

Madden-Julian Oscillation:

Recent Evolution, Current Status and Predictions



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

Overview

- The month of May begins with a strong MJO event crossing into the Indian Ocean.
- The MJO is likely to continue propagating eastward towards the Maritime Continent during the next two weeks.
 - Dynamical models are skeptical that the MJO will retain its amplitude as it crosses the Maritime Continent during late Week-2, but this skepticism is common and often misplaced.
 - Likely causes for this skepticism include a forecast equatorial Rossby wave whose suppressed phase may interfere with the MJO signal and the fact that the 120-mean is subtracted from RMM index values, which includes La Nina conditions from several months ago.
- Signs throughout the equatorial Pacific point to a rapidly developing ENSO-neutral situation.

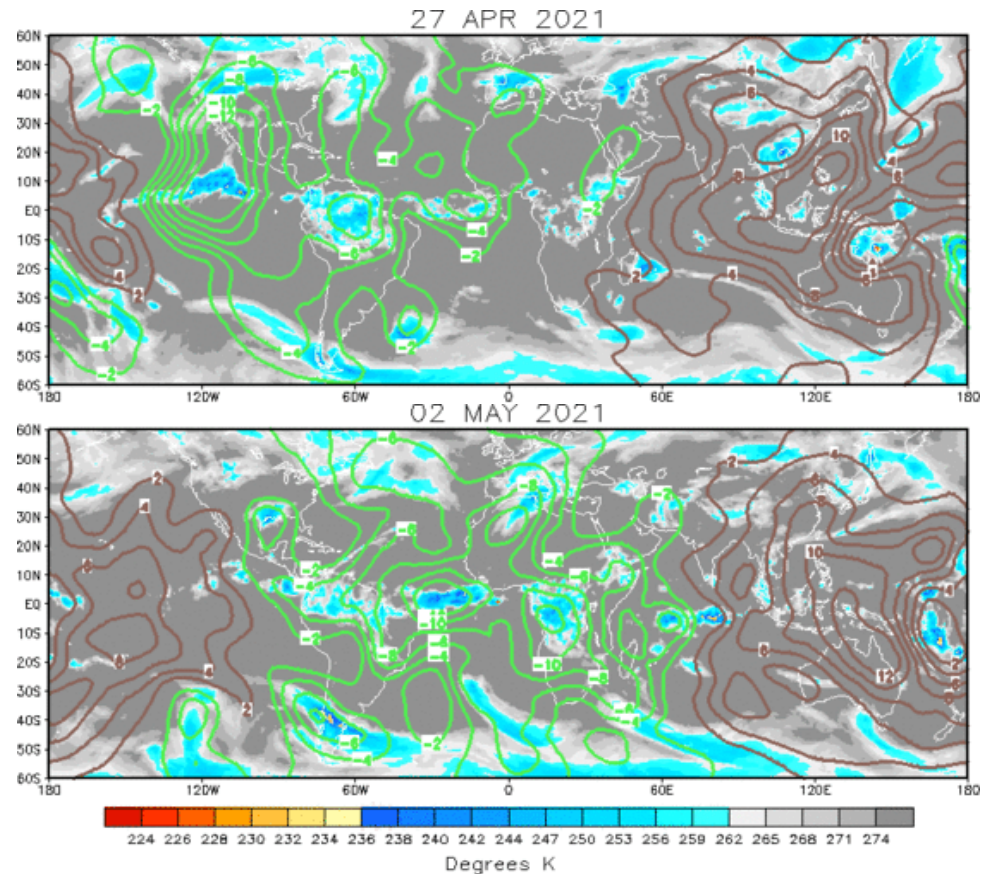
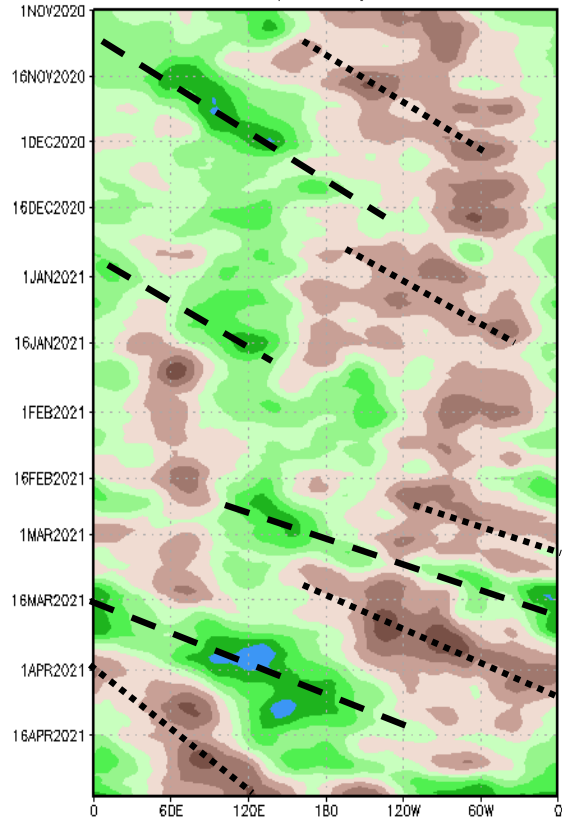
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation).

Brown shades: Anomalous convergence (unfavorable for precipitation).

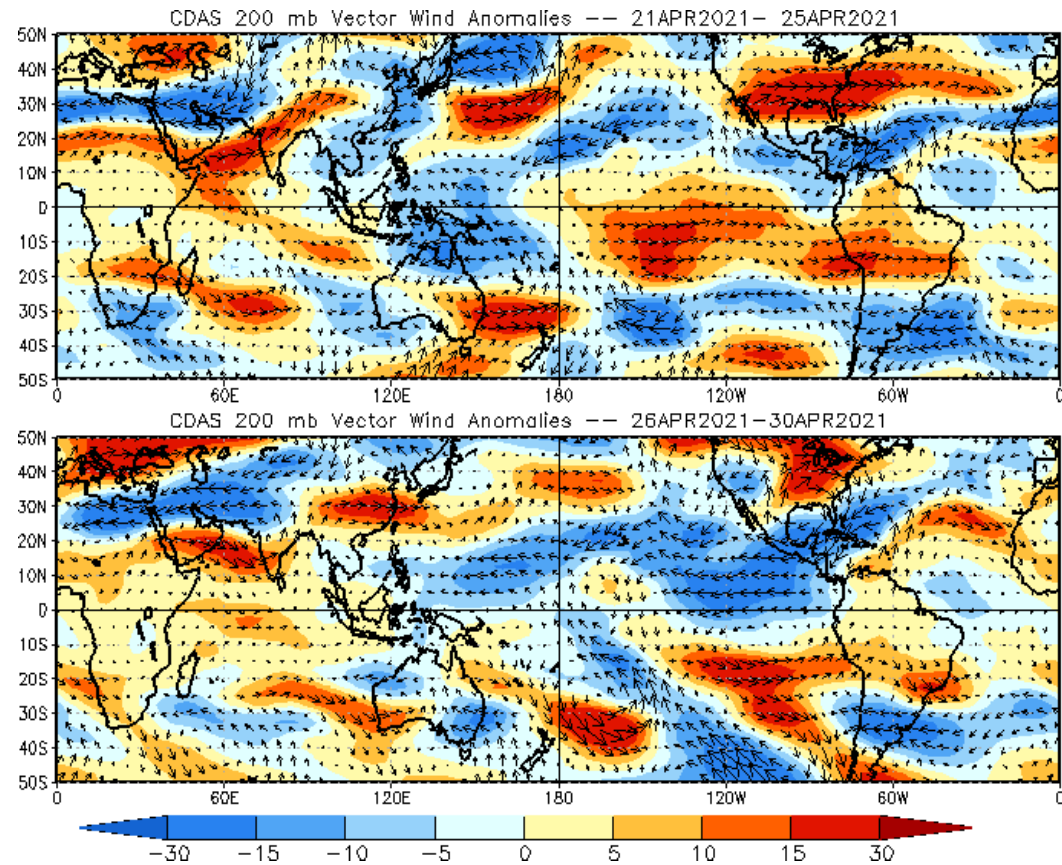
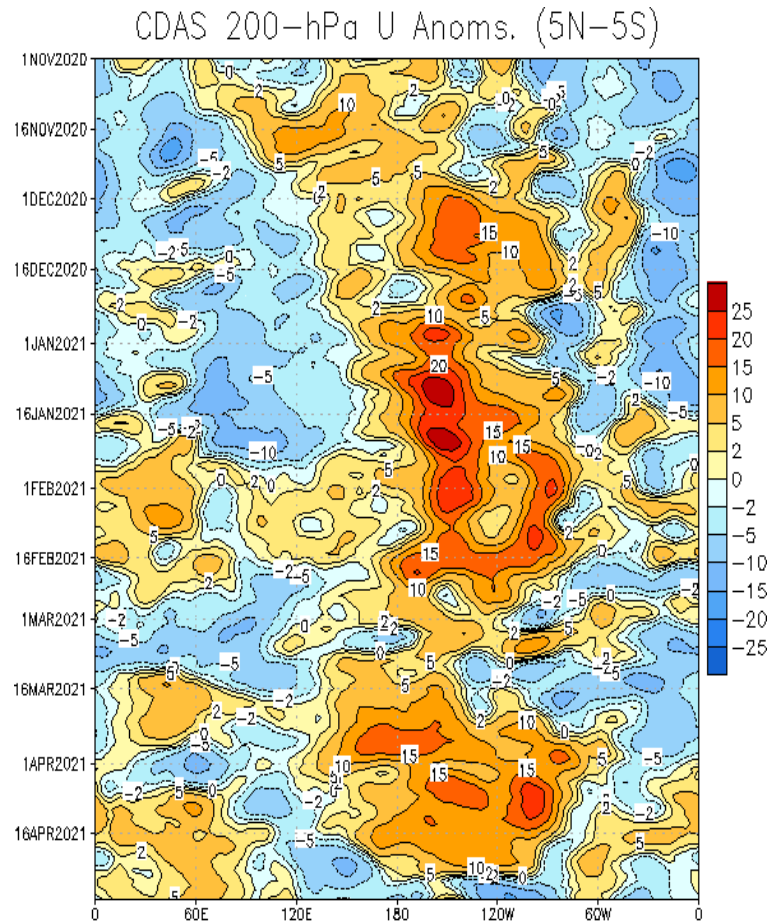
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- There is evidence of a strong MJO event crossing into the Indian Ocean in the velocity potential fields.
- The MJO is in RMM Phase 1 and is currently characterized by enhanced upper-level divergence extending from the Americas to the western Indian Ocean in a Wave-1 pattern.

200-hPa Wind Anomalies

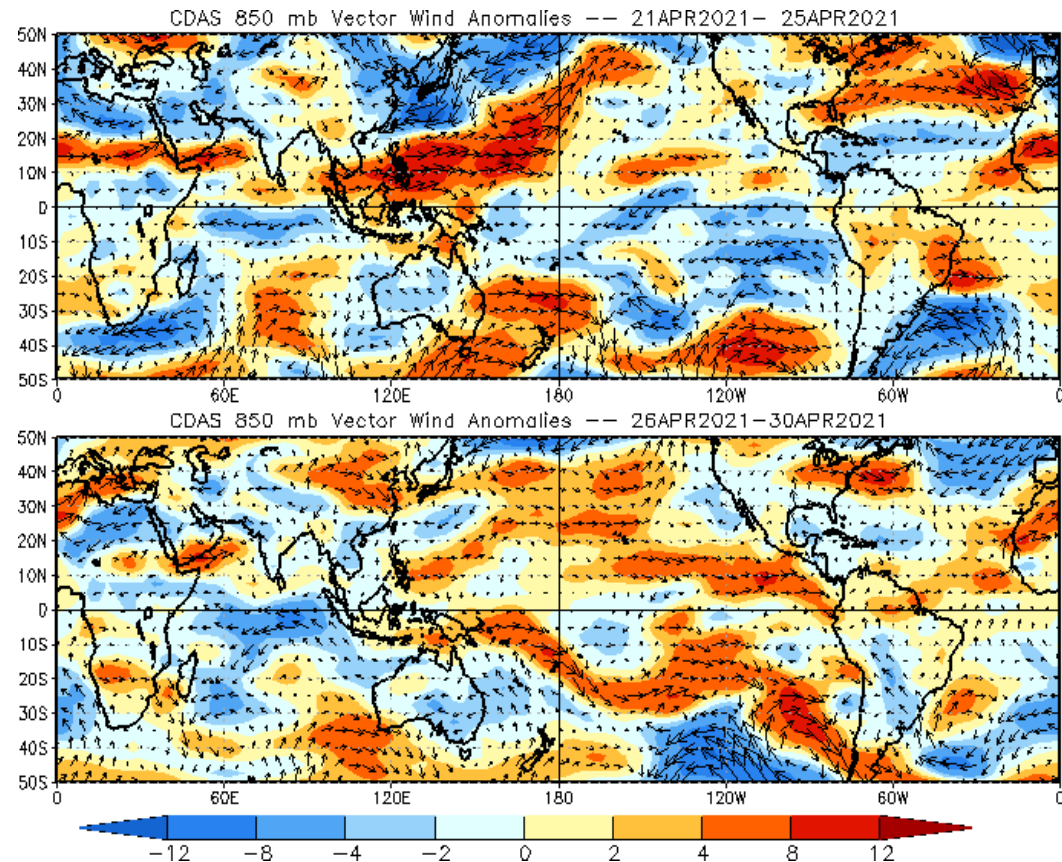
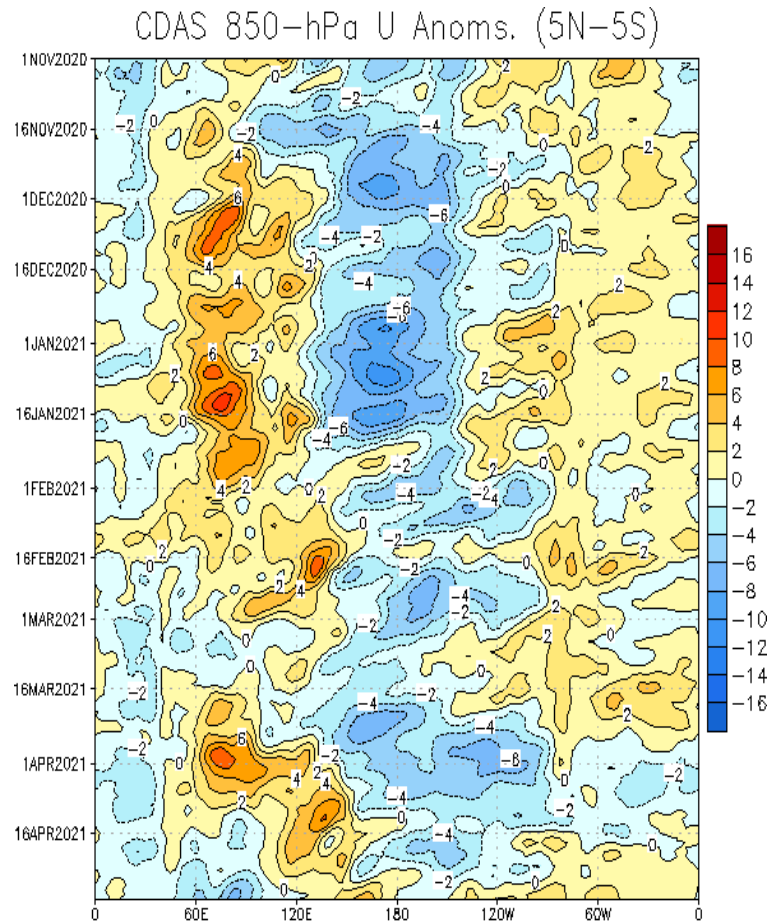
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Anomalous 200-hPa easterlies span the Pacific just north of the Equator. This structure is inconsistent with a La Niña and the weaker anomalies during the latest pentad compared to the previous pentad are indicative of the transition towards ENSO-neutral conditions.

850-hPa Wind Anomalies

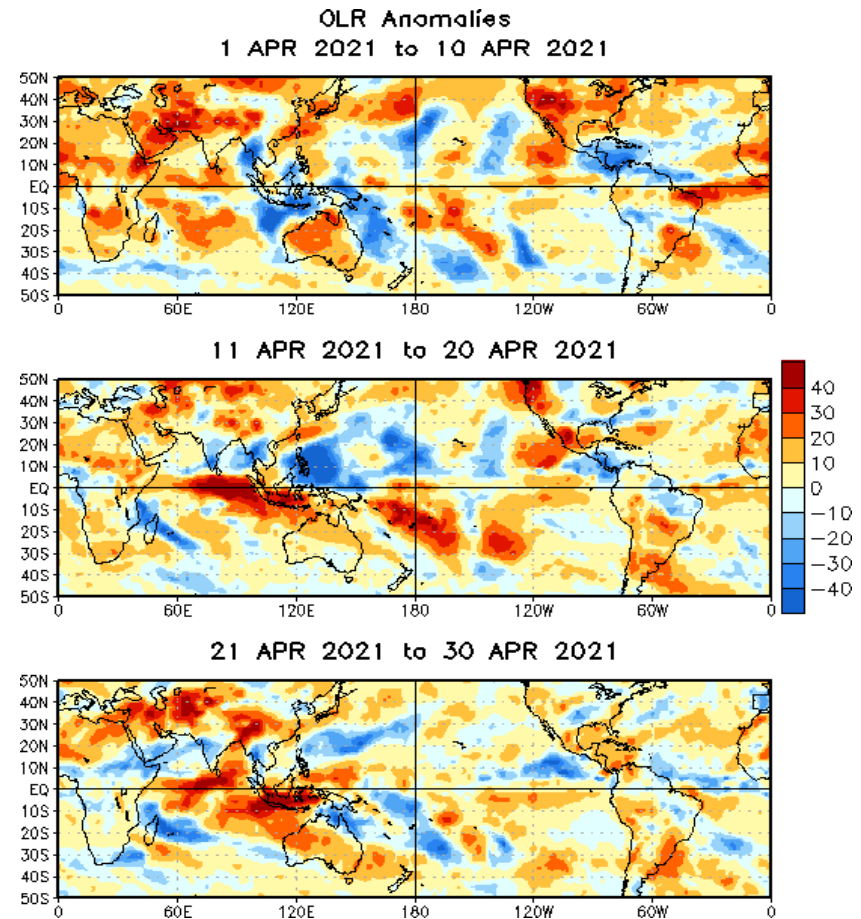
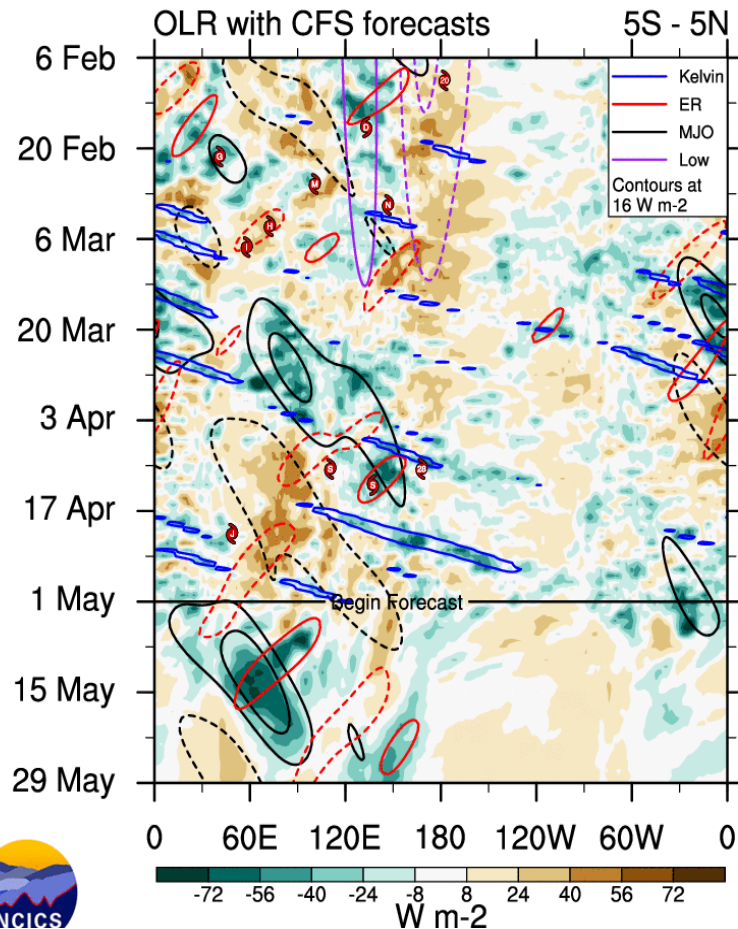
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Similar to the upper-level circulation, 850-hPa wind anomalies are weak across the equatorial Pacific, consistent with a transition to ENSO-neutral conditions.

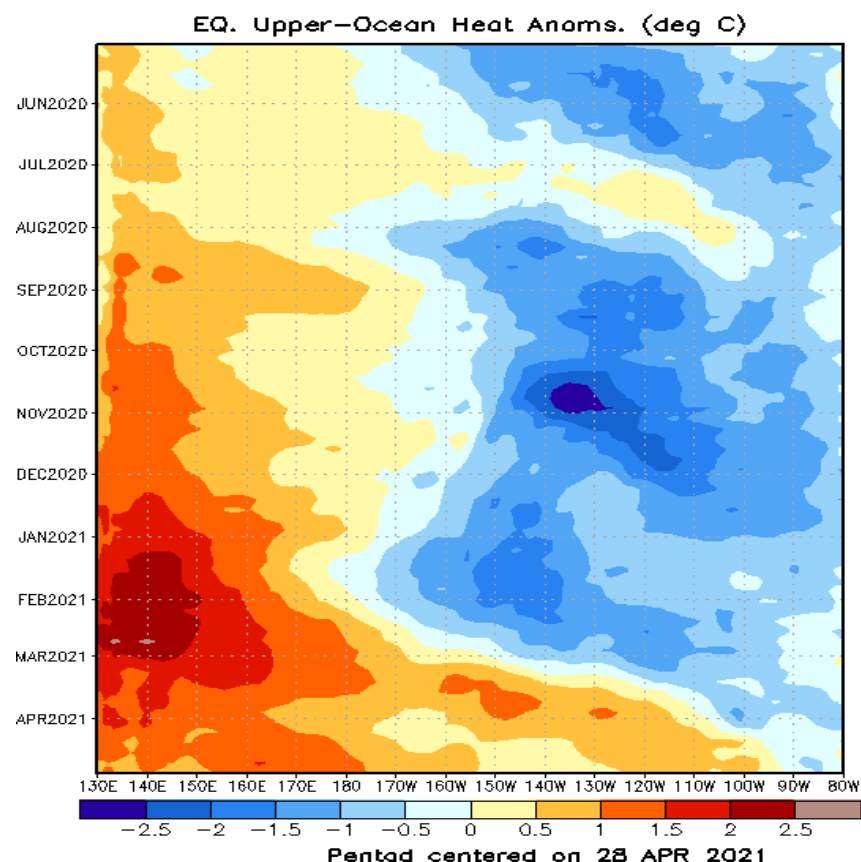
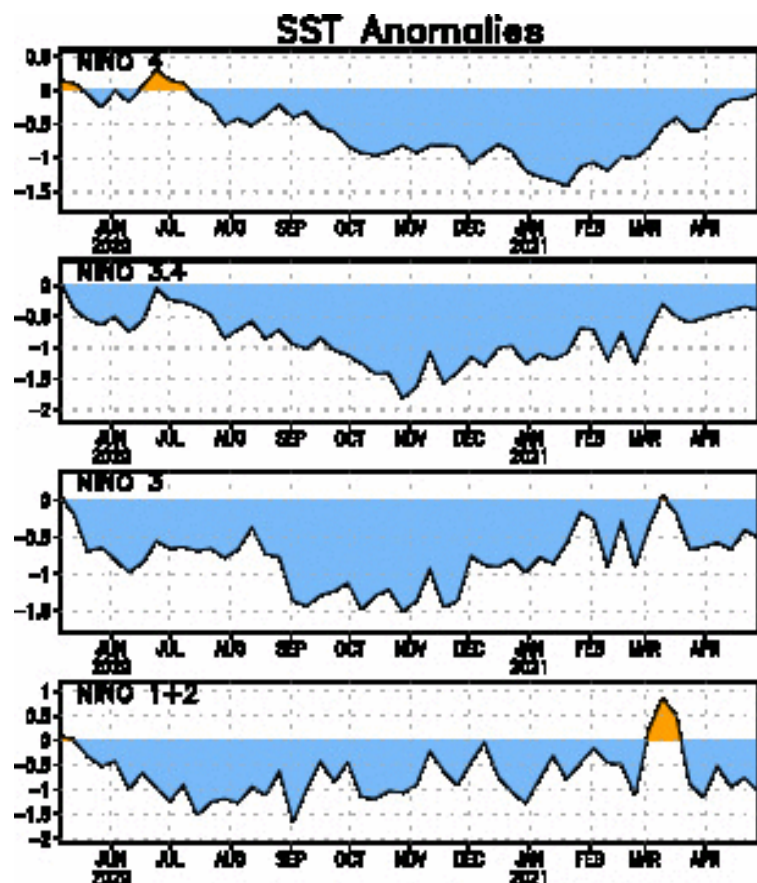
Outgoing Longwave Radiation (OLR) Anomalies

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



- There was little evidence of enhanced convection over the Indian Ocean during the previous week, consistent with the MJO propagating through RMM Phases 7-8.
- The CFS forecasts MJO, Kelvin, and equatorial Rossby wave activity across the Eastern Hemisphere during the next week.

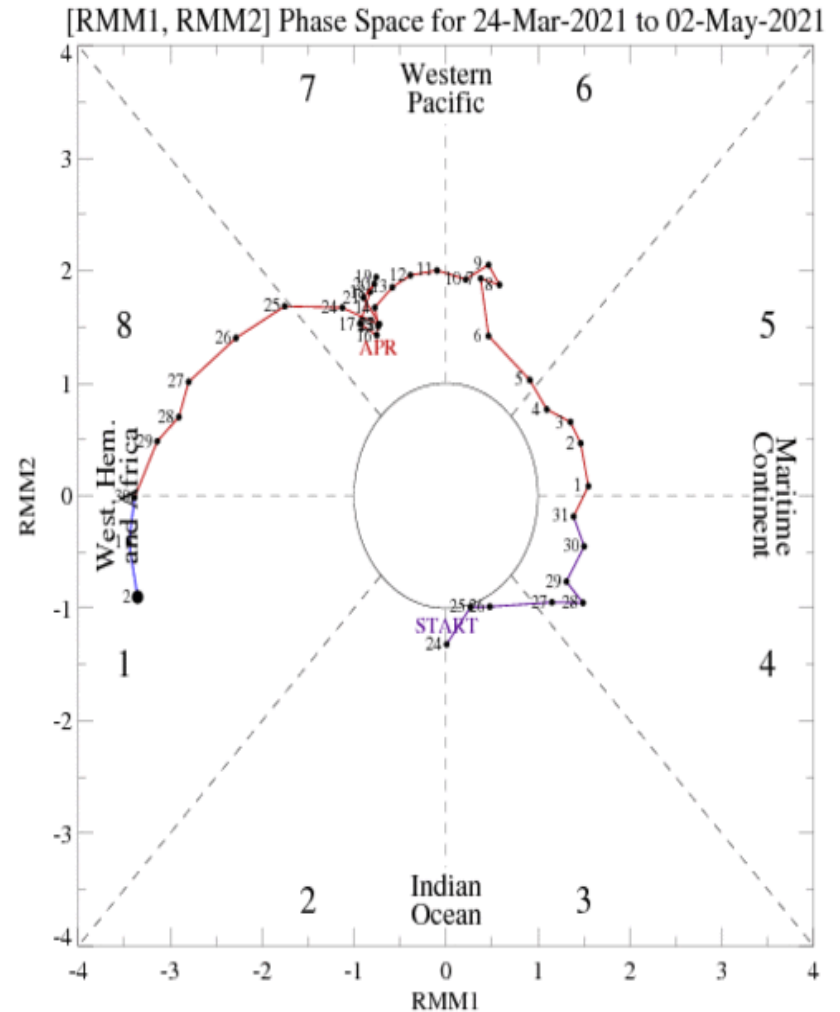
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- La Niña conditions have been present since August 2020. Negative SST anomalies in the Niño 4 region have steadily weakened since January.
- Strong Rossby wave activity over the West Pacific in February generated a westerly wind burst that initiated a downwelling oceanic Kelvin wave. This Kelvin wave pushed warmer water within the upper-ocean across the Central and East Pacific. Similarly, another wave may be ongoing near the Date Line.

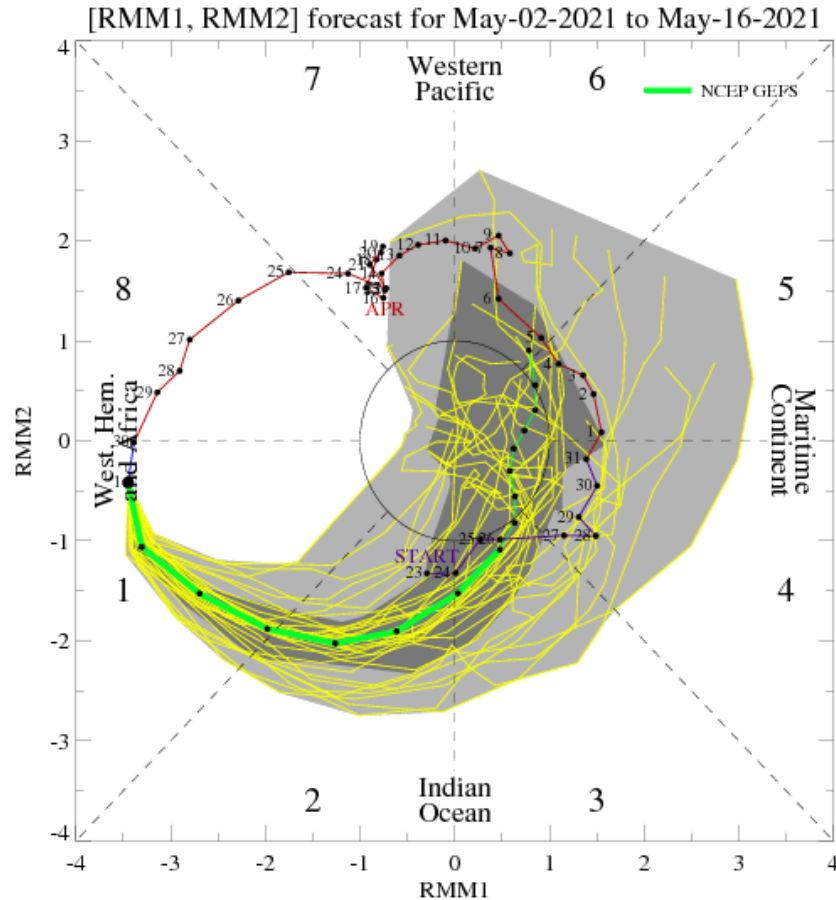
MJO Index: Recent Evolution

- The MJO is in RMM Phase 1, shifting from Africa to the Indian Ocean. Its amplitude is especially strong and will likely remain strong during the next week.

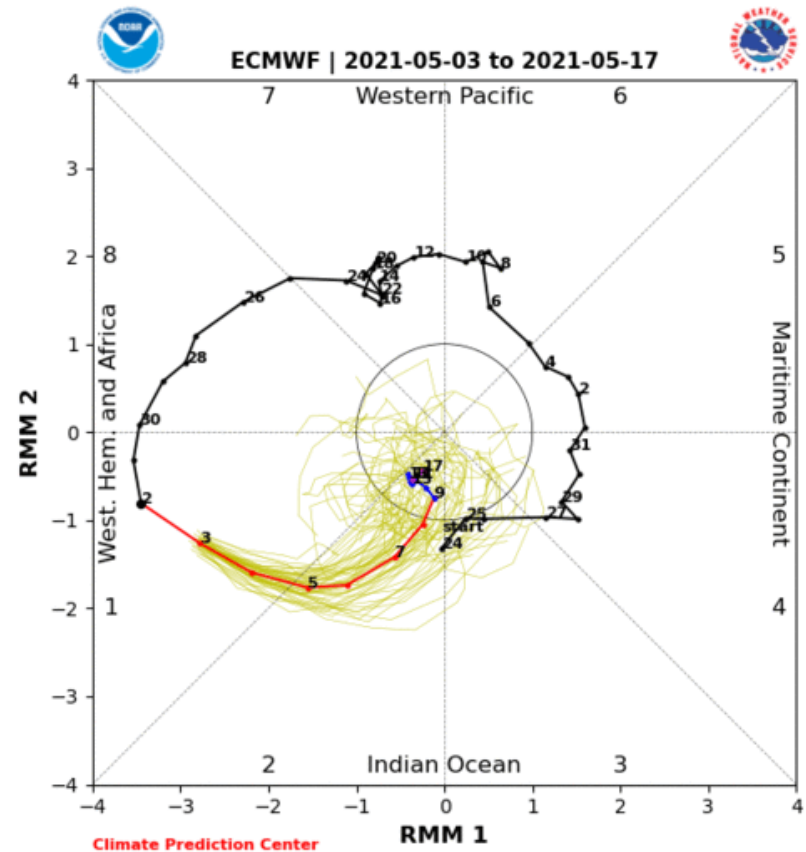


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



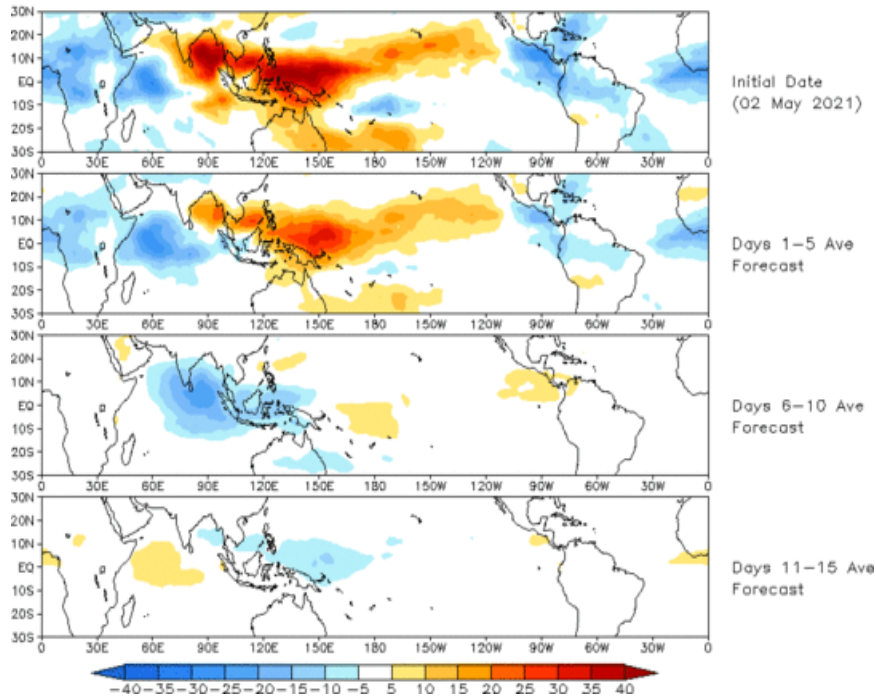
ECMWF Forecast

- The GEFS and ECMWF both forecast the MJO to propagate over the Indian Ocean during the next couple of weeks.
- Both models forecast the MJO to weaken as it shifts from the Indian Ocean to the Maritime Continent.
 - This is often incorrectly forecast because the models have difficulty propagating the MJO over the islands throughout the Maritime Continent.

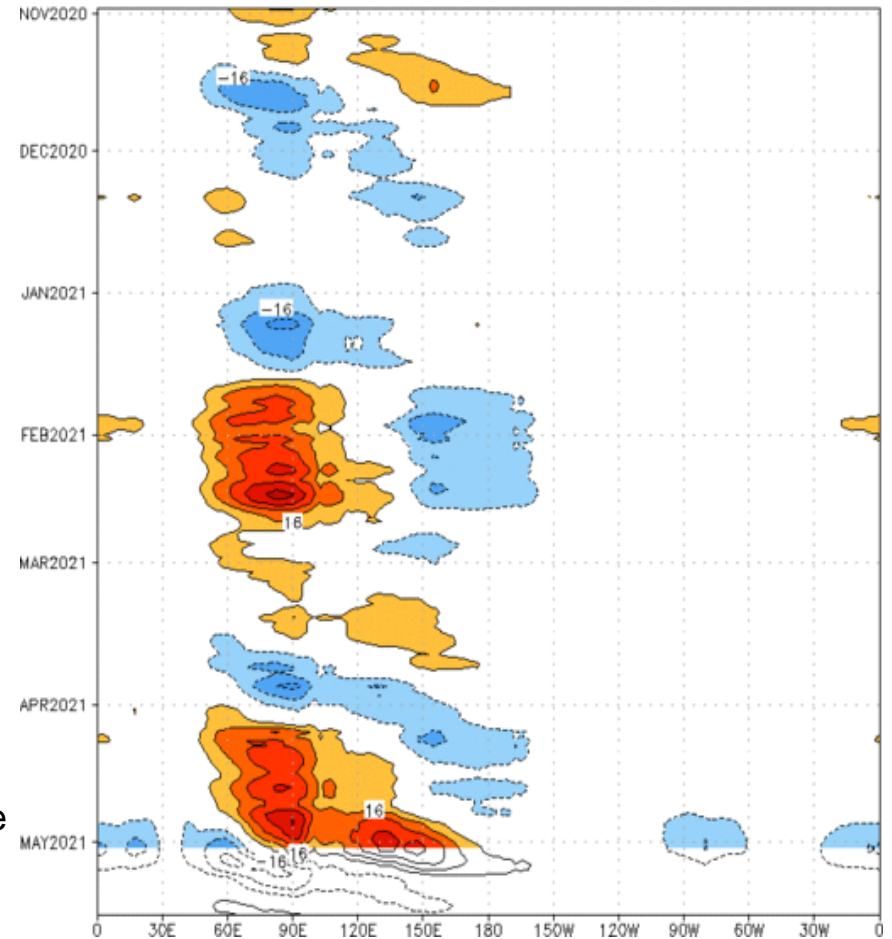
MJO: GEFS Forecast Evolution

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: 02 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: 31–Oct–2020 to 02–May–2021
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

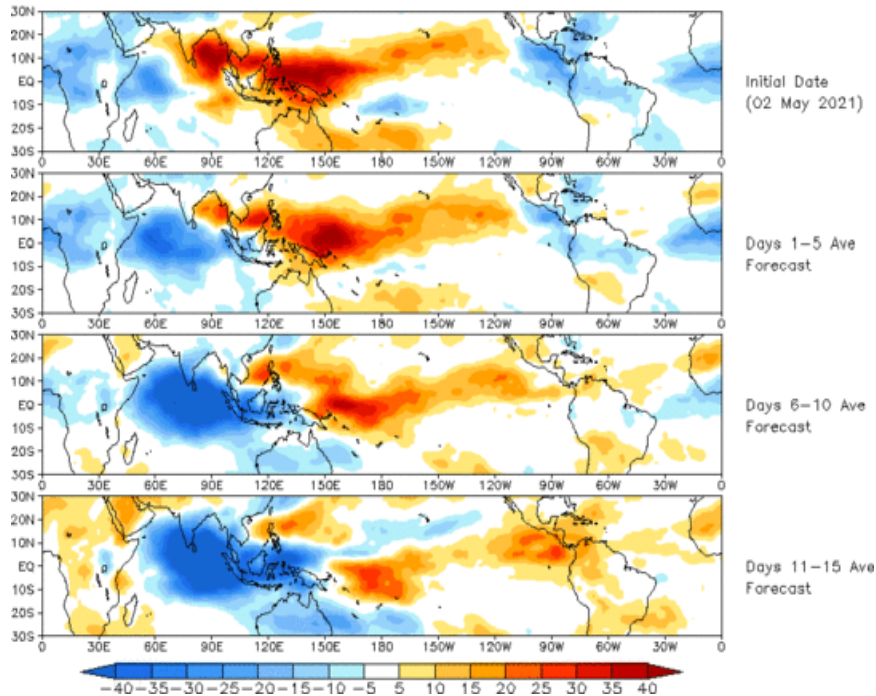


- As with the RMM index, the spatial maps of the GEFS show that the MJO has difficulty crossing the islands of Indonesia.

MJO: Constructed Analog Forecast Evolution

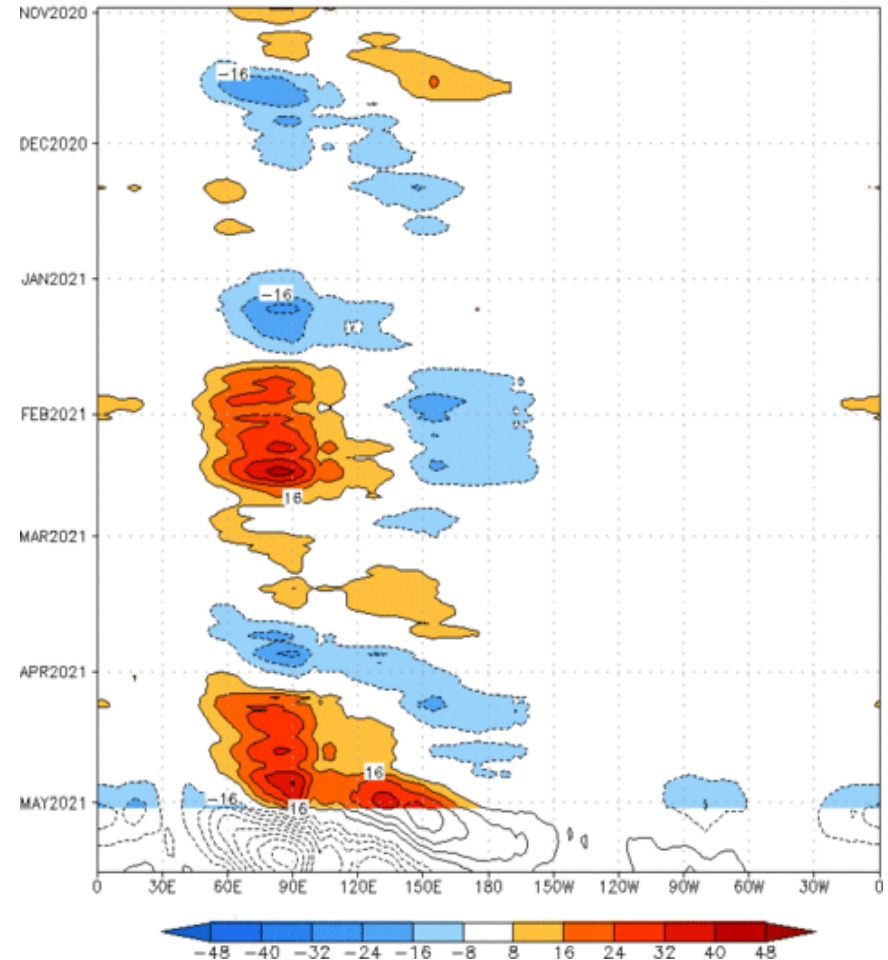
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

OLR prediction of MJO-related anomalies using CA model reconstruction by RMM1 & RMM2 (02 May 2021)



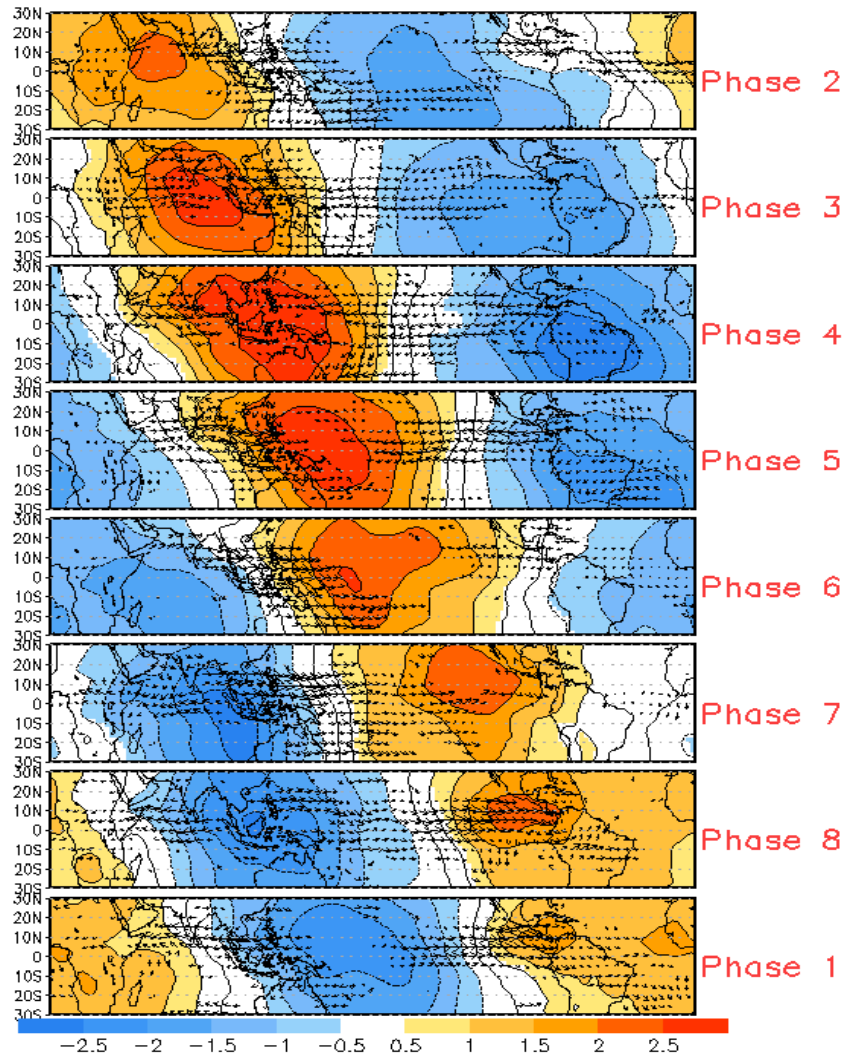
- The constructed analog shows a strong MJO propagating more slowly than the dynamical models.

Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:31-Oct-2020 to 02-May-2021
The unfilled contours are CA forecast reconstructed anomaly for 15 days

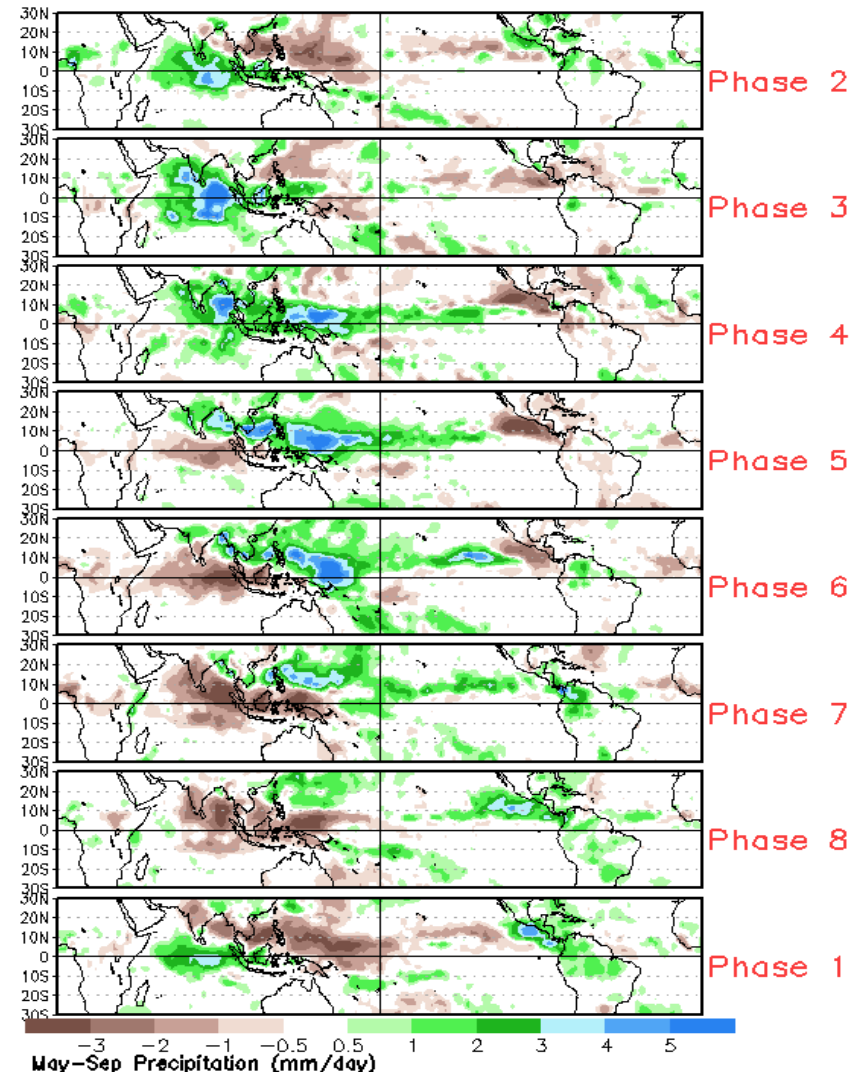


MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and
Wind Anomalies



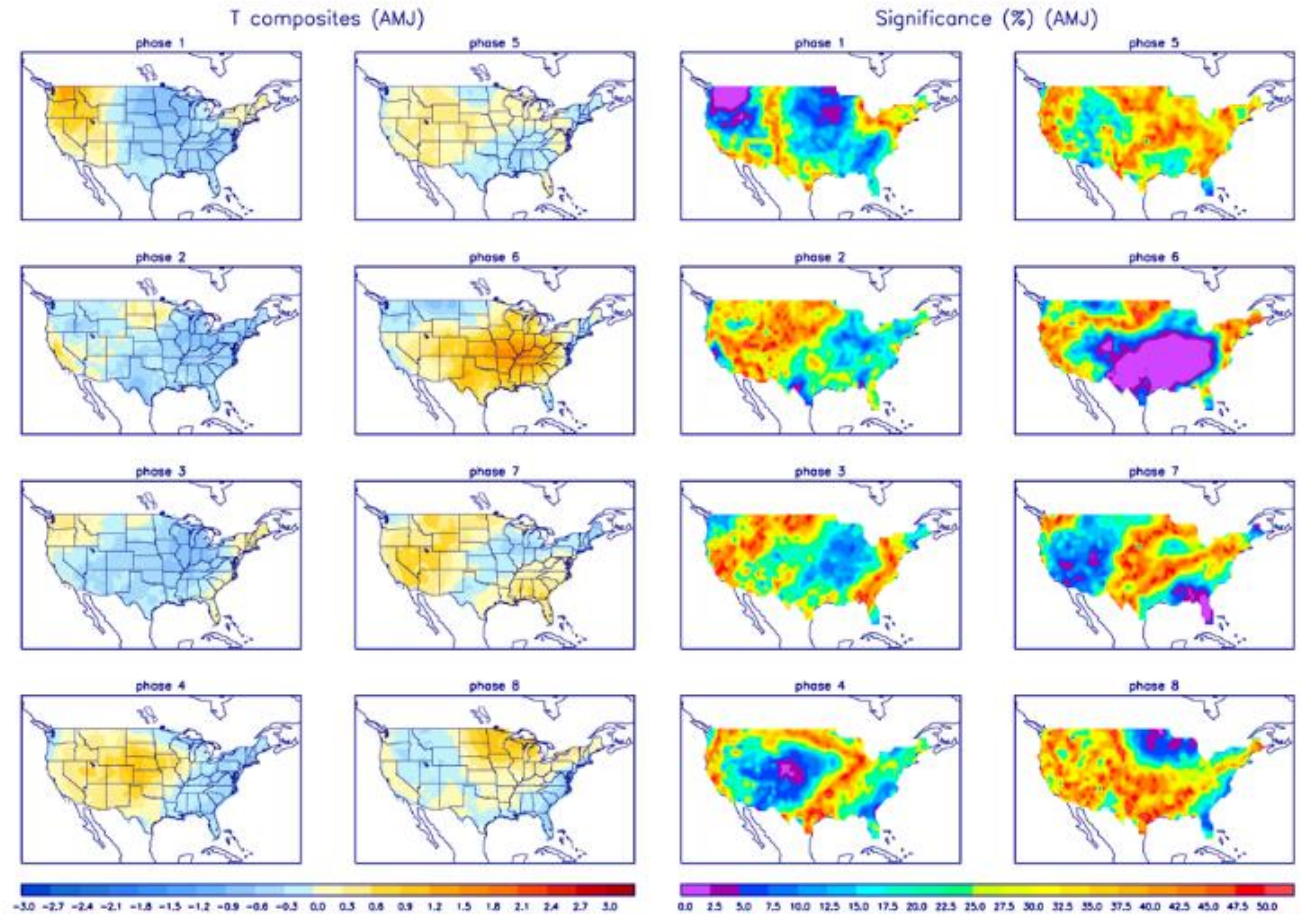
Precipitation Anomalies



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.

