

Madden-Julian Oscillation:

Recent Evolution, Current Status and Predictions



Update prepared by the Climate Prediction Center
Climate Prediction Center / NCEP
6 May 2019

Overview

- The MJO crossed the Maritime Continent over the past week, entering the West Pacific.
- GEFS and ECMWF model forecasts show some initial slowing of the MJO's eastward progression, tied to possible tropical cyclone activity, before pushing the signal to the Western Hemisphere by Week-2. The ECMWF model weakens the MJO, which is likely artificial and tied to differences in phase speed among its ensemble members.
- Tropical cyclone activity is likely to see an uptick across the West Pacific and in the vicinity of Australia over the next week, as the MJO pushes eastward.
- Extratropical impacts across the U.S. from the MJO may not be dominant, but there are signs of the tropics helping to amplify and extend the subtropical jet across the Pacific, leading to a relatively wet pattern across the southern tier of the U.S.

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>

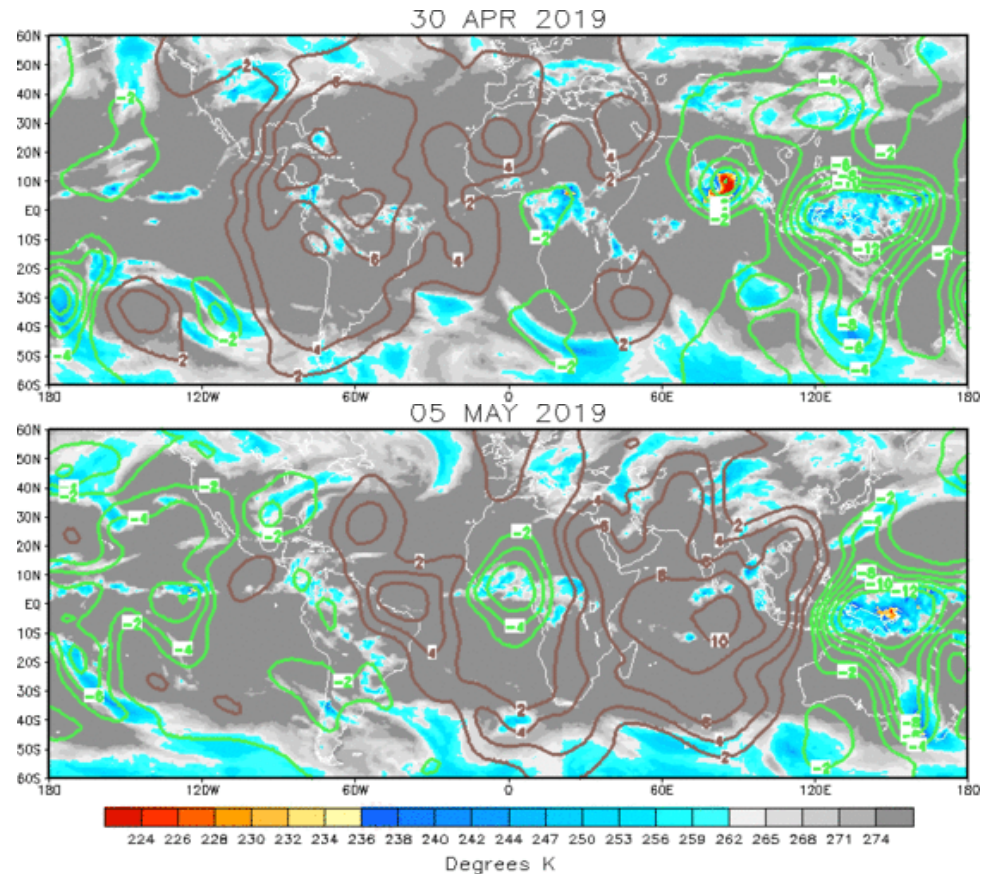
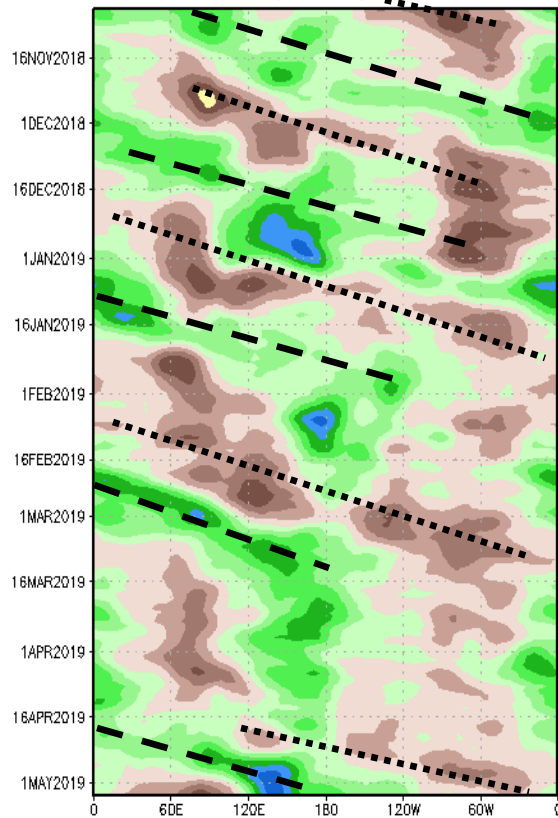
200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation).

Brown shades: Anomalous convergence (unfavorable for precipitation).

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

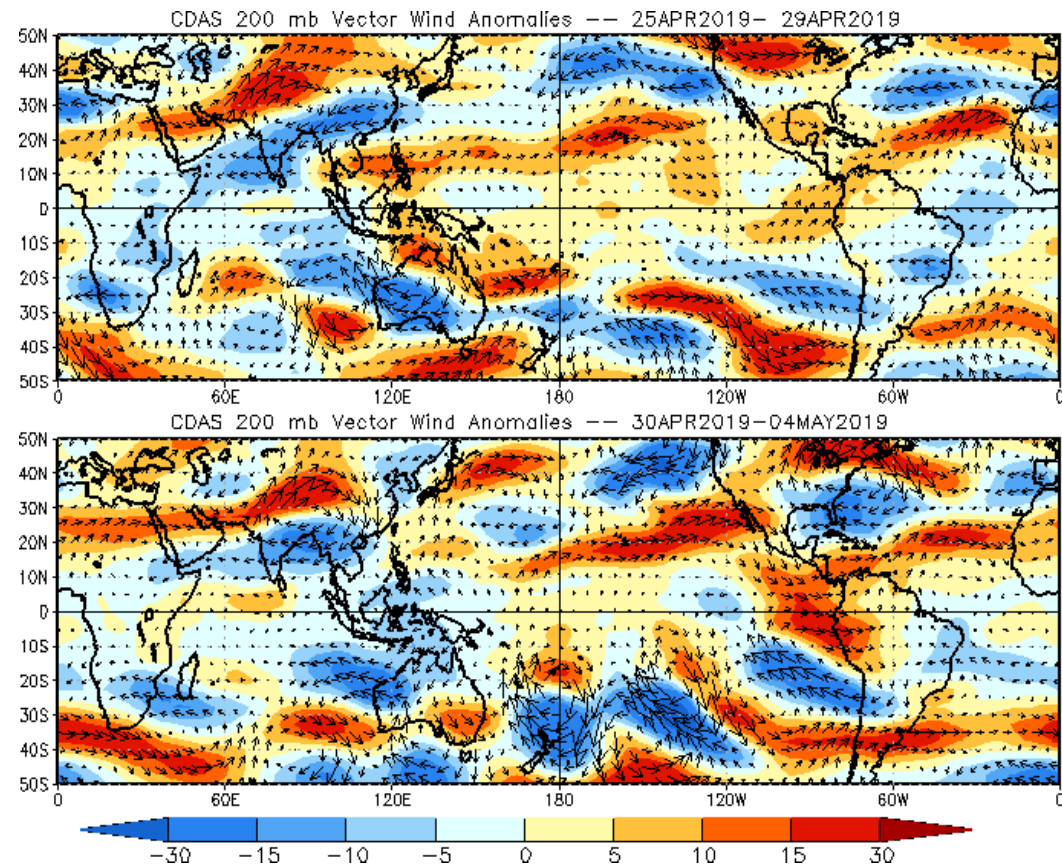
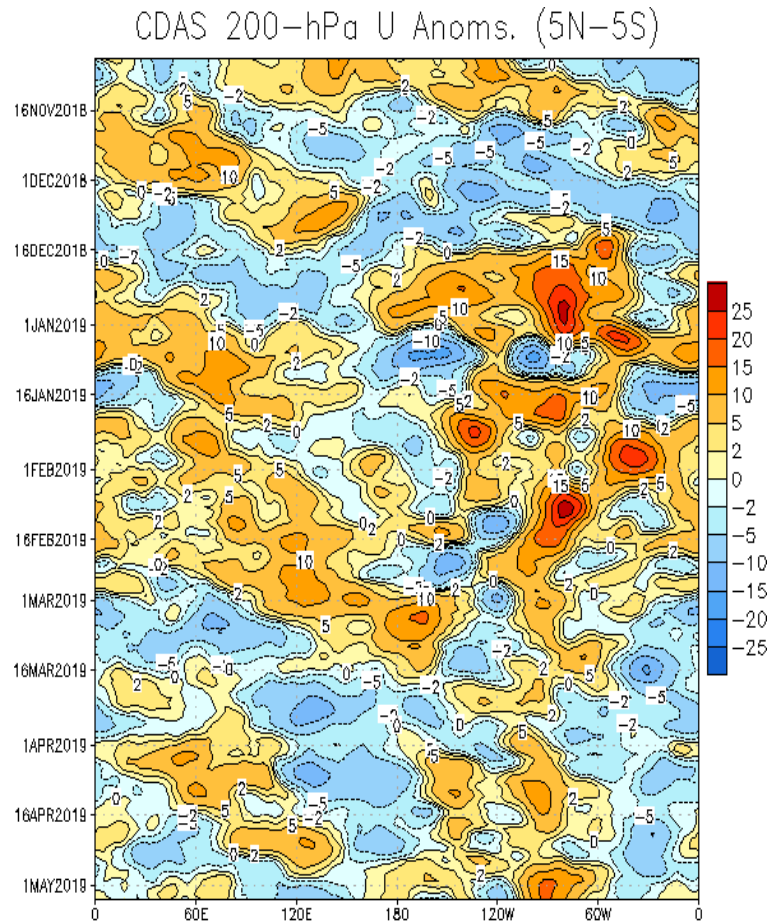
5-day Running Mean



- The MJO, which was consistently active throughout boreal fall and winter, quieted during mid-March.
- Since the beginning of March, the pattern has been dominated by low-frequency signals, with some modulation by Rossby and Kelvin wave activity.
- Mid-April shows the beginning of renewed eastward propagation with a transition toward a renewed wave-1 signature of the active MJO crossing the Indian Ocean by late April. This broke down into more of a wave-2 pattern in recent observations.

200-hPa Wind Anomalies

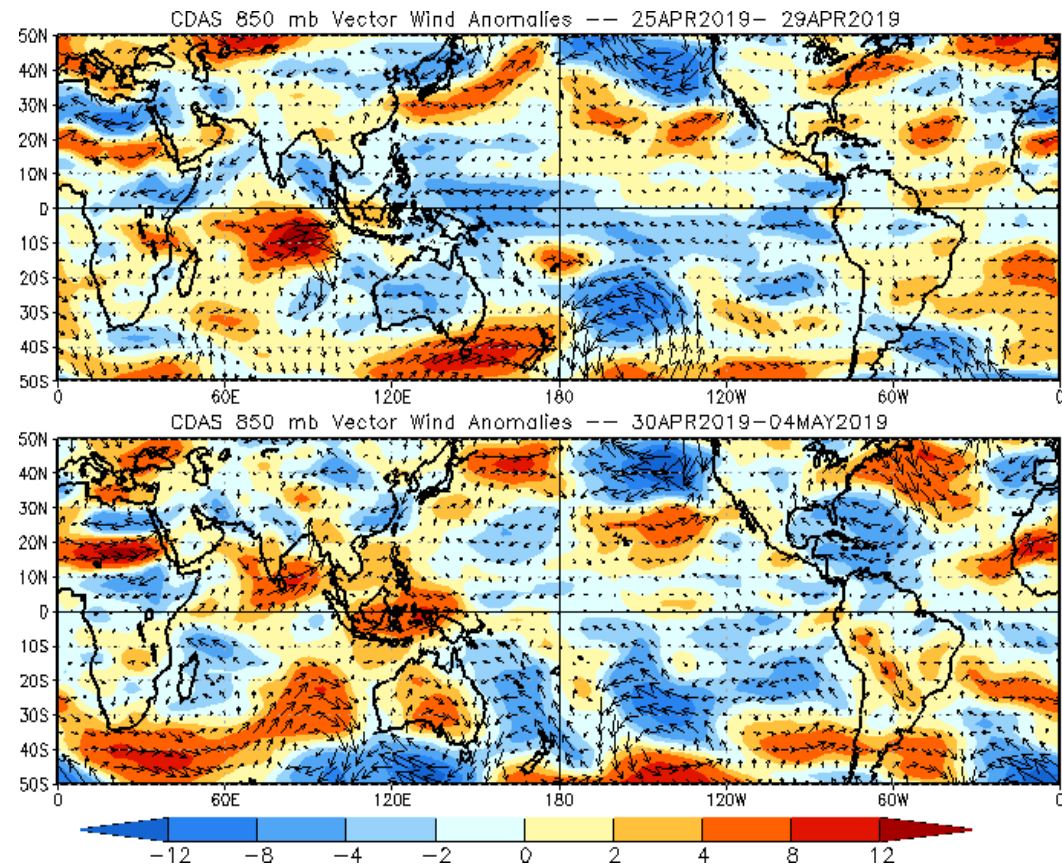
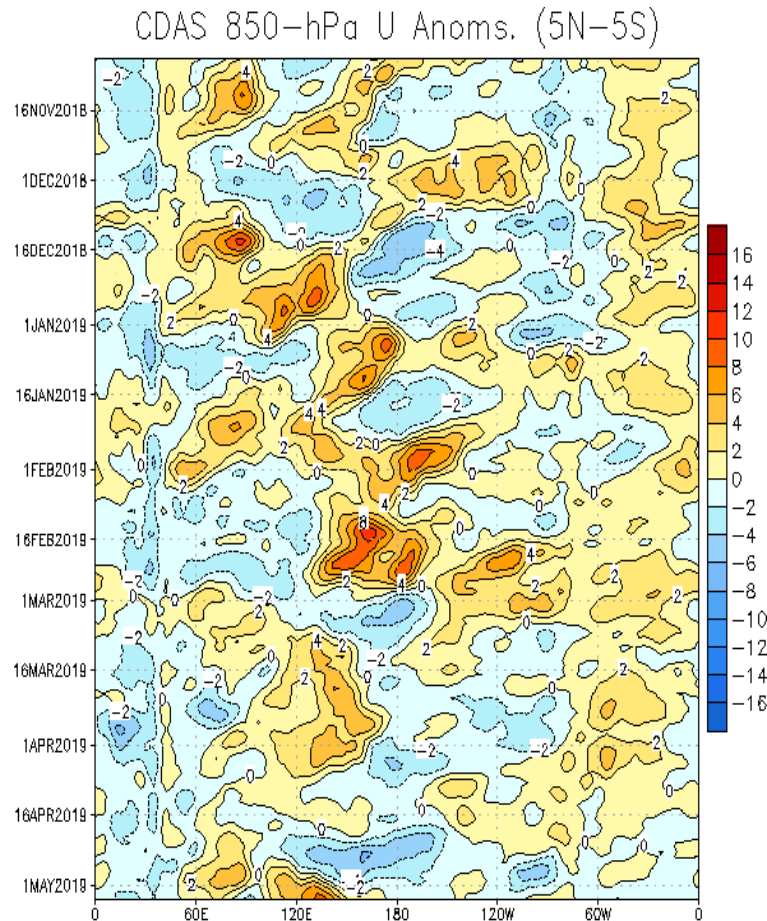
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- As seen in the upper-level VP field on the previous slide, the MJO became inactive during mid-March, but showed signs of re-emerging by April.
- Upper-level wind anomalies reversed across the Maritime Continent since late April, becoming easterly.
- Some strengthening and eastward extension of the subtropical jet was apparent over the northeast Pacific in recent weeks.

850-hPa Wind Anomalies

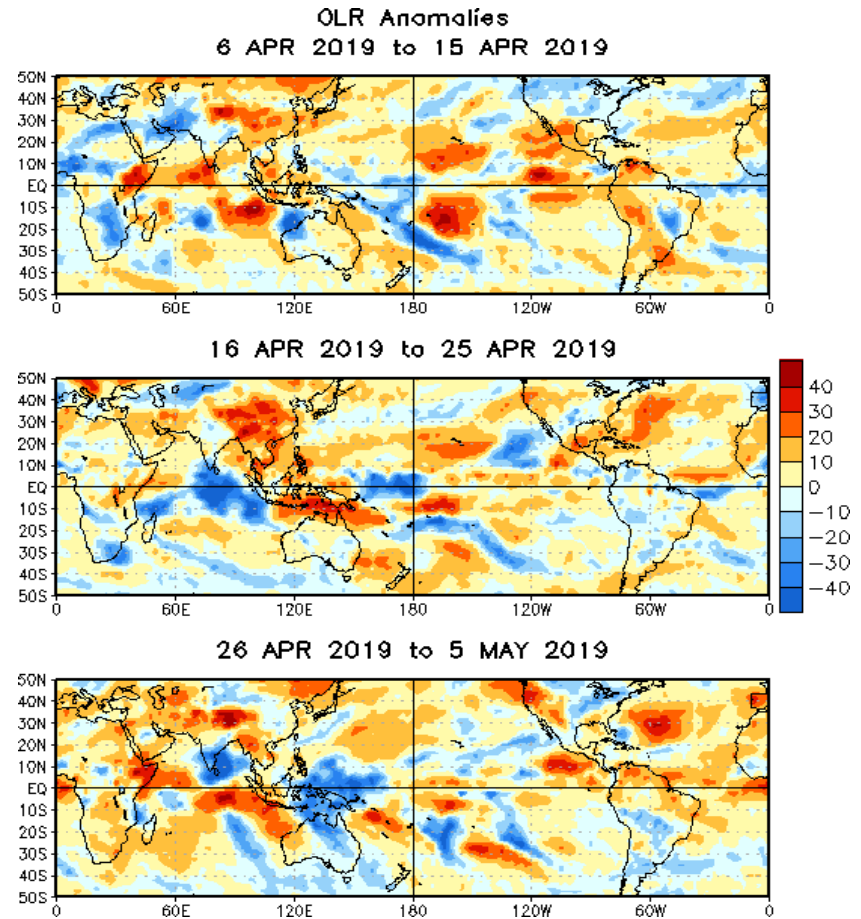
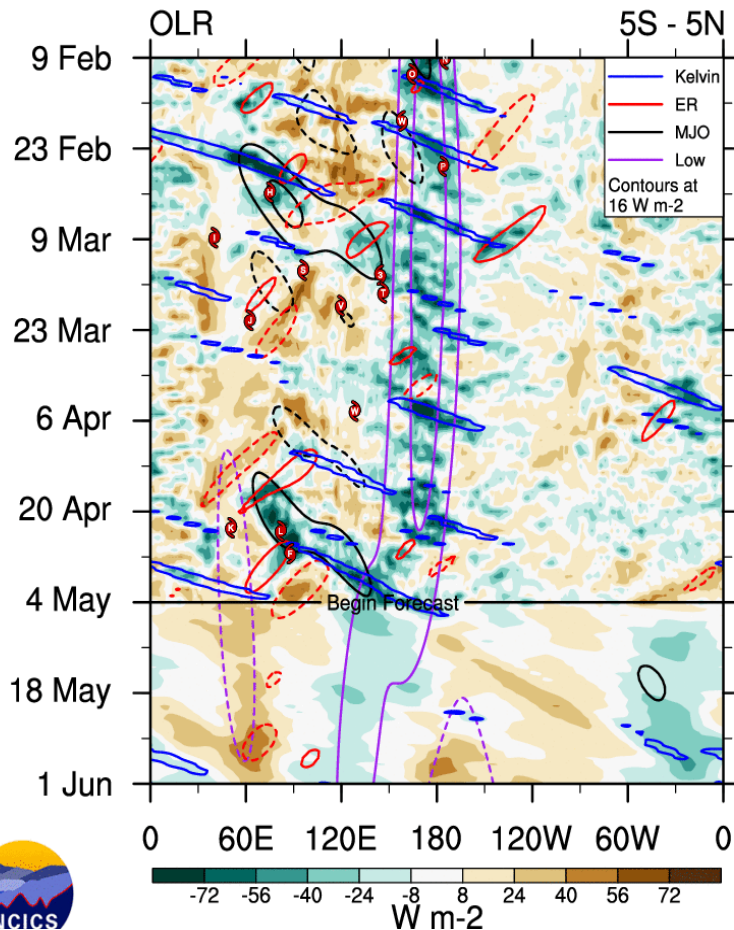
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- Anomalous westerlies tied to the MJO shifted from the Indian Ocean to over the Maritime Continent from late April into early May.
- Low-level wind anomalies over the equatorial Pacific have reverted to a weak state, after a surge in the trade winds in late April.
- Tropical Cyclone Fani's circulation is apparent over the Bay of Bengal.

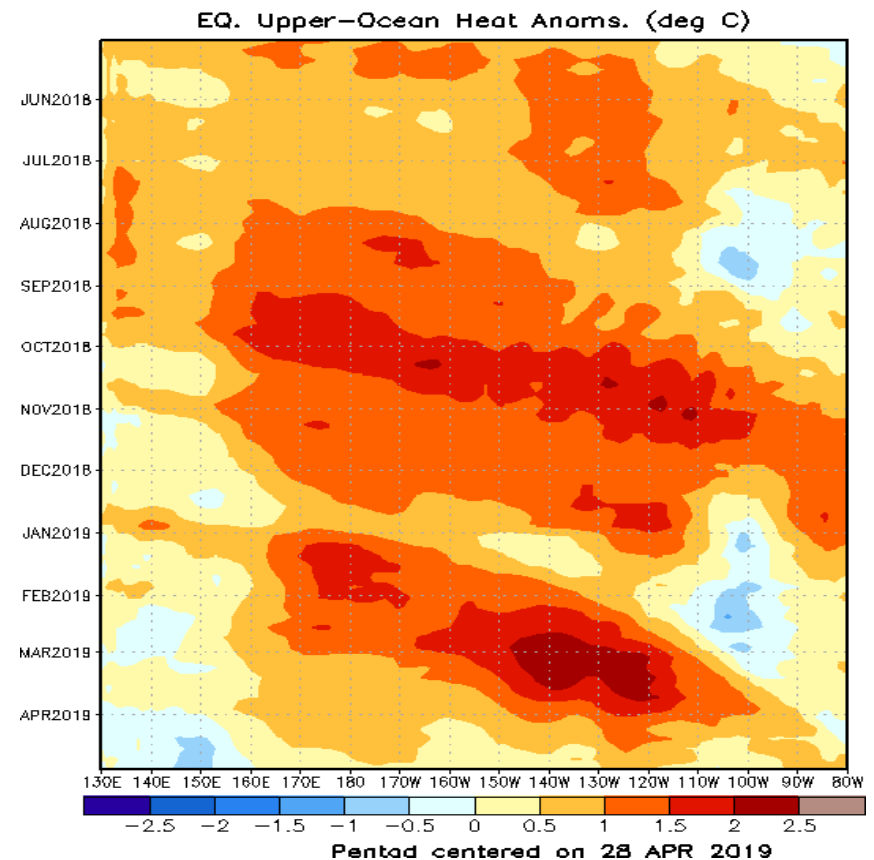
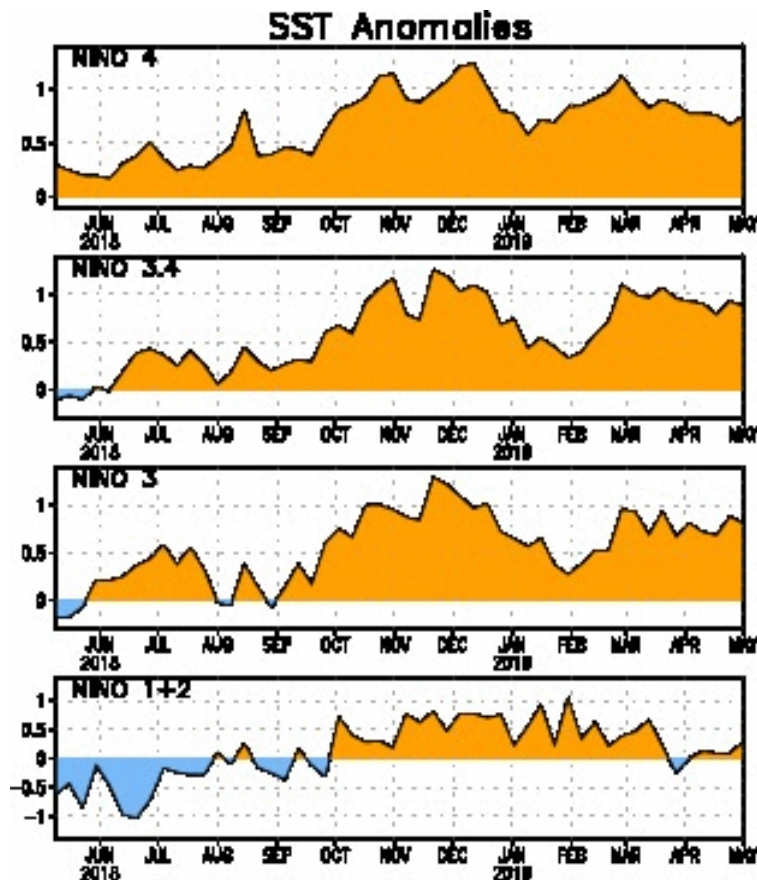
Outgoing Longwave Radiation (OLR) Anomalies

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



- The low-frequency enhancement of convection just west of the Date Line has been the most consistent signal during 2019.
- The MJO has been apparent since at least mid-April, with recent observations showing the enhanced envelope shifting rapidly from the Indian Ocean to over New Guinea over the last 10 days. This destructively interfered some with the low-frequency state just west of the Date Line from the ongoing El Niño.
- The Rossby wave activity over the Bay of Bengal eventually became TC Fani.

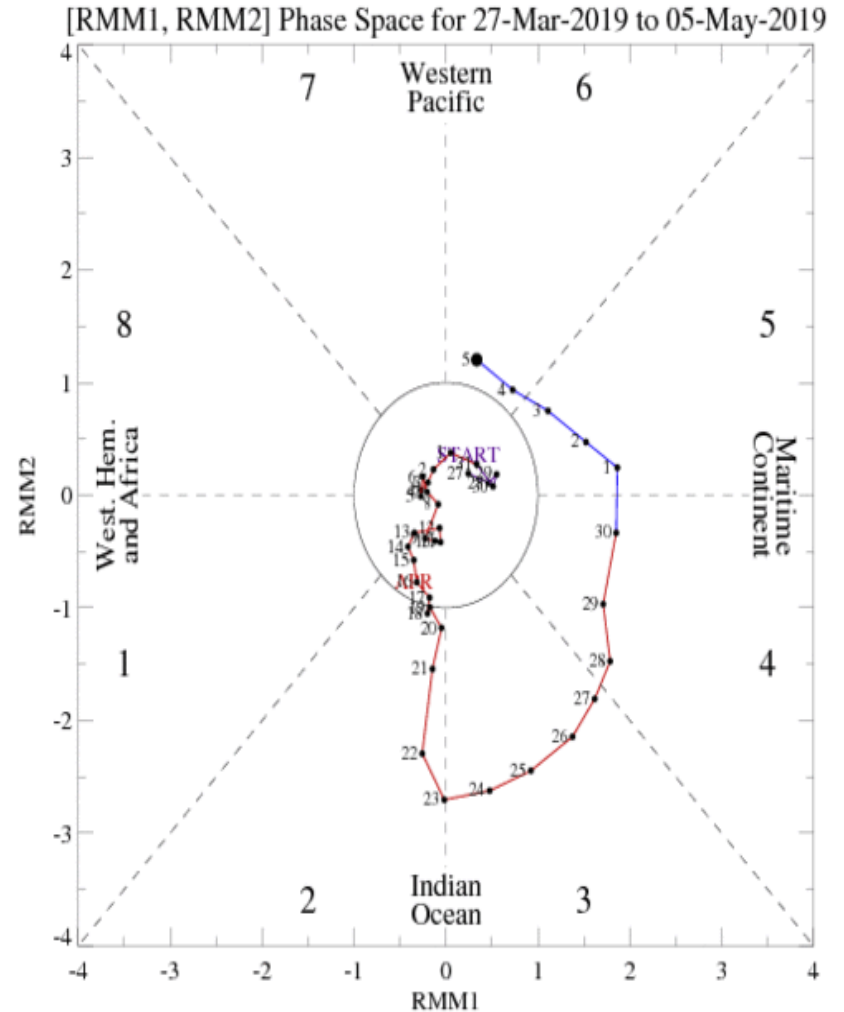
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- SST anomalies remain above climatology across much of the equatorial Central and East Pacific, consistent with the ongoing El Niño event.
- Some erosion of upper ocean heat content is apparent east of the Maritime Continent, but most noteworthy is a westerly wind burst appears underway near 150E. This is likely to trigger a downwelling oceanic Kelvin wave to help reinforce the warm water availability for the low frequency state in the Pacific.

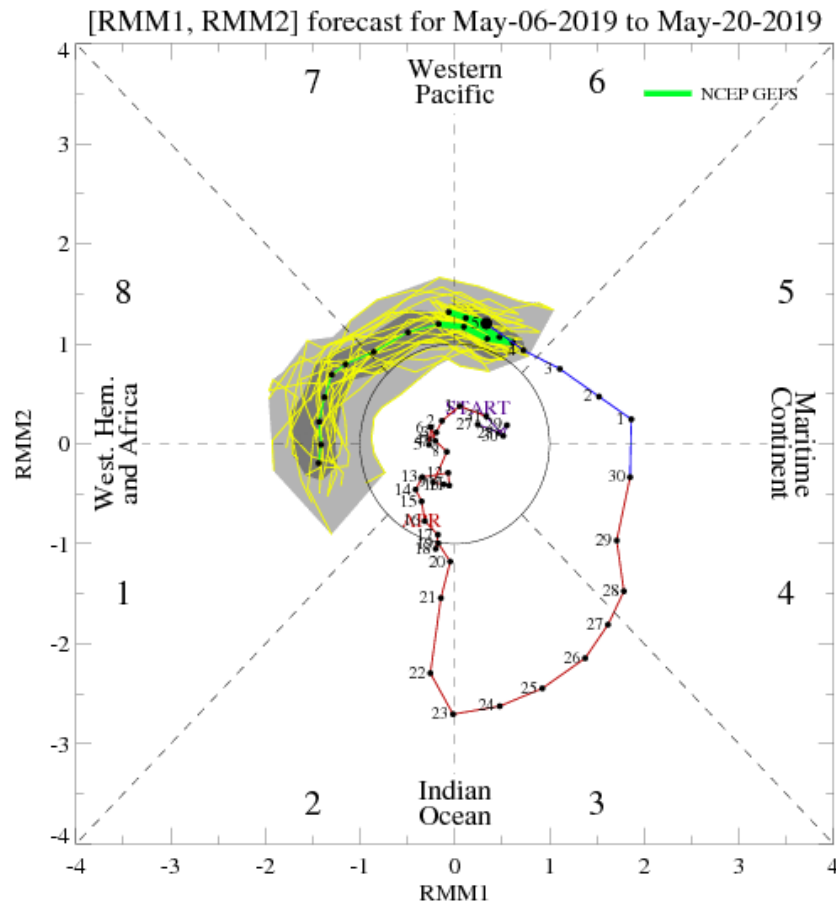
MJO Index: Recent Evolution

- The RMM index shows the MJO moving rapidly across the Maritime Continent and over the West Pacific during the last 7 days.

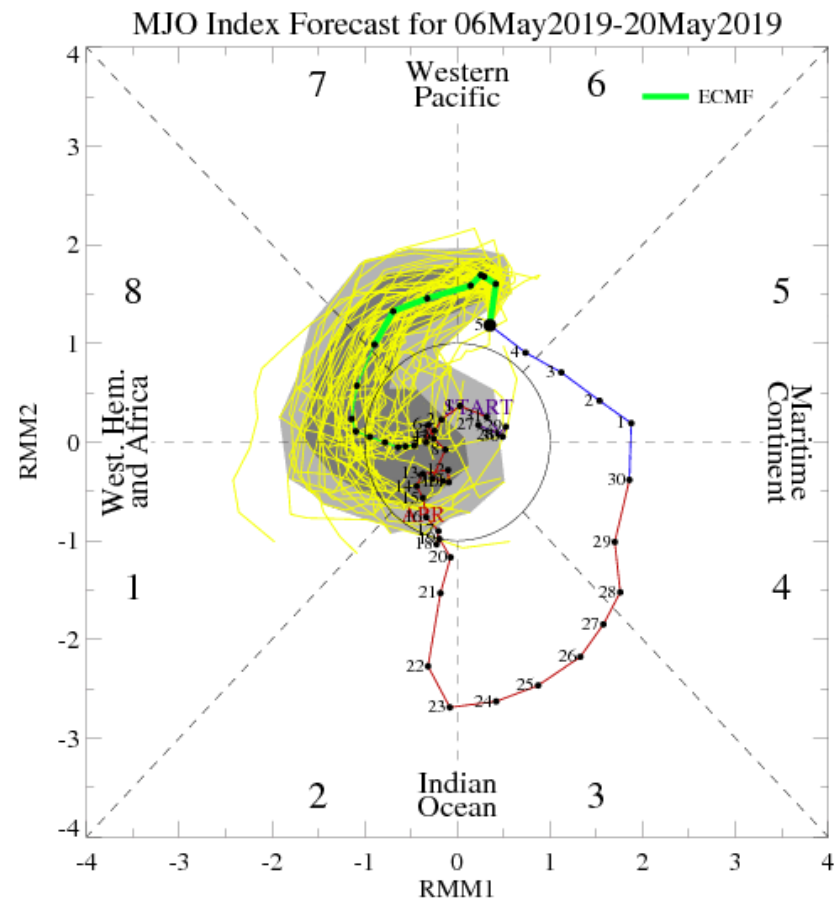


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



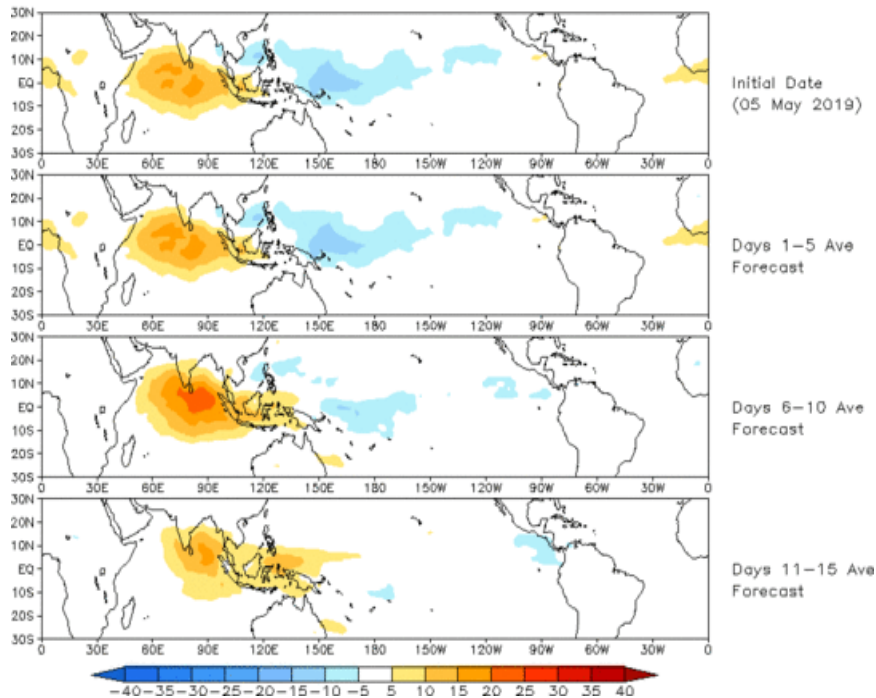
ECMWF Forecast

- Model guidance shows a brief slowdown in the next few days, potentially tied to equatorial Rossby wave (and associated tropical cyclone) activity in the West Pacific.
- Model guidance diverges in the near future regarding the strength and speed of the MJO envelope. The ECMWF model is initially more intense, before weakening the MJO later in Week-2, while the GEFS maintains the MJO through the Western Hemisphere over the next two weeks. The weaker ECMWF solution is likely tied to differences in MJO phase speed among its ensemble members.

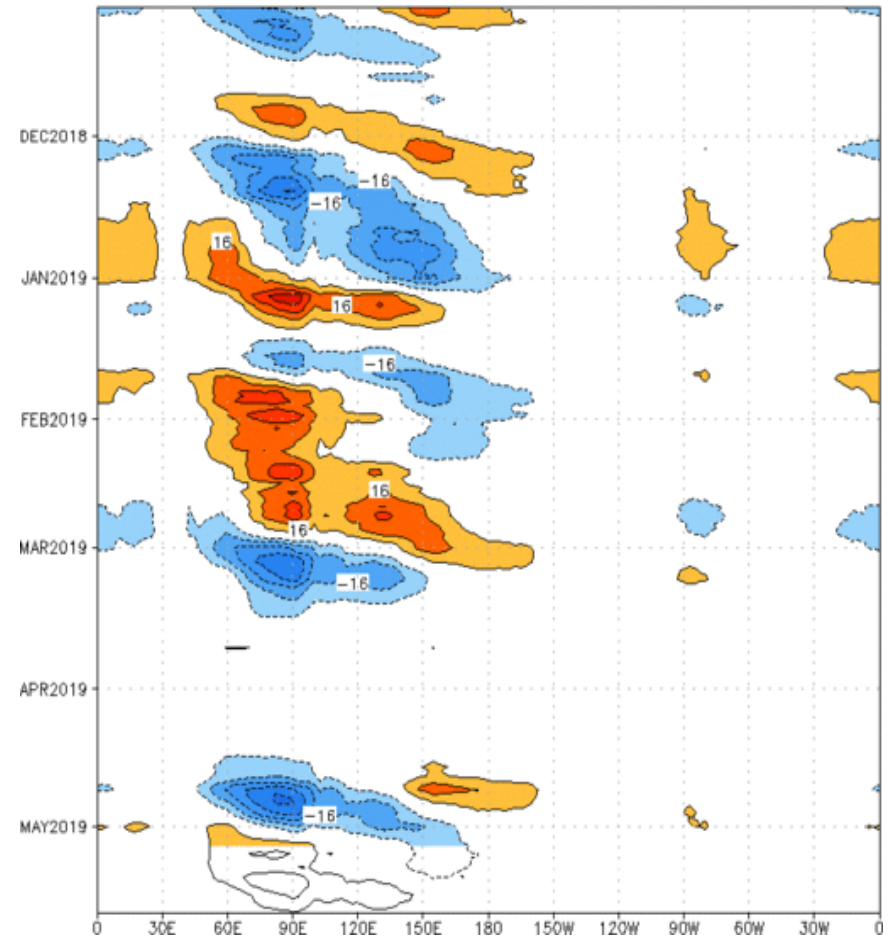
MJO: GEFS Forecast Evolution

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: 05 May 2019
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: 03-Nov-2018 to 05-May-2019
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

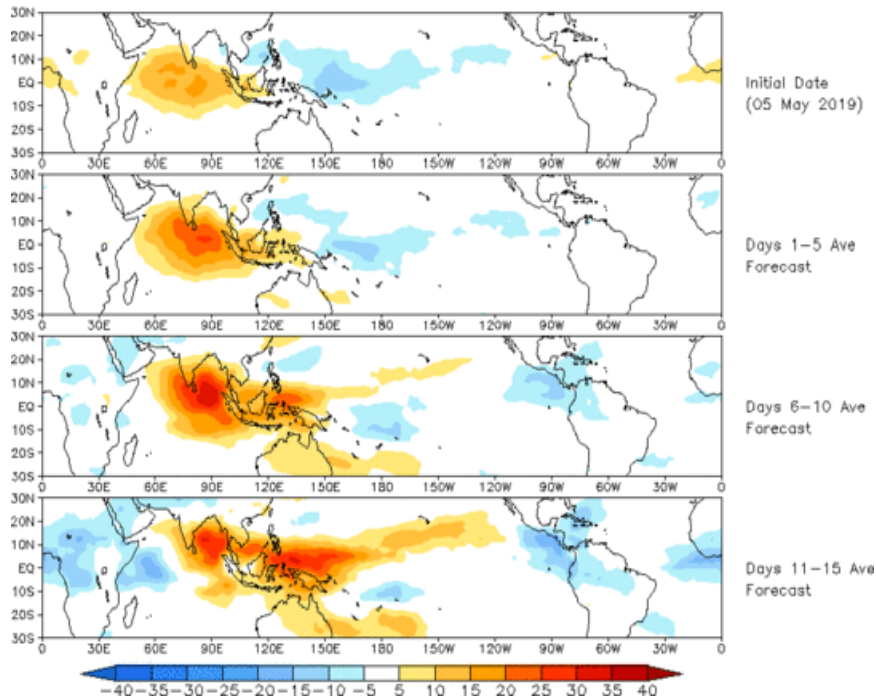


- The GEFS shows some slow eastward propagation of the suppressed and enhanced phases of the MJO envelope, but the suppressed convection over the Indian Ocean is primarily emphasized.

MJO: Constructed Analog Forecast Evolution

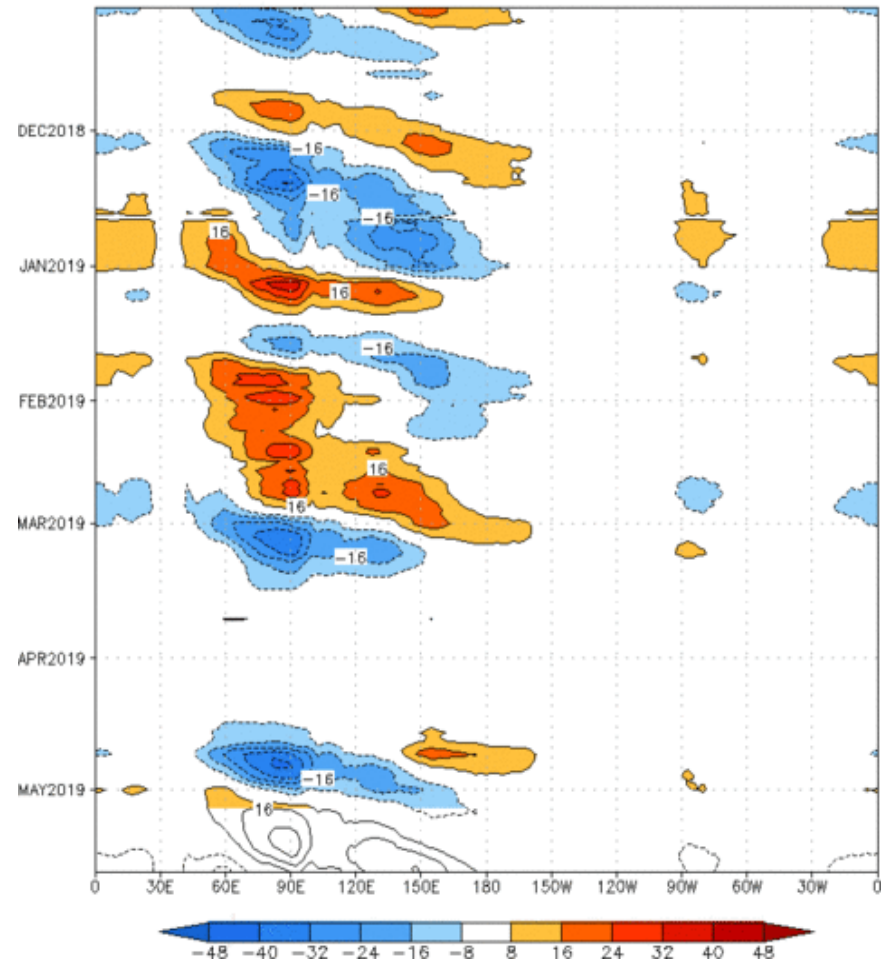
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

OLR prediction of MJO-related anomalies using CA model reconstruction by RMM1 & RMM2 (05 May 2019)



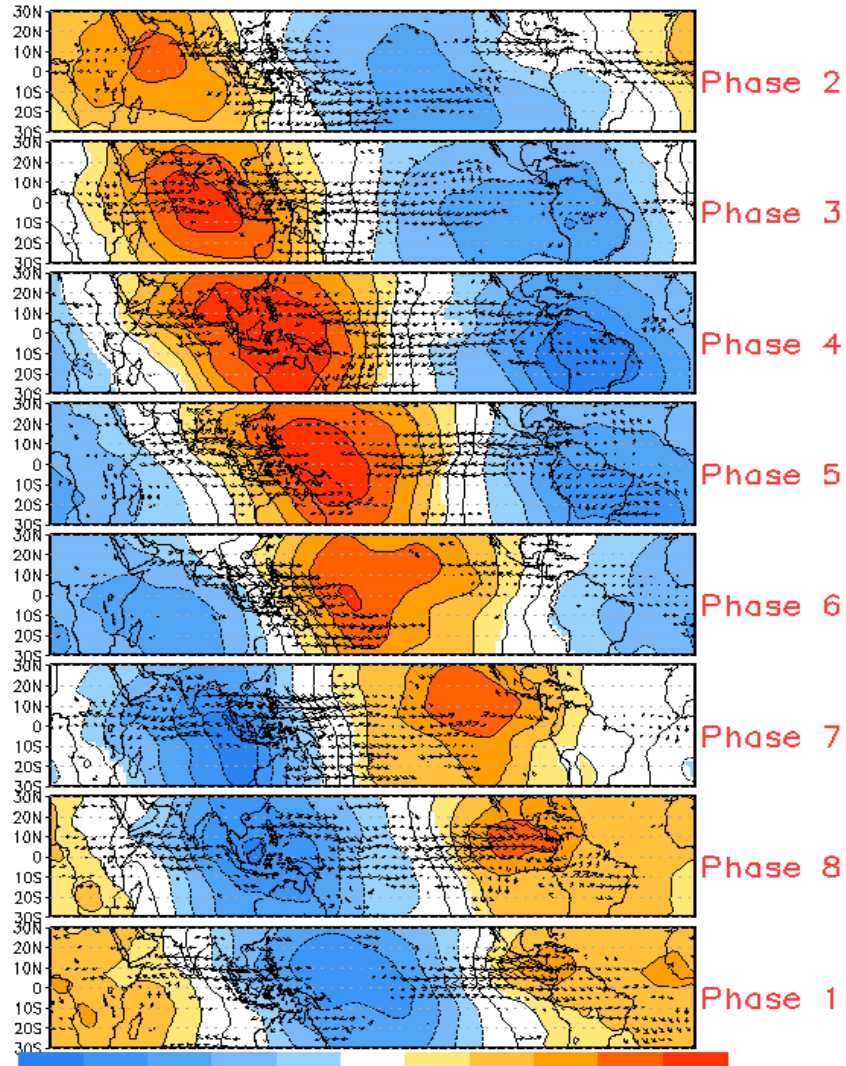
- The constructed analog forecast is somewhat similar to the GEFS, but much stronger in maintaining the enhanced convection across the Pacific during Week-1 and Western Hemisphere, Africa, and western Indian Ocean in Week-2.

Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:03–Nov–2018 to 05–May–2019
The unfilled contours are CA forecast reconstructed anomaly for 15 days

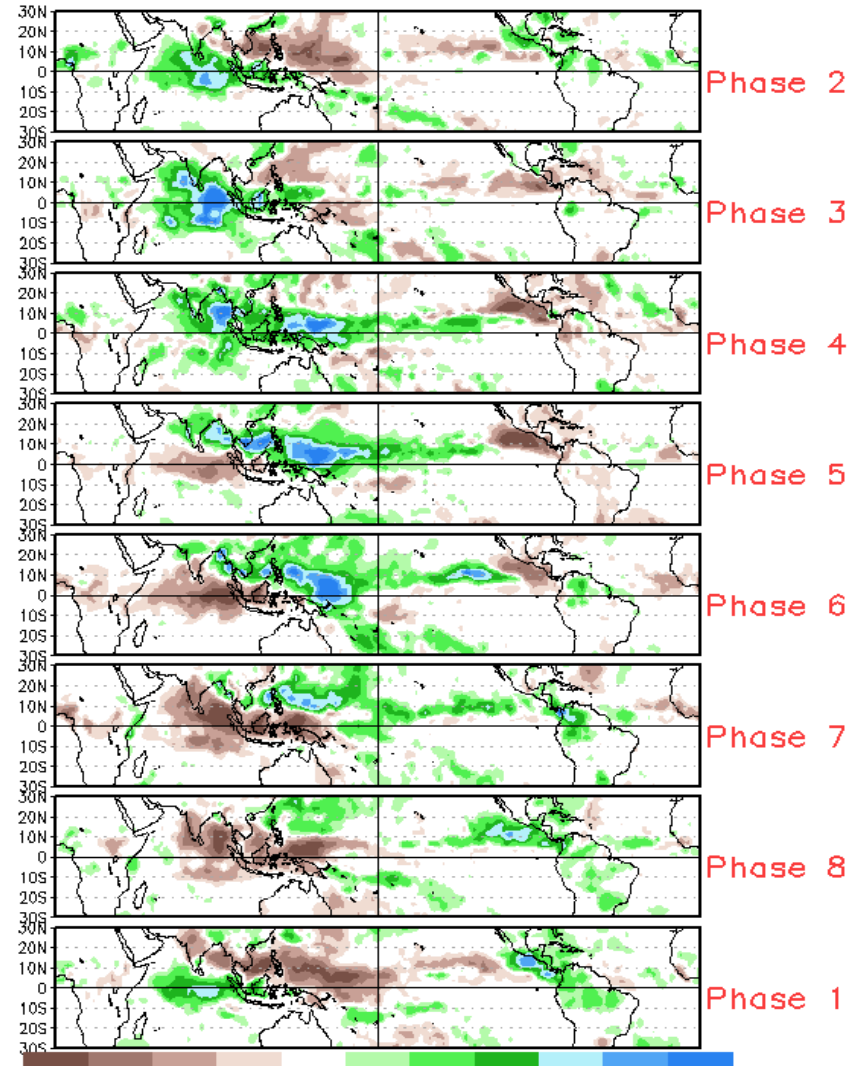


MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and
Wind Anomalies



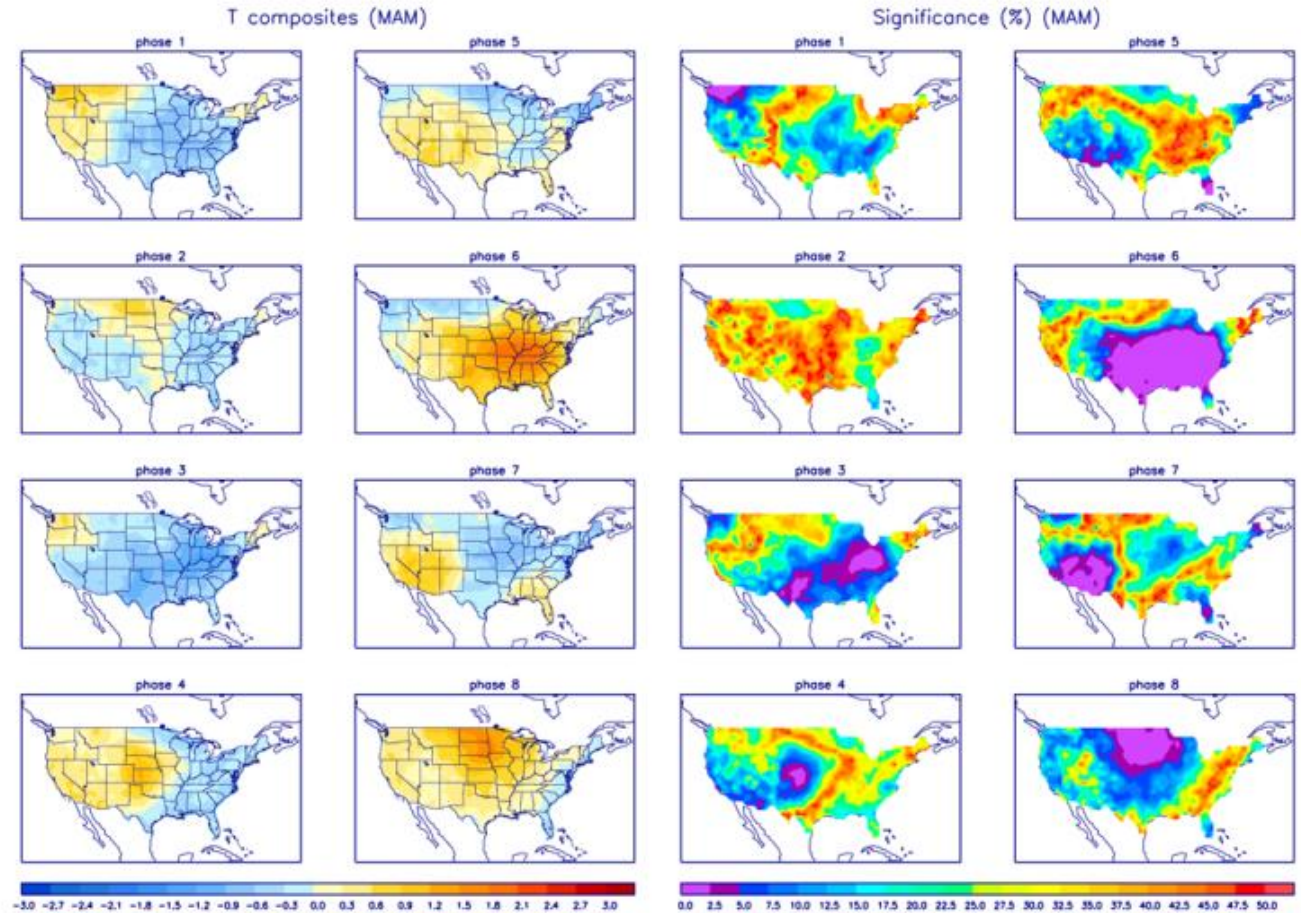
Precipitation Anomalies



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.

