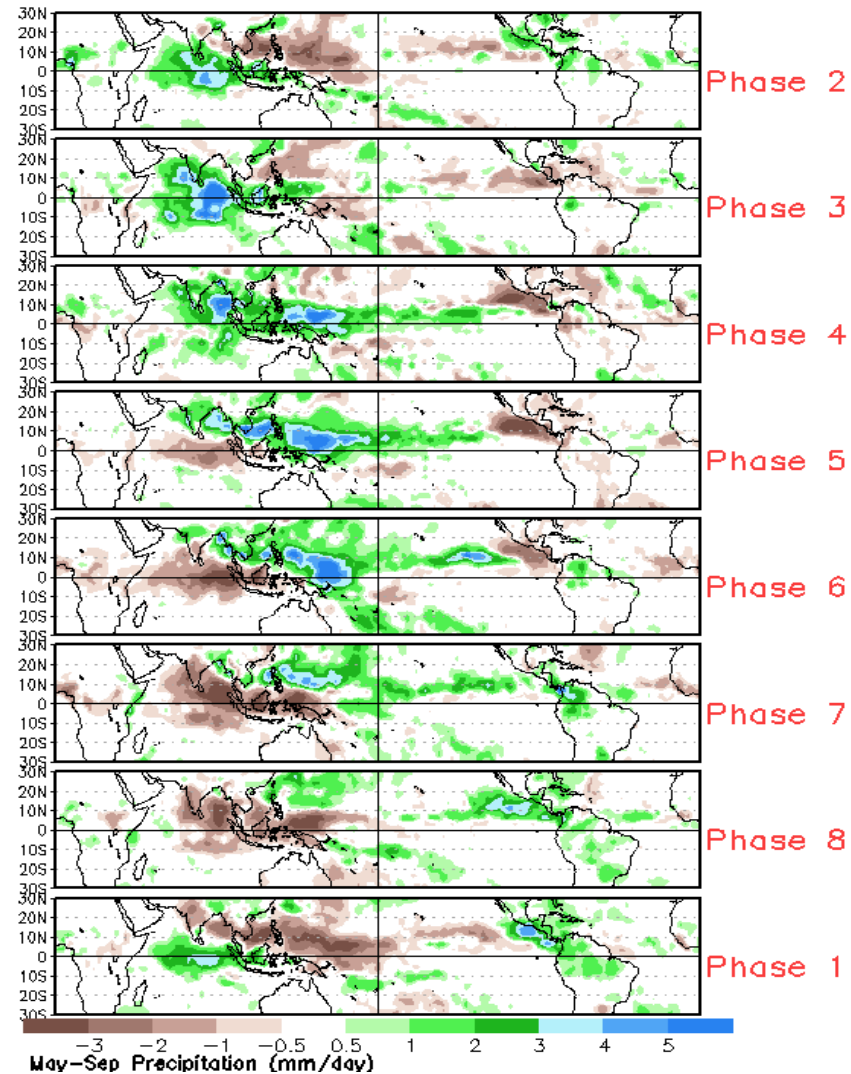
- The constructed analog forecast of RMM-based OLR anomalies suggests a more canonical progression of MJO activity, propagating enhanced convection eastward into the Western Pacific and bringing in suppressed convection into the Indian Ocean late in the forecast period.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and
Wind Anomalies



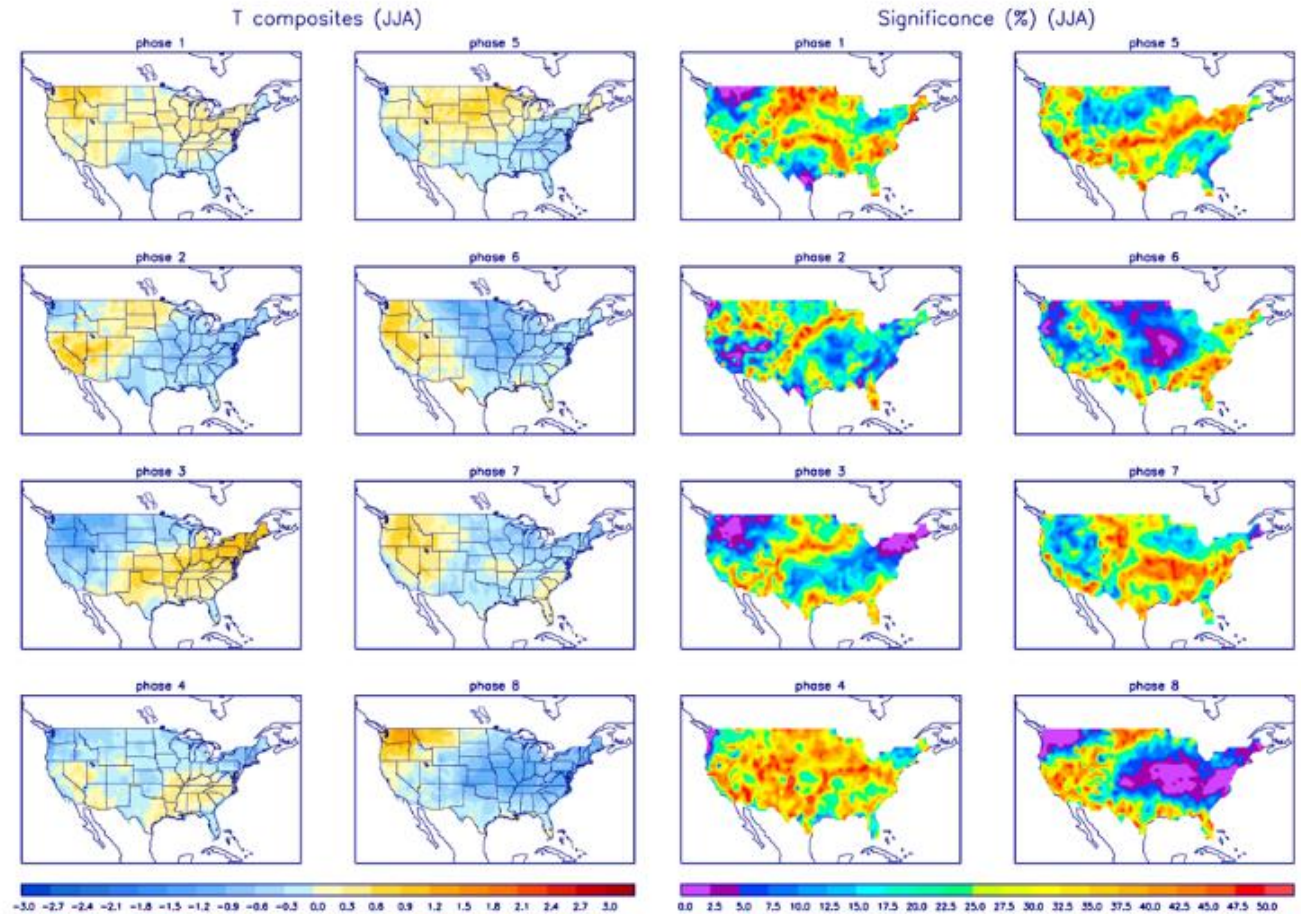
Precipitation Anomalies



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.

