

Madden-Julian Oscillation: Recent Evolution, Current Status and Predictions



Update prepared by the Climate Prediction Center
Climate Prediction Center / NCEP
20 April 2020

Overview

- A rapidly propagating intraseasonal signal crossed the Western Hemisphere over the past week, with the strongest footprint in the upper-level wind field.
- Dynamical models support the continued progression of this envelope across the Indian Ocean during Week-1, with potential interference from Rossby wave activity during Week-2.
- Easterly low-level wind anomalies over the equatorial Pacific may help erode the low frequency signal that has favored enhanced convection near or west of the Date Line and is based on warm SSTs that are increasingly shallow.
- The MJO is not anticipated to play a substantial role in the evolution of the midlatitude pattern.

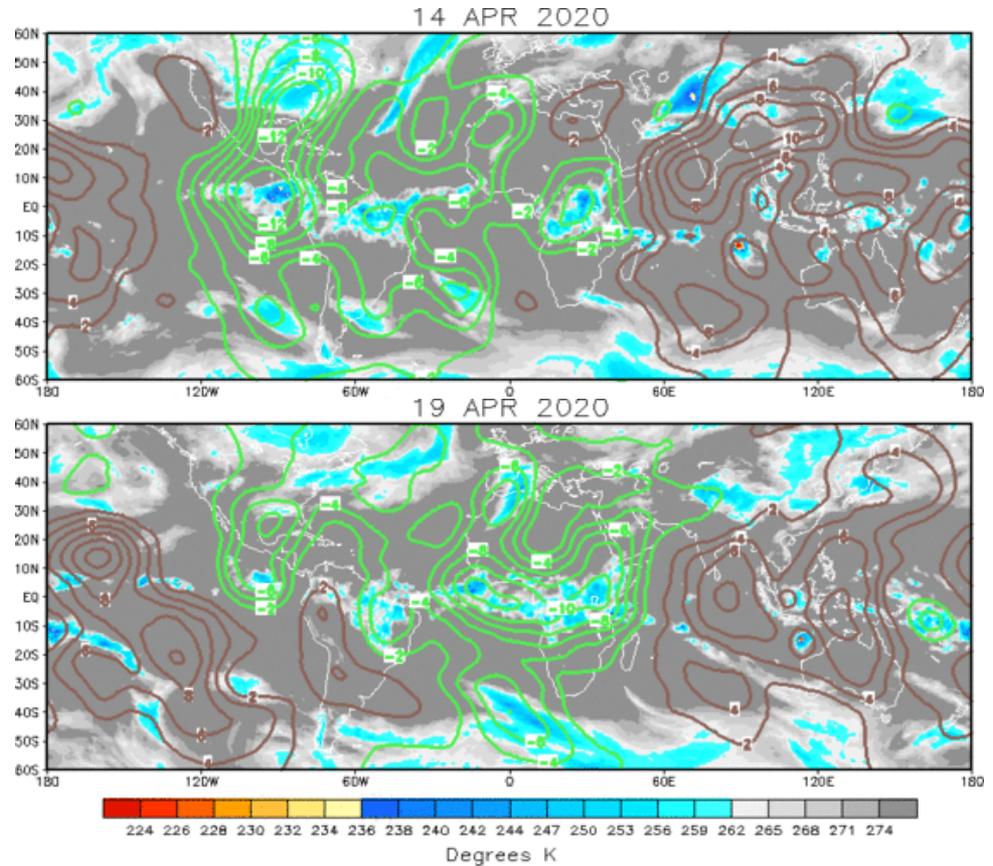
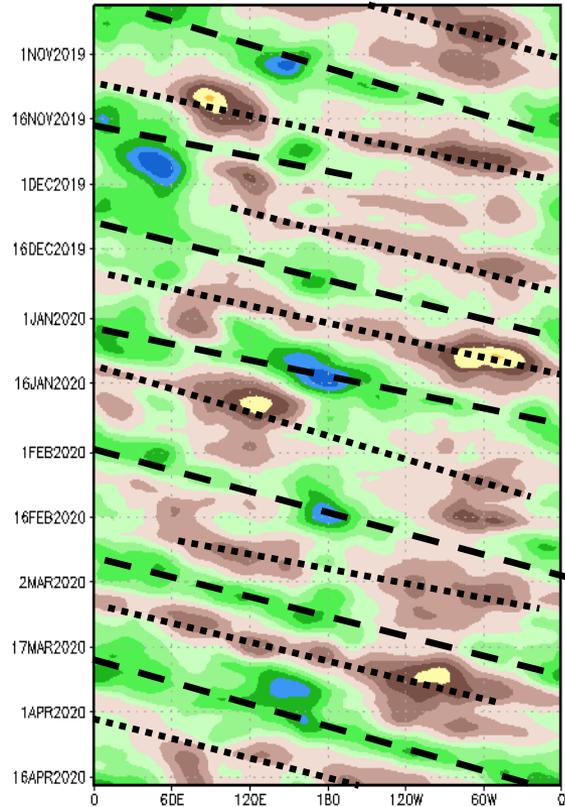
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation).

Brown shades: Anomalous convergence (unfavorable for precipitation).

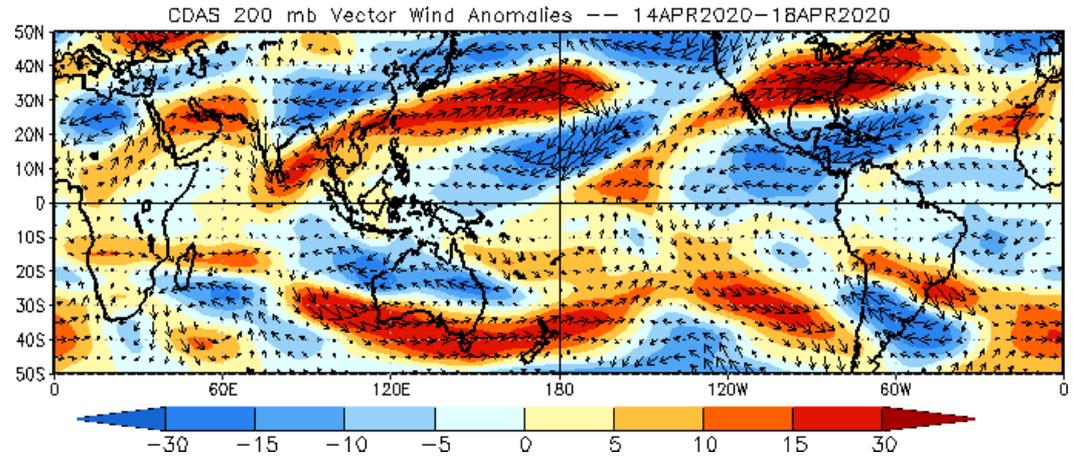
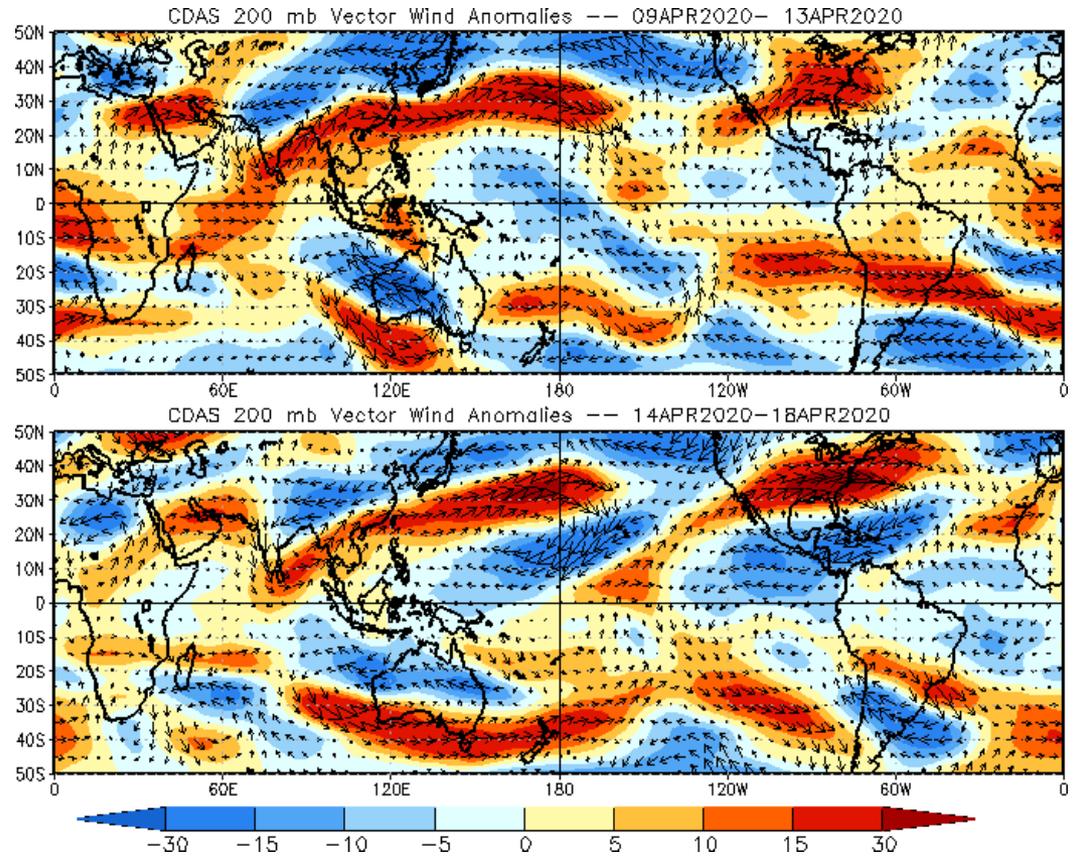
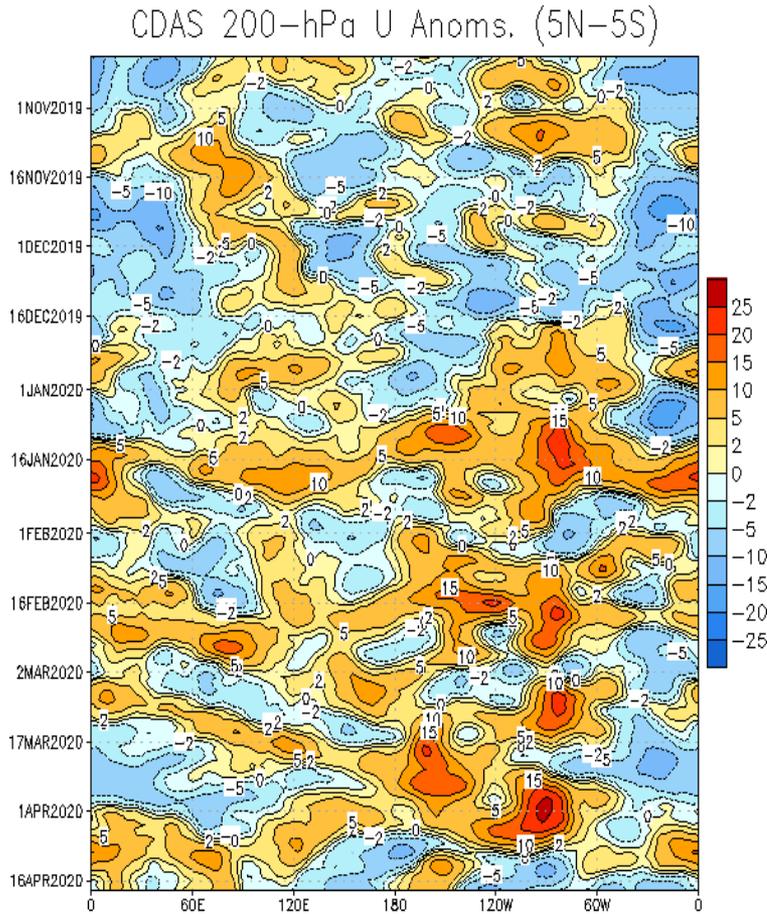
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- A fast moving intraseasonal signal has maintained a robust upper-atmospheric footprint over the past week, with a Wave-1 structure and clear eastward propagation across the Western Hemisphere.
- This upper-level intraseasonal signal has circumnavigated the globe multiple times during the past several months, with a consistently fast phase speed suggestive of convectively coupled Kelvin wave activity.
- As the upper-level signal comes into phase with the low-frequency state, there have been pulses of enhanced convective activity near the Date Line. Since February, this feature appears to be moving slowly westward.

200-hPa Wind Anomalies

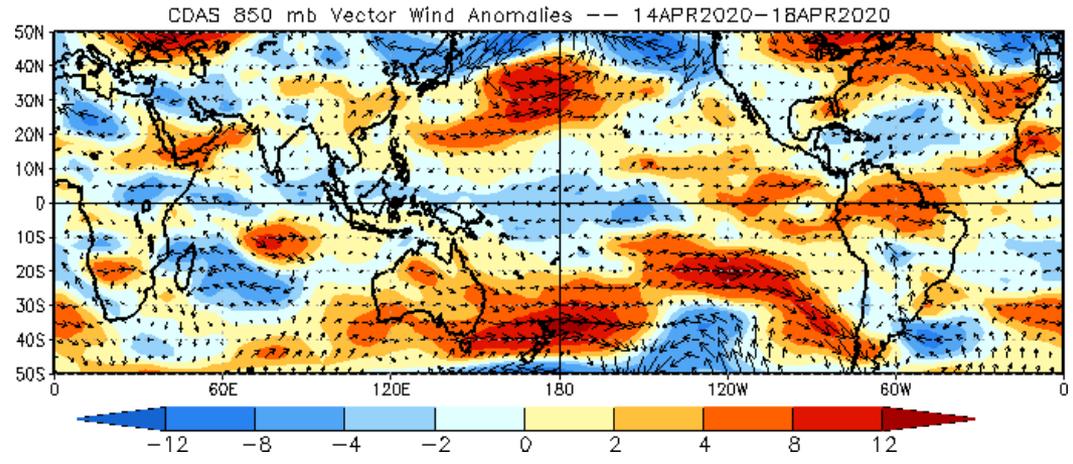
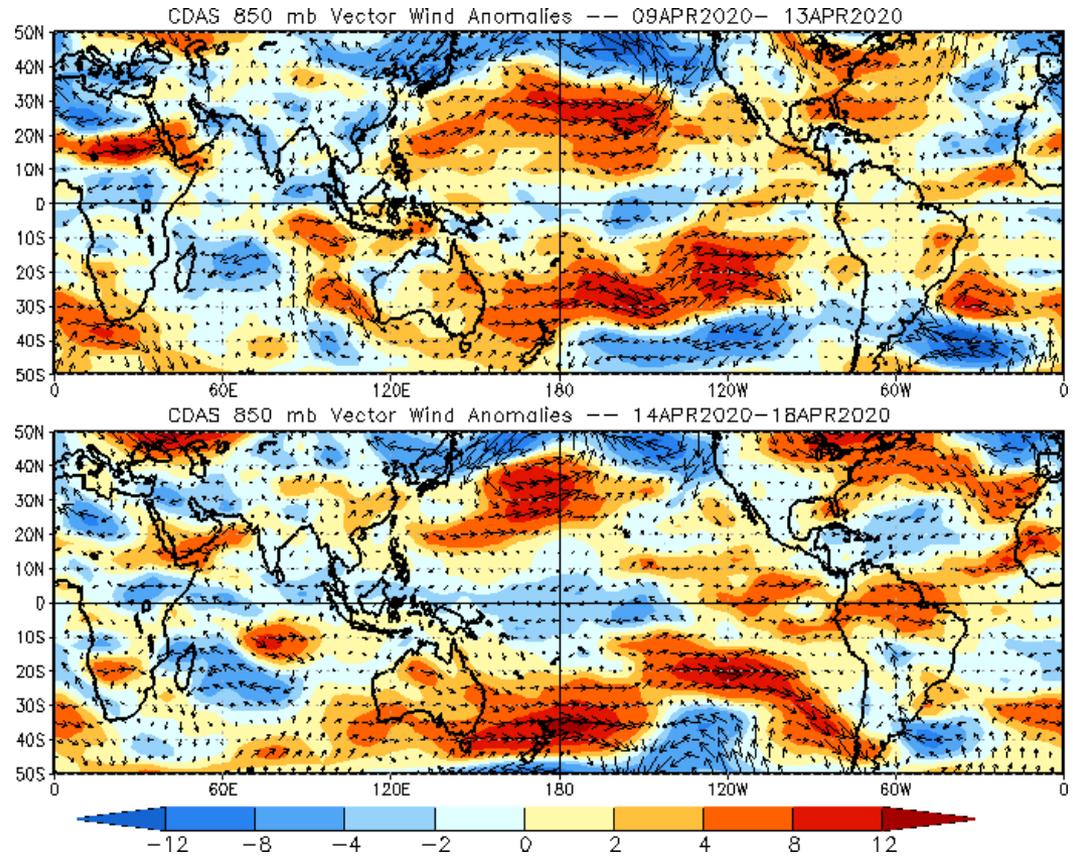
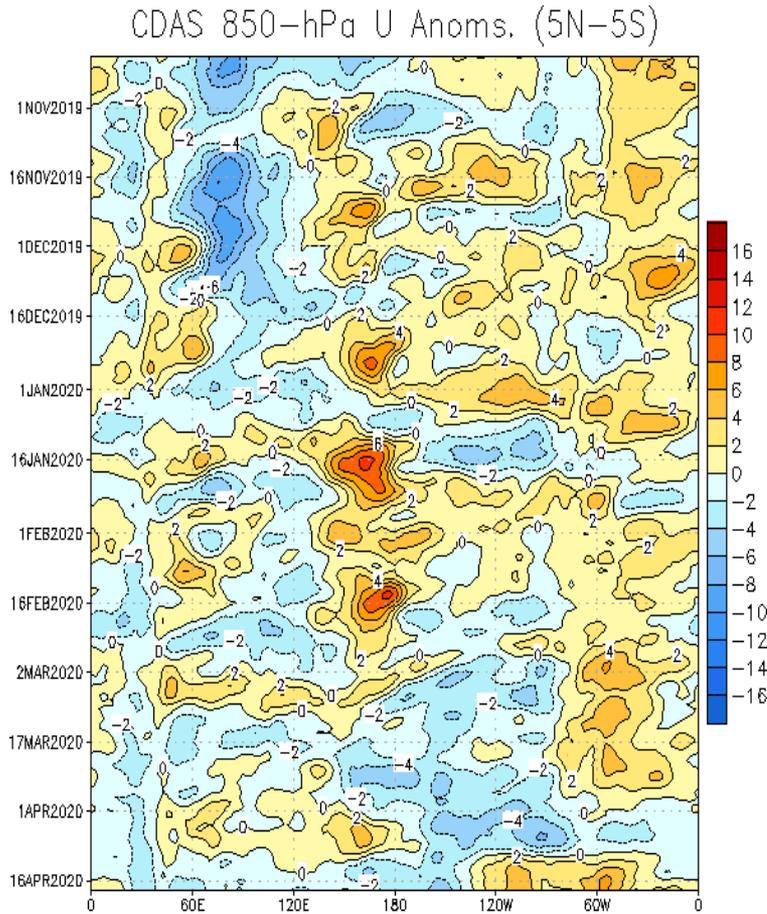
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- A robust mid-latitude anti-cyclonic circulation north of the equator near the Date Line along with an extended East Asian Jet appear to be out of phase with the intraseasonal signal.
- Rossby wave activity is apparent near the Date Line since early April.
- A strengthened subtropical jet extending from the tropical Pacific to the central U.S. may be contributing to episodic severe weather outbreaks during early to mid-April.

850-hPa Wind Anomalies

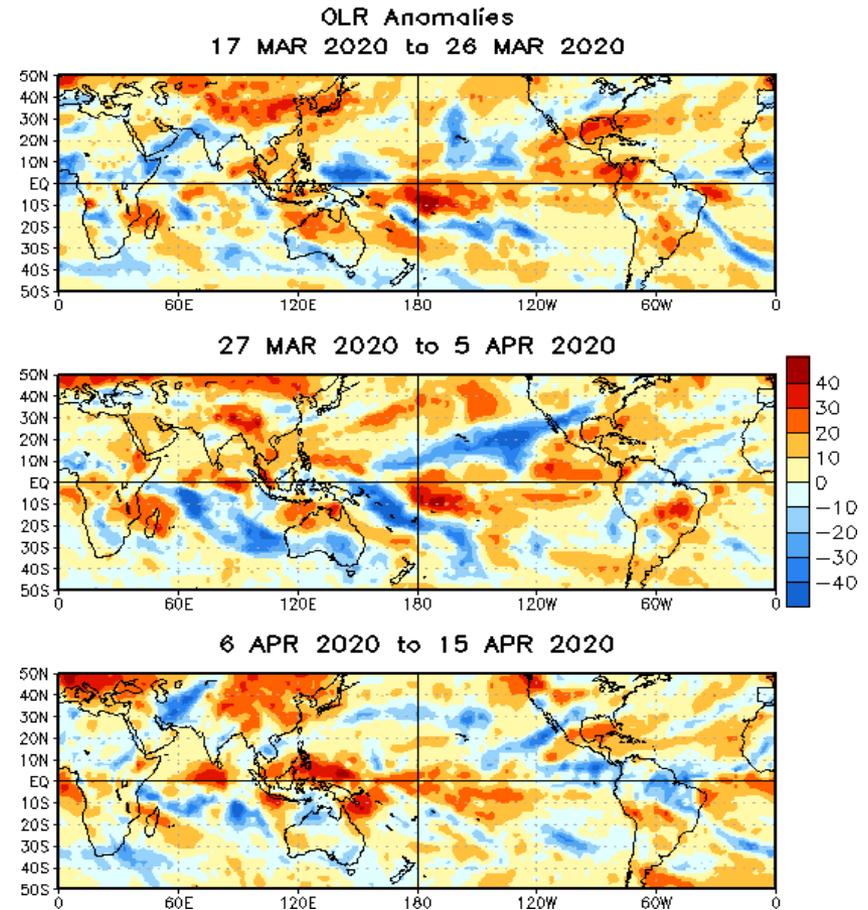
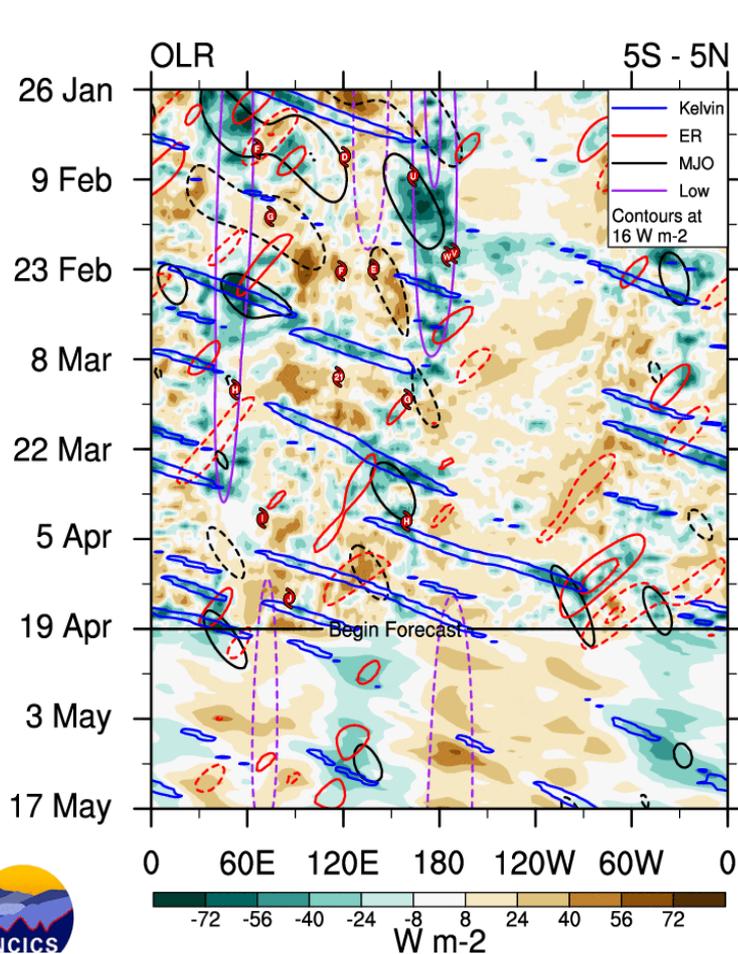
Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.



- The anomalous low-level wind field has a fairly weak amplitude, but is broadly consistent with a Western Hemisphere enhanced intraseasonal signal.
- Anomalous strong trades near the Date Line may help erode near surface oceanic warmth via upwelling cooler water found at depth. This would also accelerate the decay of low frequency convection in the area.

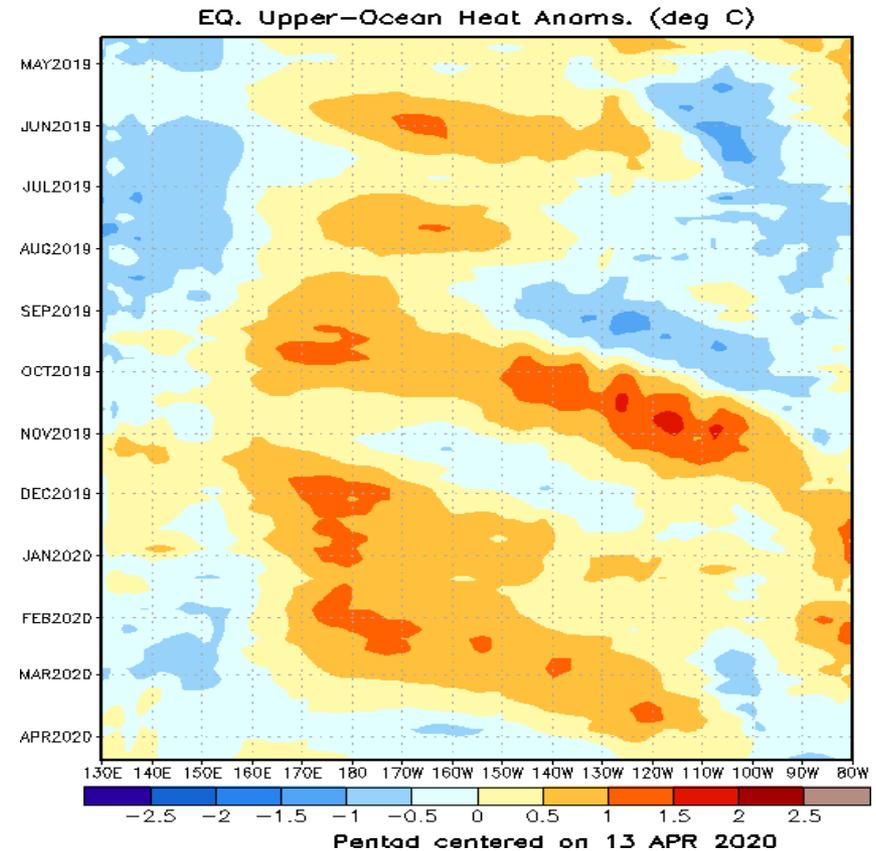
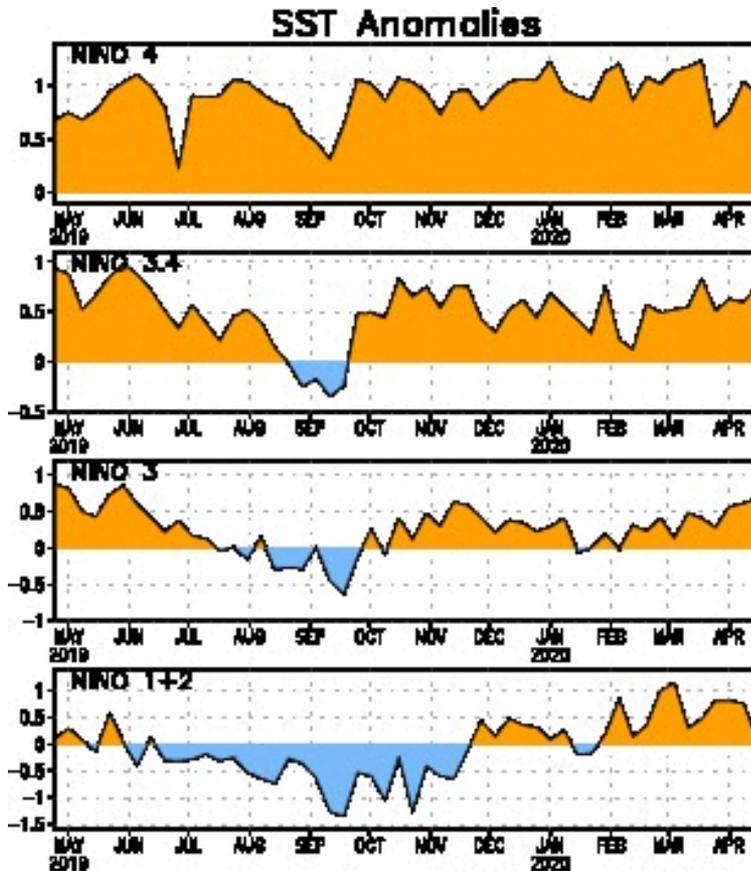
Outgoing Longwave Radiation (OLR) Anomalies

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



- There has not been recent slowing of the evolution of convective anomalies associated with MJO activity. Higher frequency modes, especially Kelvin wave activity, have dominated observed shifts in clouds/radiation.
- The low-frequency state is generally apparent just west of the Date Line.
- Forecasts continue to show enhanced (suppressed) convection becoming anchored over the Maritime Continent (along the Date Line).

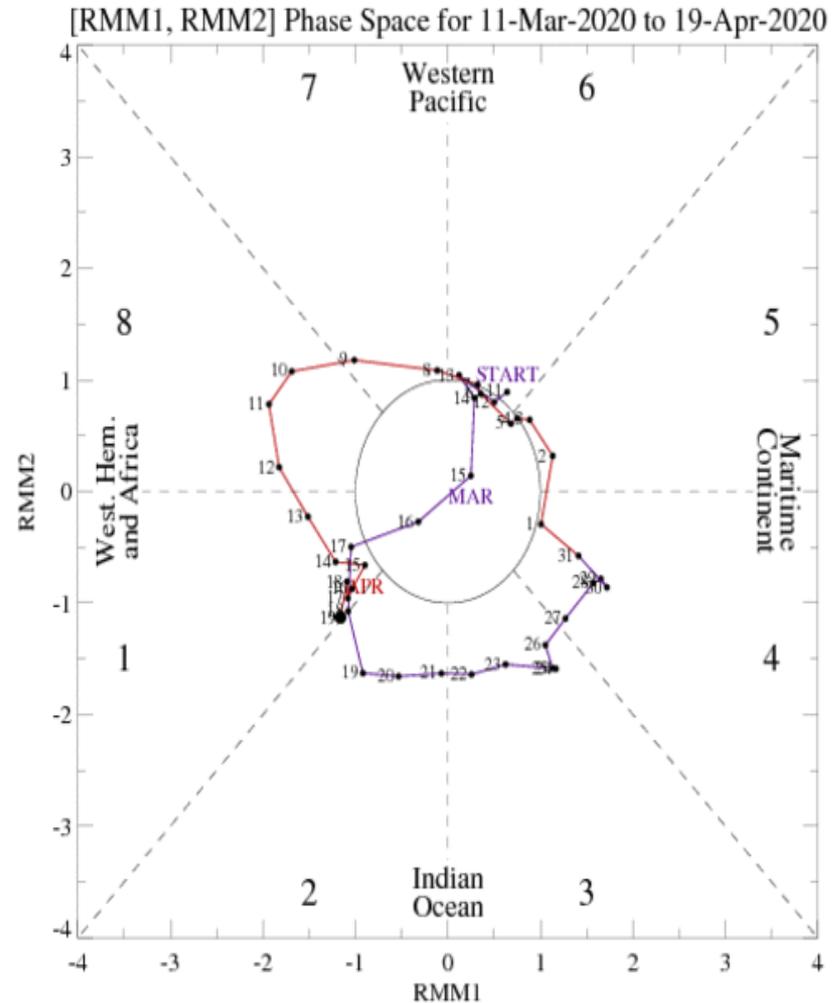
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- Upper-ocean heat content anomalies remain marginally below-average over much of the equatorial Pacific, with the exception of between 135-110W where a reservoir of heat remains following a downwelling event that began during February.
- Above-average SSTs in the ENSO domains are very shallow and not associated with additional downwelling events.

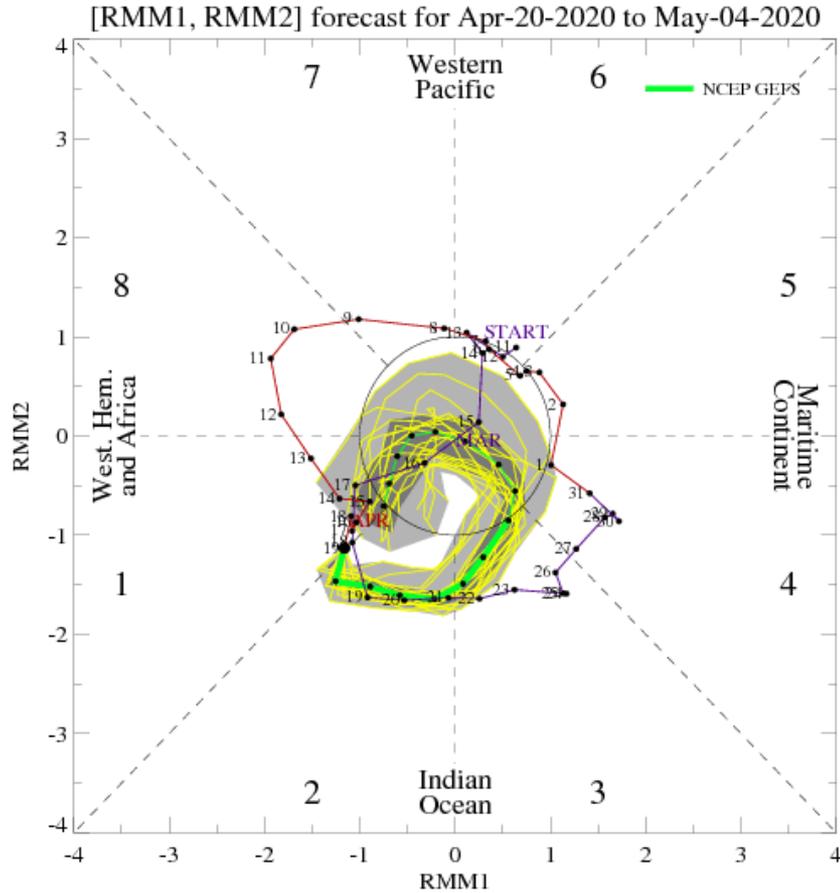
MJO Index: Recent Evolution

- The RMM index propagated rapidly across the Western Hemisphere during the past week, suggestive of Kelvin wave activity.
- The signal has slowed a bit over the past several days.

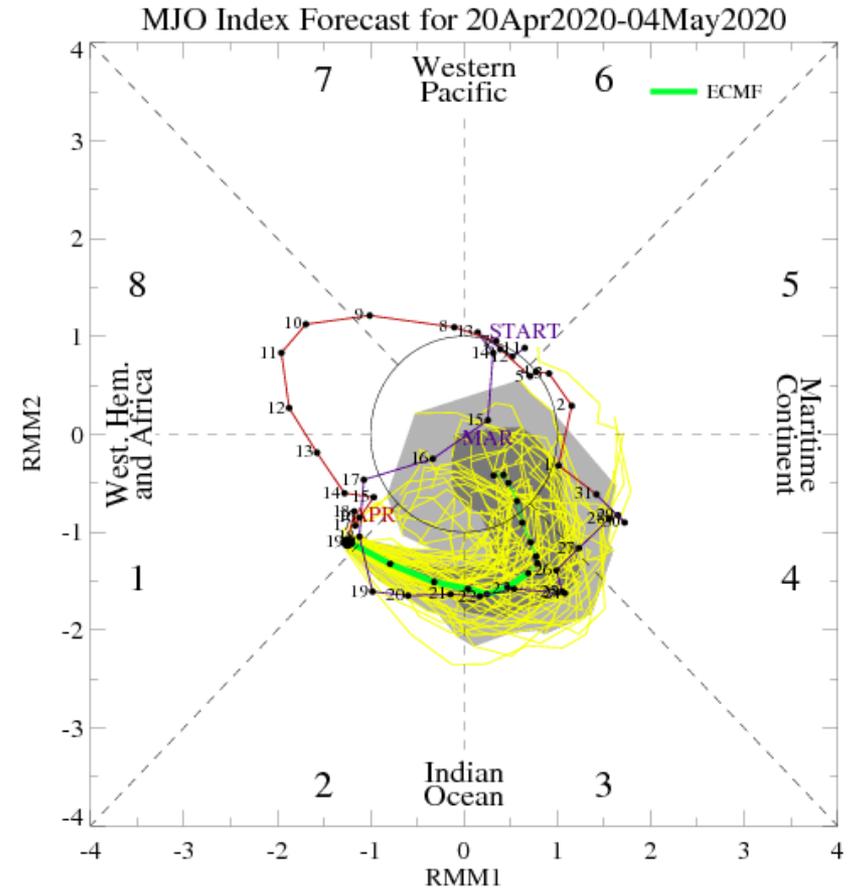


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



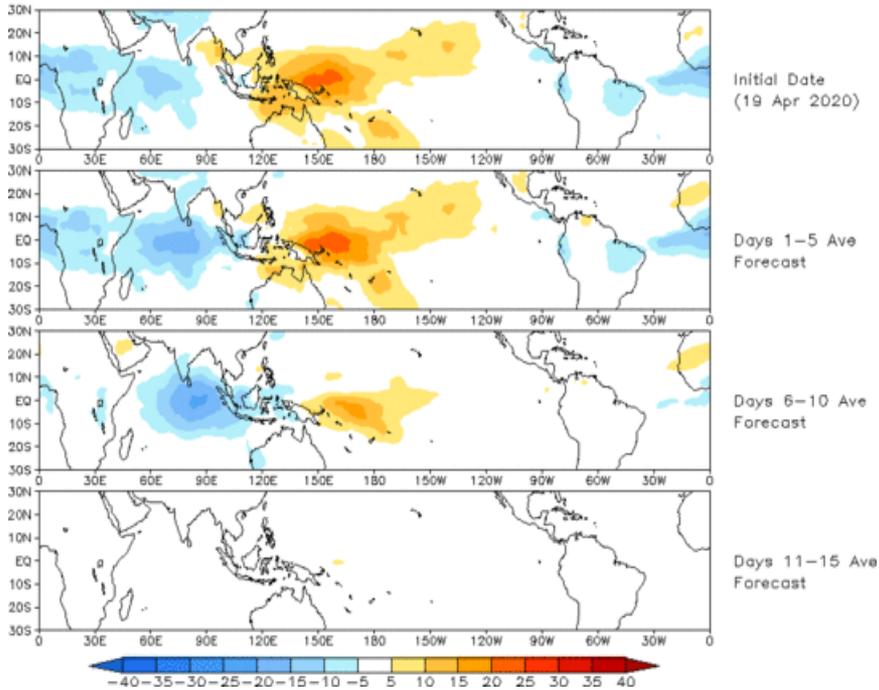
ECMWF Forecast

- Dynamical models favor a continued eastward propagating signal across the Indian Ocean during Week-1, with likely interference from Rossby wave activity during Week-2.
- Most GEFS and ECMWF ensemble members bring the index within the unit circle during Week-2, with only a few ECMWF ensemble members depicting the signal crossing the Maritime Continent.

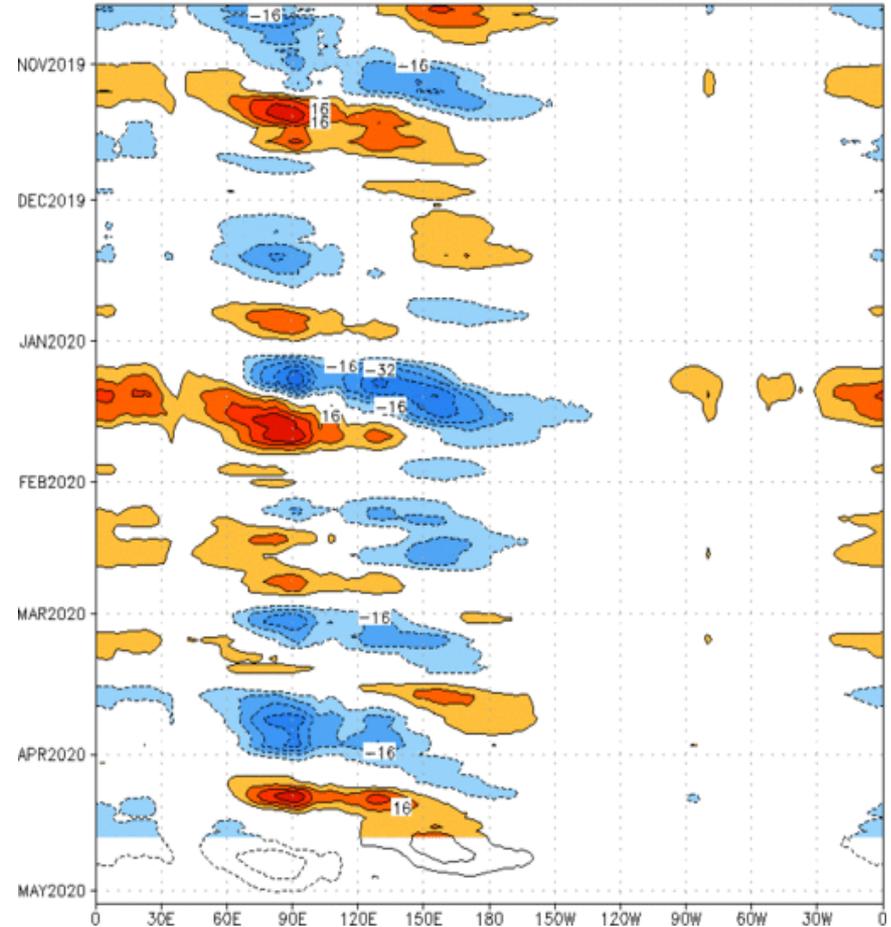
MJO: GEFS Forecast Evolution

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: 19 Apr 2020
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:19-Oct-2019 to 19-Apr-2020
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

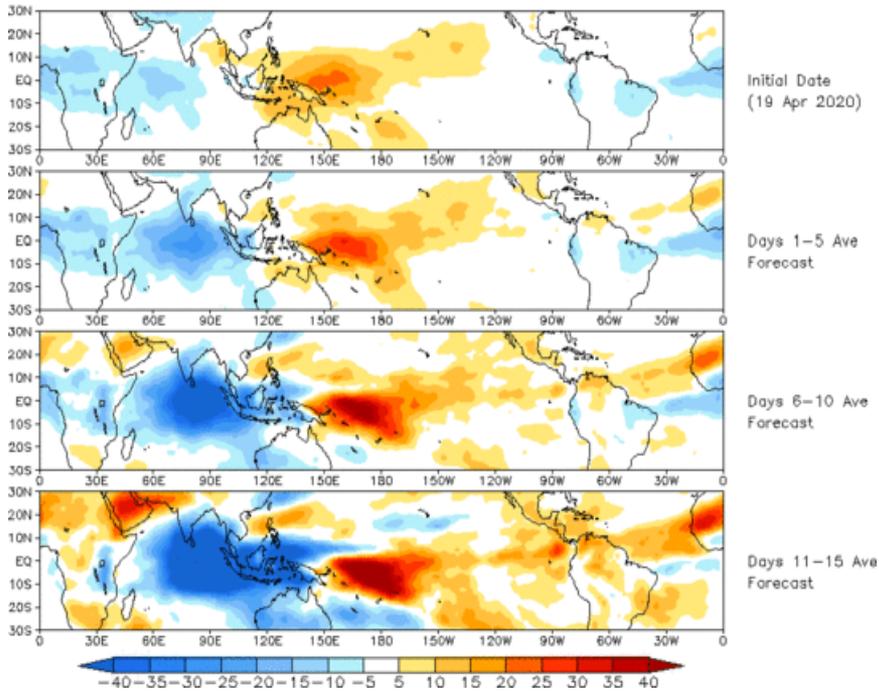


- The GEFS OLR forecast based on the RMM index shows robust convective anomalies associated with an Indian Ocean MJO event that fail to propagate to the Maritime Continent during Week-2.

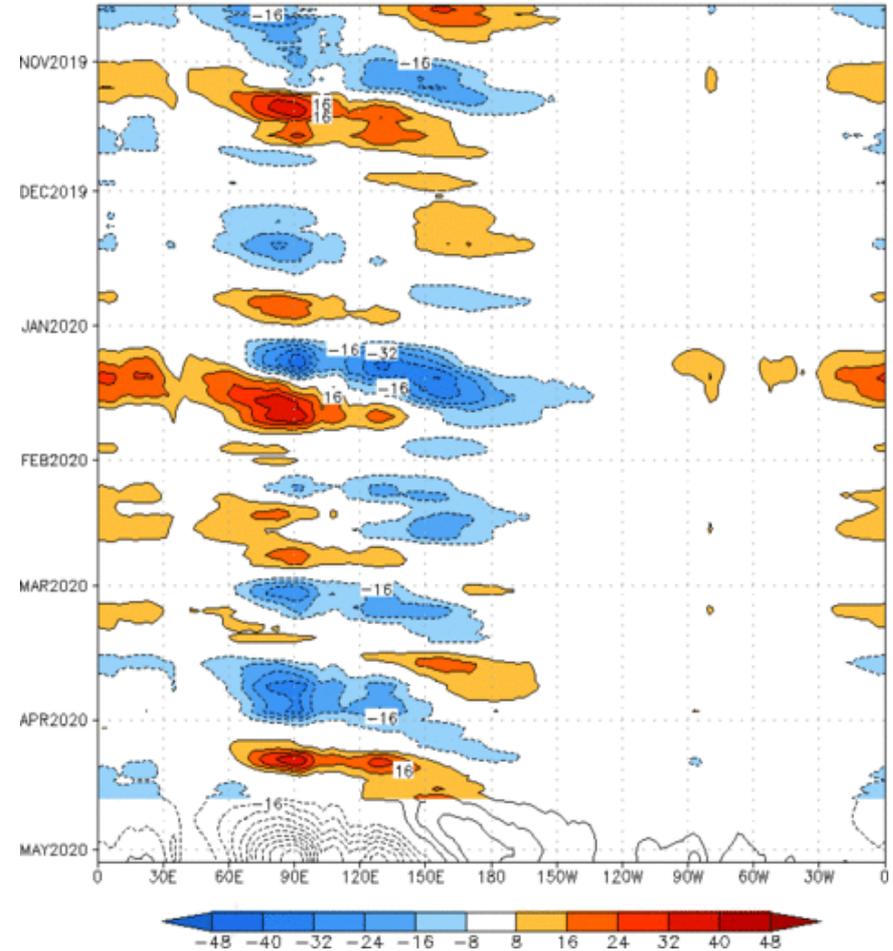
MJO: Constructed Analog Forecast Evolution

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 (19 Apr 2020)



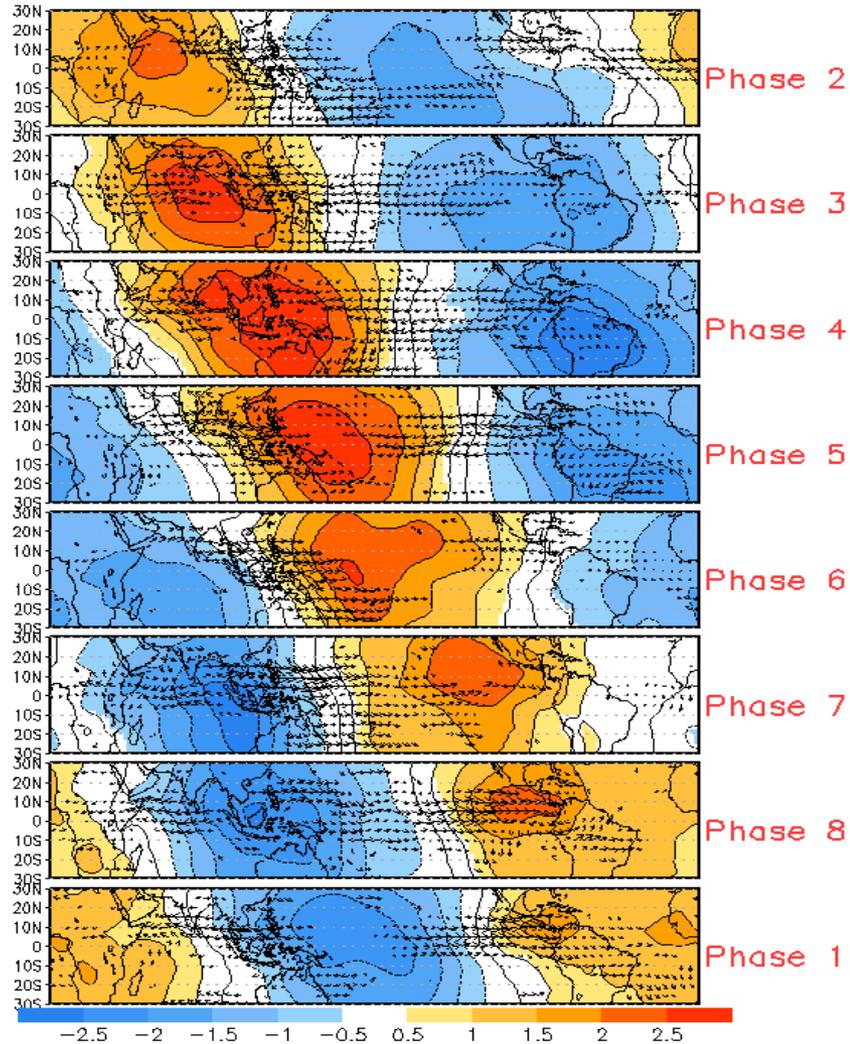
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cont:4Wm⁻²) Period:19-Oct-2019 to 19-Apr-2020
The unfilled contours are CA forecast reconstructed anomaly for 15 days



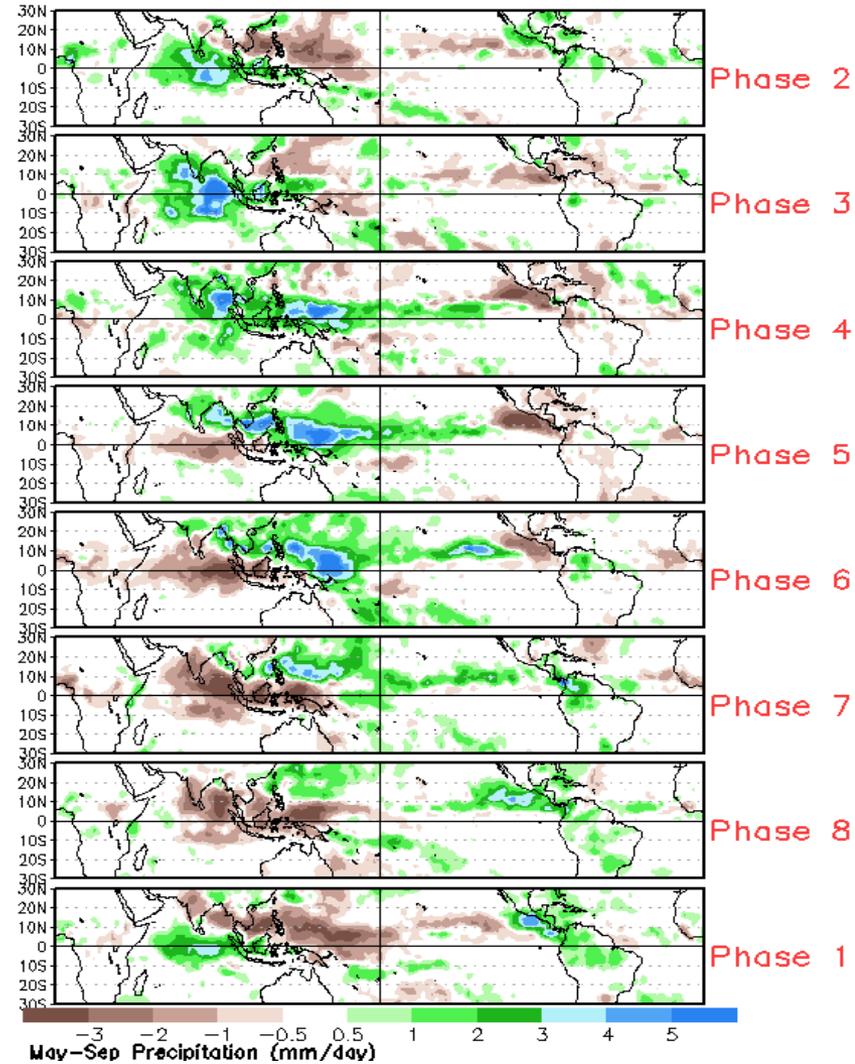
- The constructed analog forecast depicts a considerably stronger MJO event that does propagate to the Maritime Continent during Week-2.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



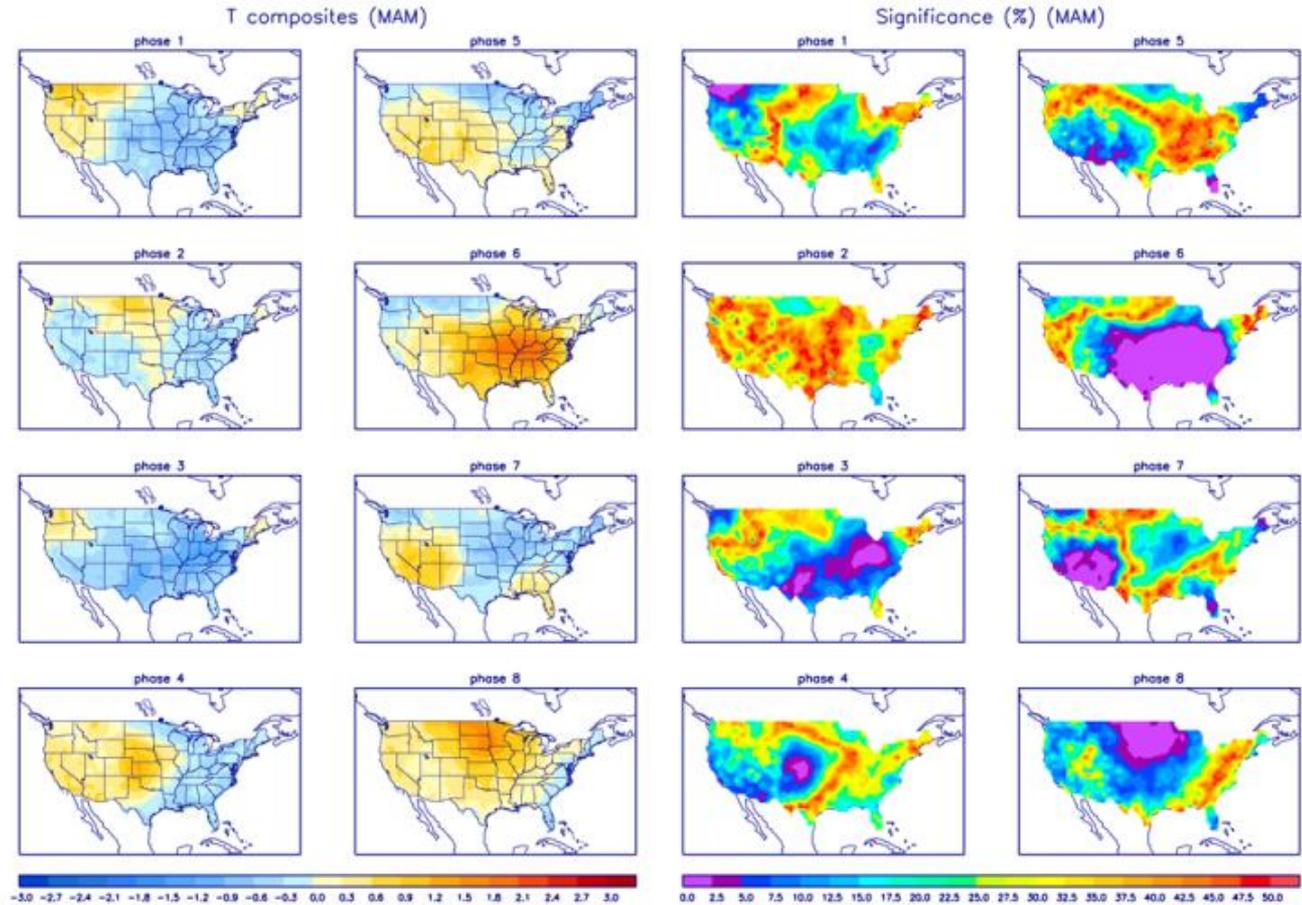
Precipitation Anomalies



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.

