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

Update prepared by the Climate Prediction Center

Climate Prediction Center / NCEP

27 April 2020

Overview

- A fast moving MJO is in RMM Phase 3. Dynamical models agree that it will propagate over the Maritime Continent during the next two weeks.

- The dynamical models weaken the MJO signal as it moves over the Maritime Continent, but this is probably due to difficulty handing convection and must be taken cautiously.

- A superposition of tropical wave modes (MJO, ER, Kelvin) over the Bay of Bengal is likely to lead to tropical cyclone development during the next several days.

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

21 APR 2020

26 APR 2020

Degrees K
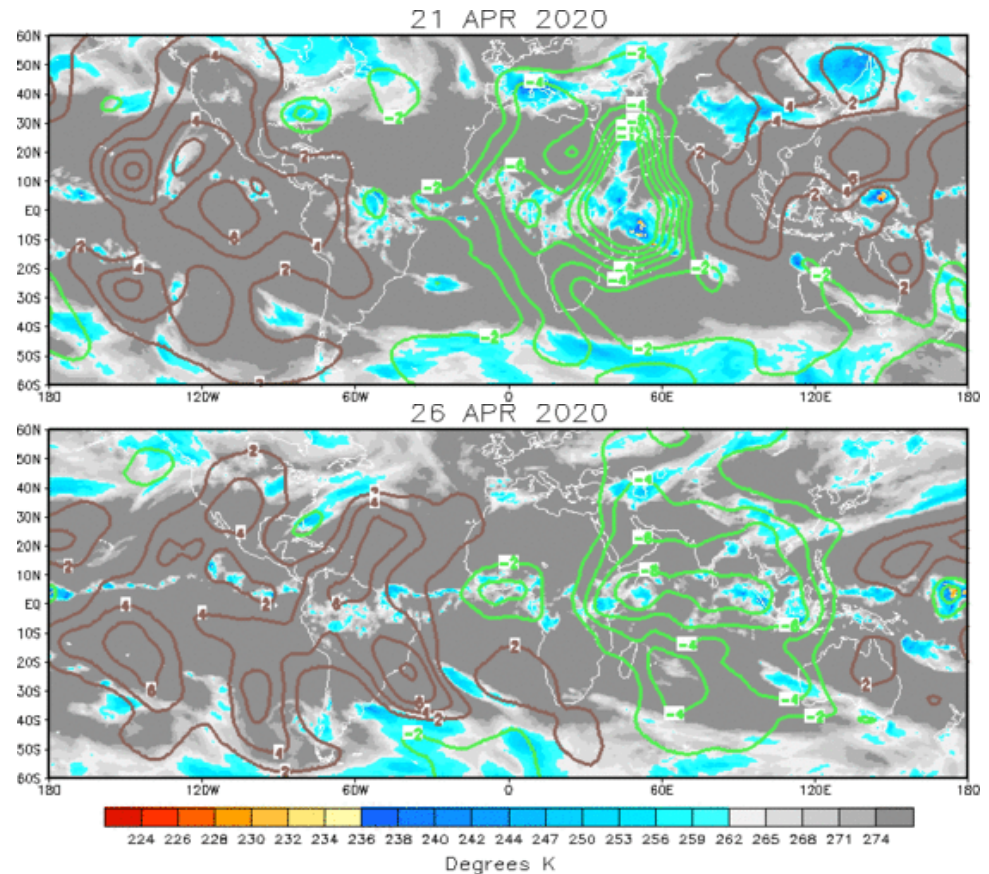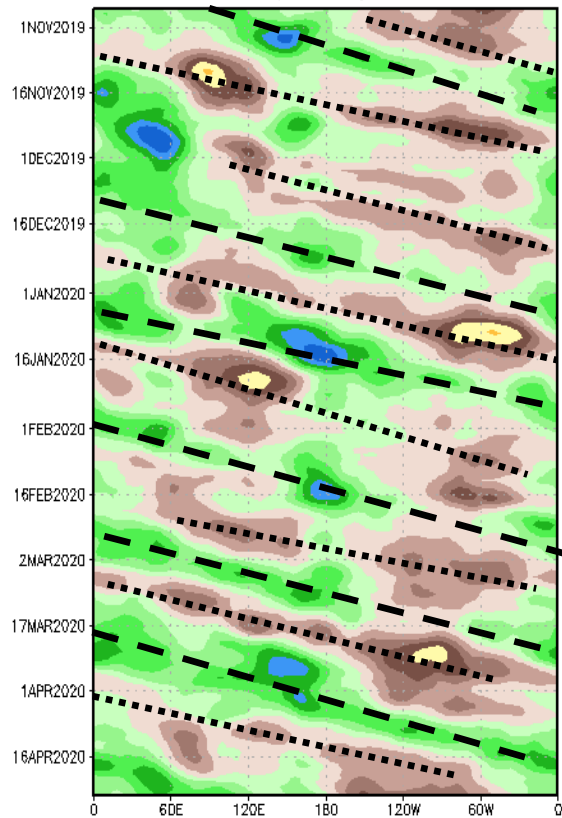
- Convection over the Indian Ocean has weakened and spread out since last week, causing the upper-level velocity potential field to weaken.
- There is still a wave-1 pattern, with a little bit a convective "noise" just west of the Dateline associated with tropical wave activity. This area has the potential to turn into a tropical cyclone during the next week.

200-hPa Wind Anomalies

Shading denotes the zonal wind anomaly. <u>Blue shades</u>: Anomalous easterlies. <u>Red shades</u>: Anomalous westerlies.
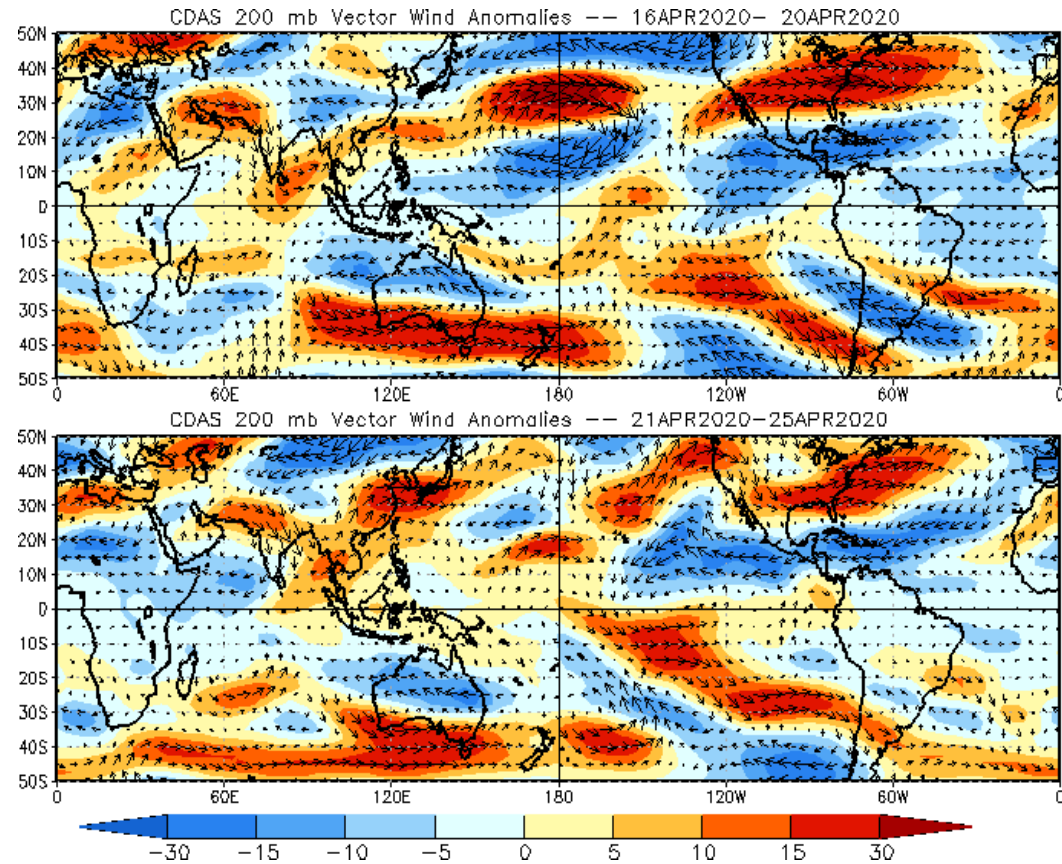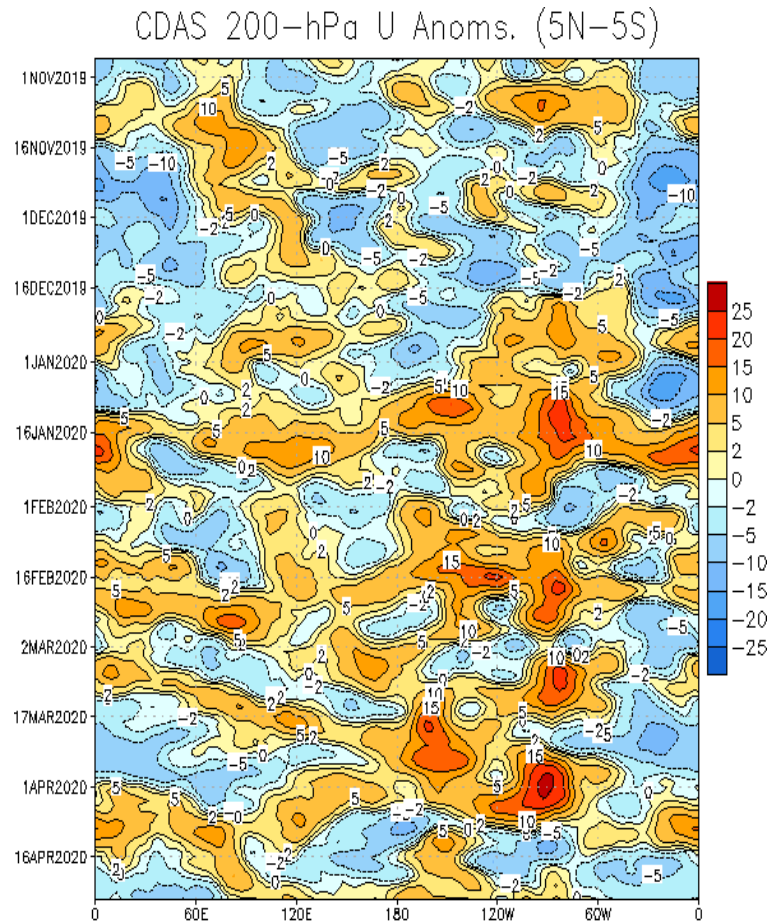
- Mid-latitude wave breaking over the central Pacific has slowed during the past week.
- There is an amplified pattern over most of the Northern Hemisphere.
- An upper-level anomalous anti-cyclone has formed over the western Indian Ocean, associated with the reduced convection that we saw in the previous slide.

850-hPa Wind Anomalies

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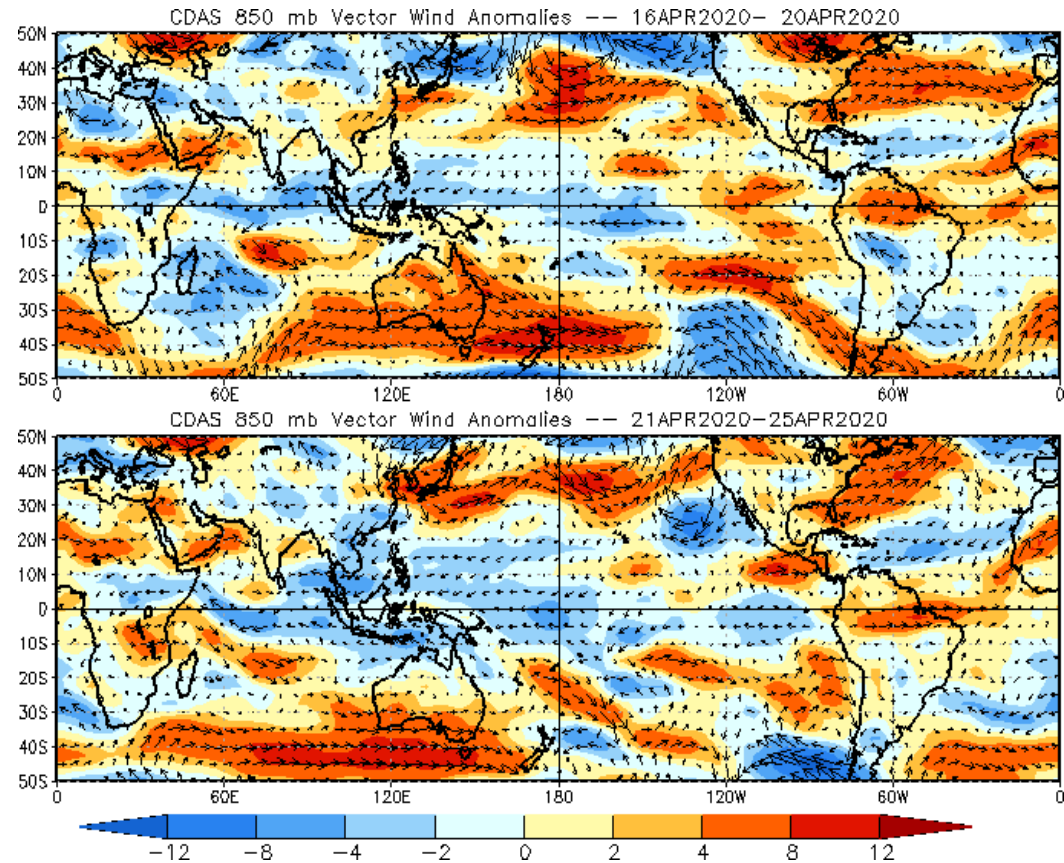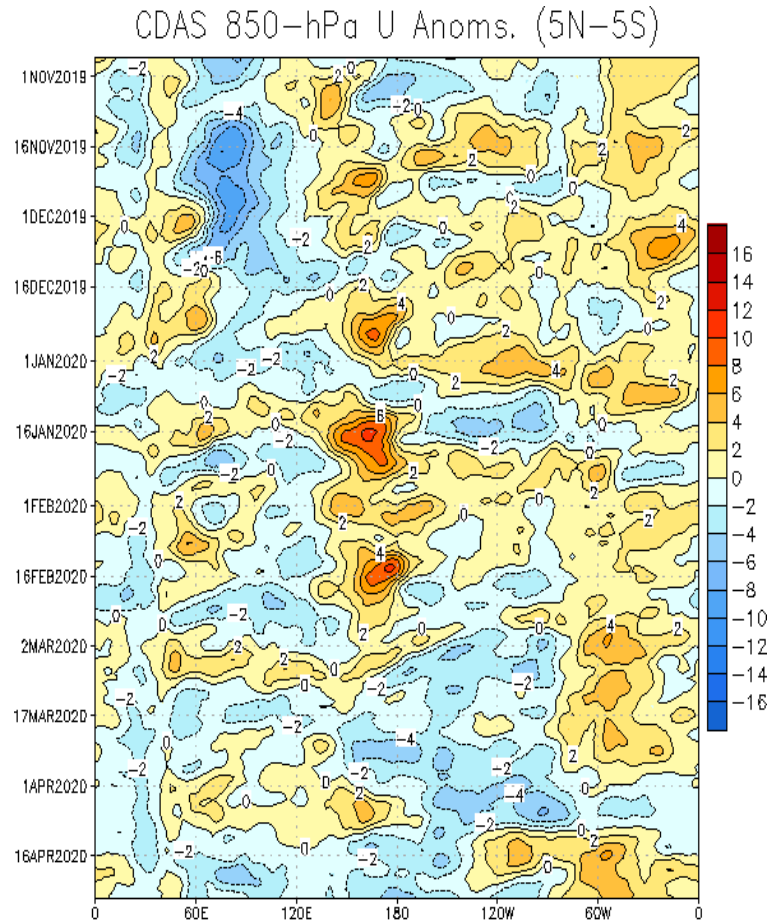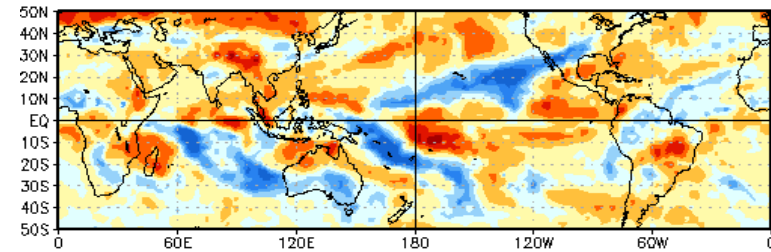

- Anomalously strong trades near the Date Line may help erode near surface oceanic warmth via upwelling relatively cooler water found at depth. This would also accelerate the decay of low frequency convection in the area.
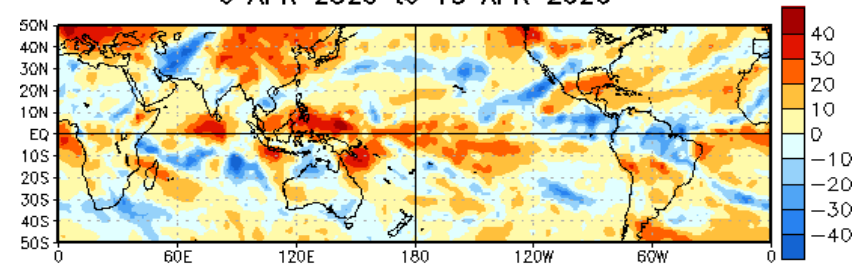
Outgoing Longwave Radiation (OLR) Anomalies

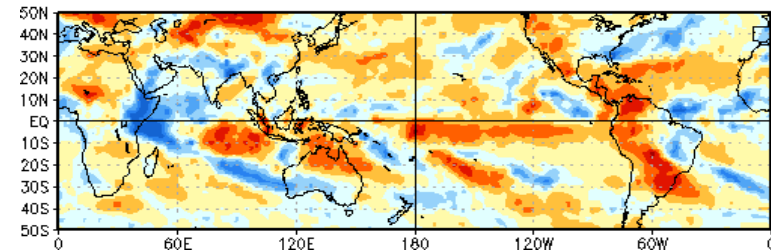Blue shades: Anomalous convection (wetness). Red shades: Anomalous subsidence (dryness).
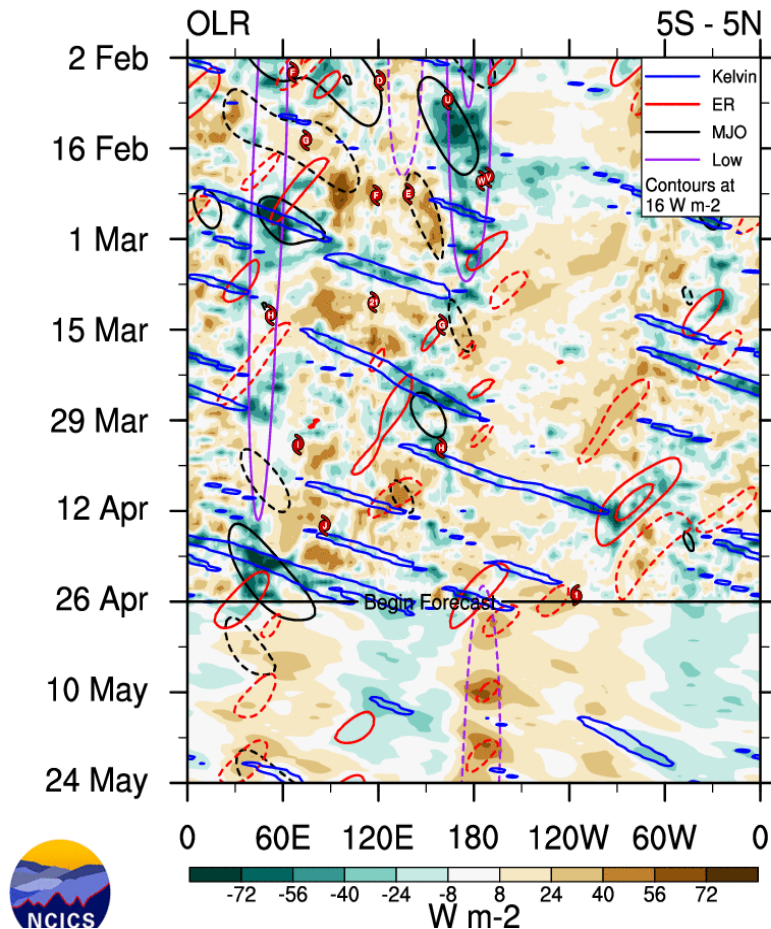
- A combination of a fast MJO, Kelvin, and equatorial Rossby wave signals is located around the Bay of Bengal. A tropical cyclone could form here during the next few days.
- The largest region of anomalously enhanced convection during the last pentad is over the western Indian Ocean and Horn of Africa.
- A strip of anomalously suppressed convection has formed just south of the Date Line over the eastern Pacific.

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific
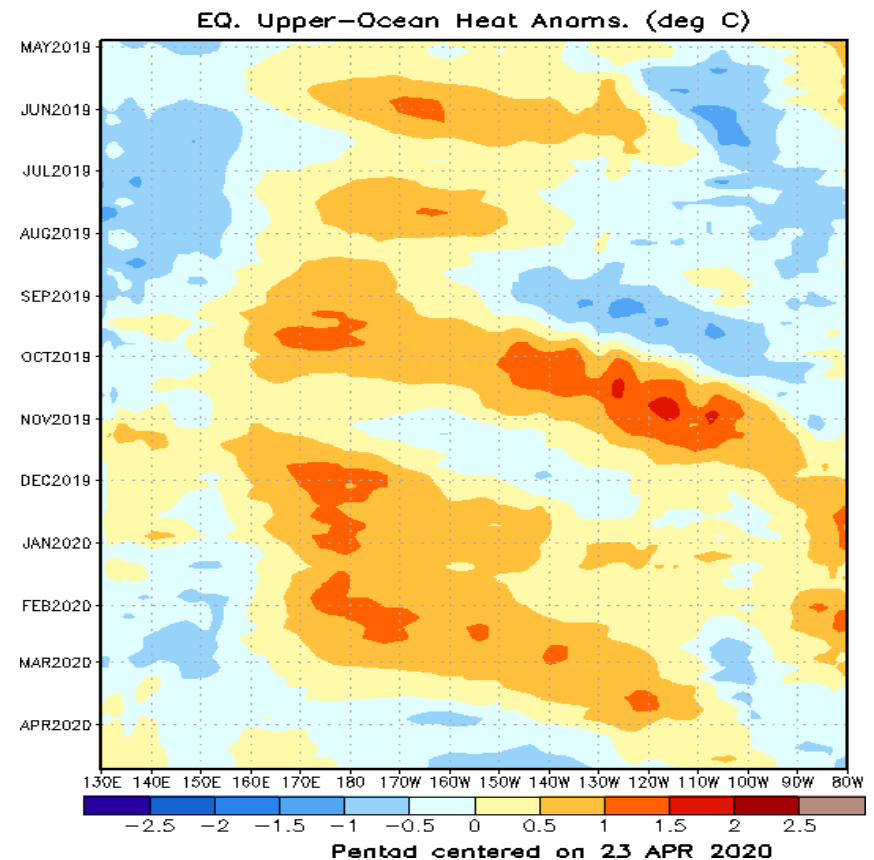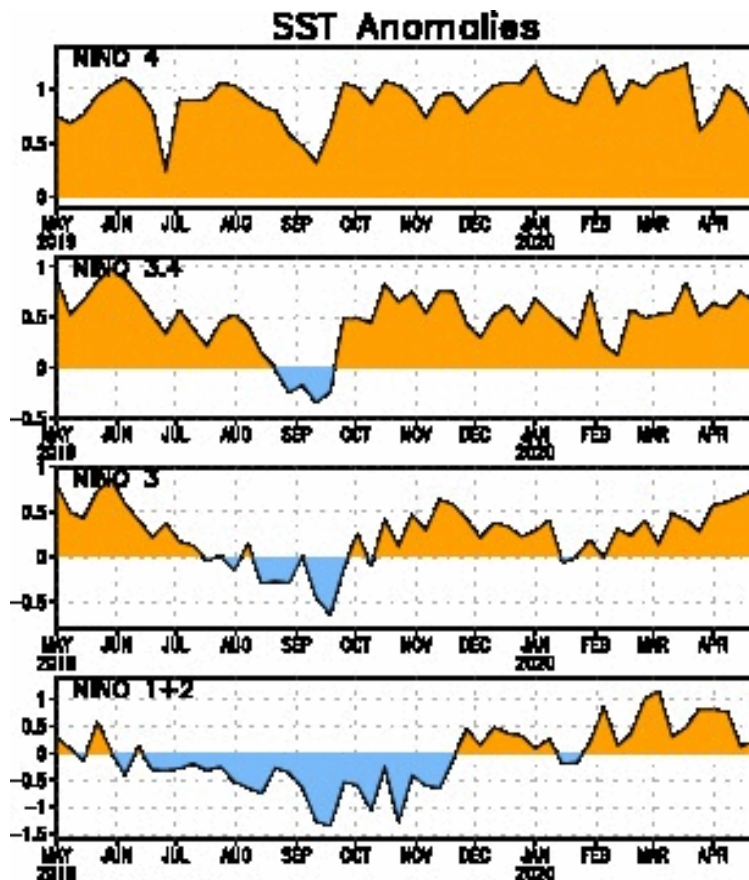
- Upper-ocean heat content anomalies remain marginally below-average over much of the equatorial Pacific, with the exception of between 135-110W where a reservoir of heat remains following a downwelling event that began during February.

- Above-average SSTs in the ENSO domains are shallow and not associated with additional downwelling events.

MJO Index: Recent Evolution

- The RMM index is located in Phase 3, over the Indian Ocean.

- The recent MJO event has been on the fast side of the spectrum, close to a 30 day period.

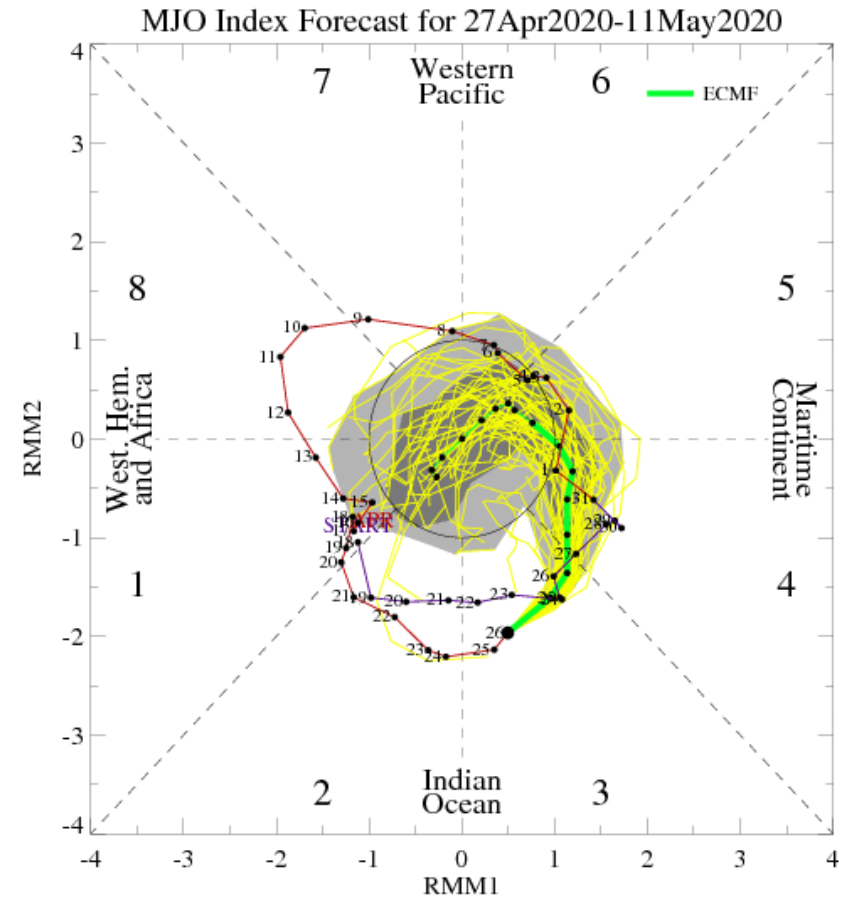[RMM1, RMM2] Phase Space for 18-Mar-2020 to 26-Apr-2020
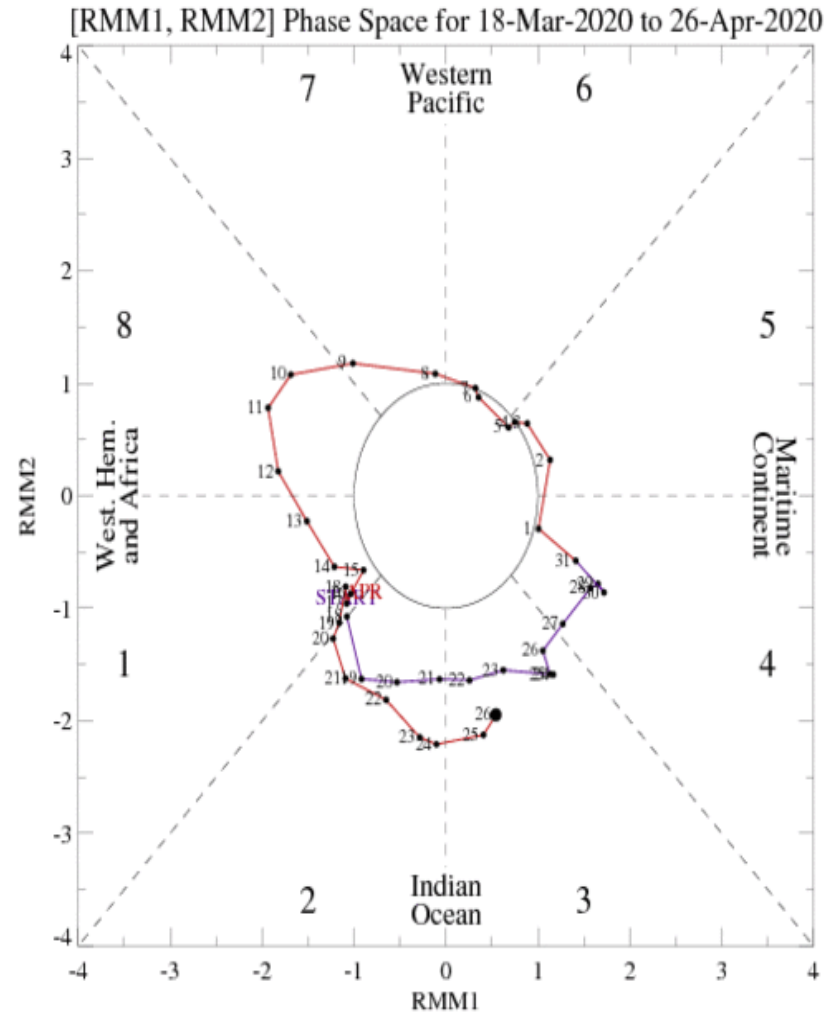
For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution
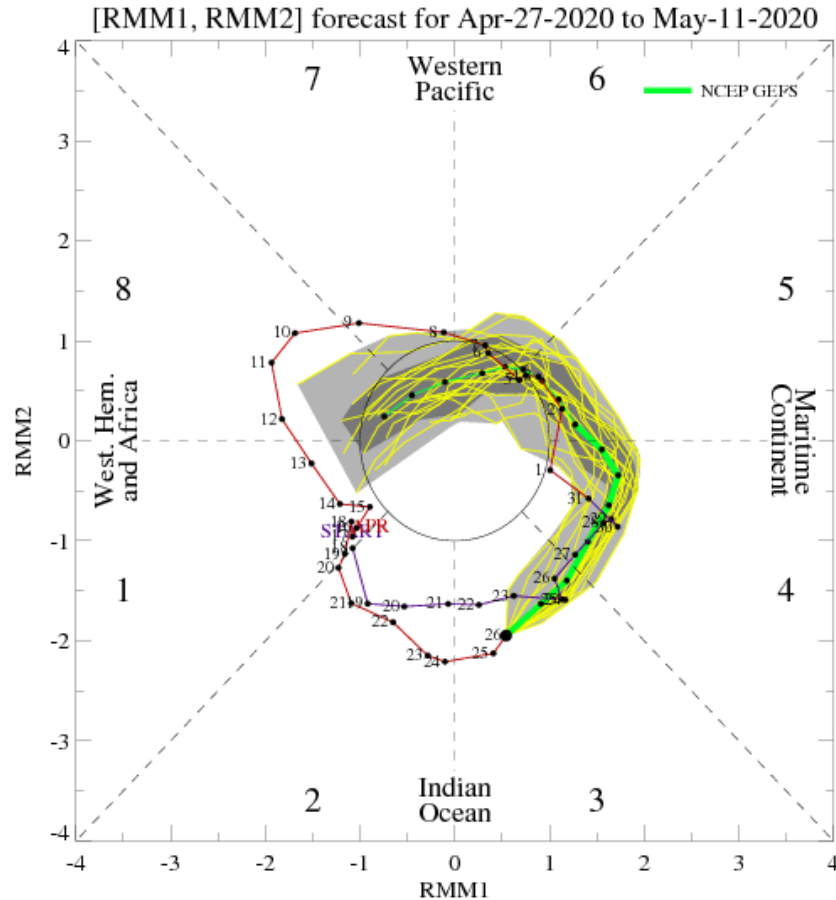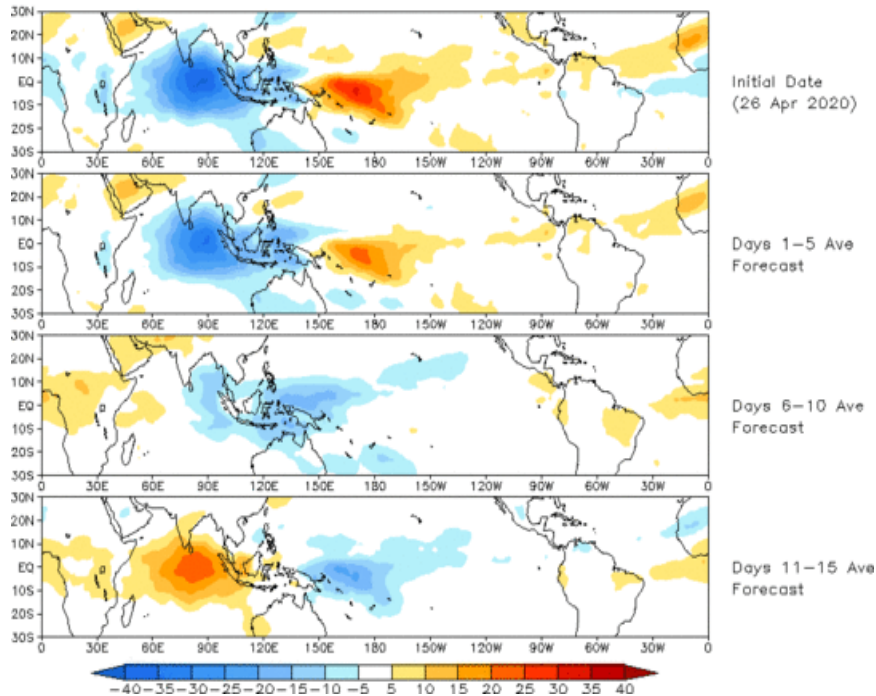

GEFS Forecast

ECMWF Forecast

- The GEFS and ECMWF have remarkably similar forecasts for the MJO.
- Both models forecast a the MJO to progress into Phase 4 and weaken as it moves over the Maritime Continent.
- It is not unusual for models to erroneously forecast the MJO to weaken over the Maritime Continent.
  - This is mainly due to difficulty properly simulating convection over the islands.

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: 26 Apr 2020
OLR

Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:26-Oct-2019 to 26-Apr-2020
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

- This is very similar to the GEFS RMM forecast, although it suggests that convection may stay intact as if moves over the Maritime Continent.
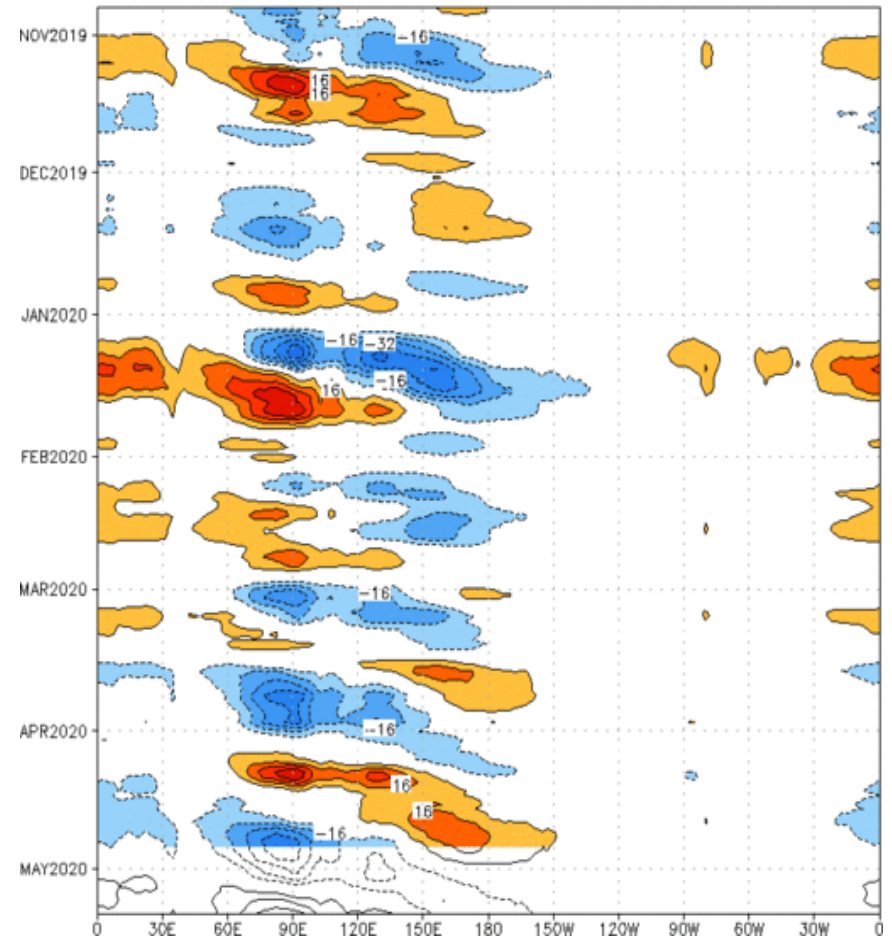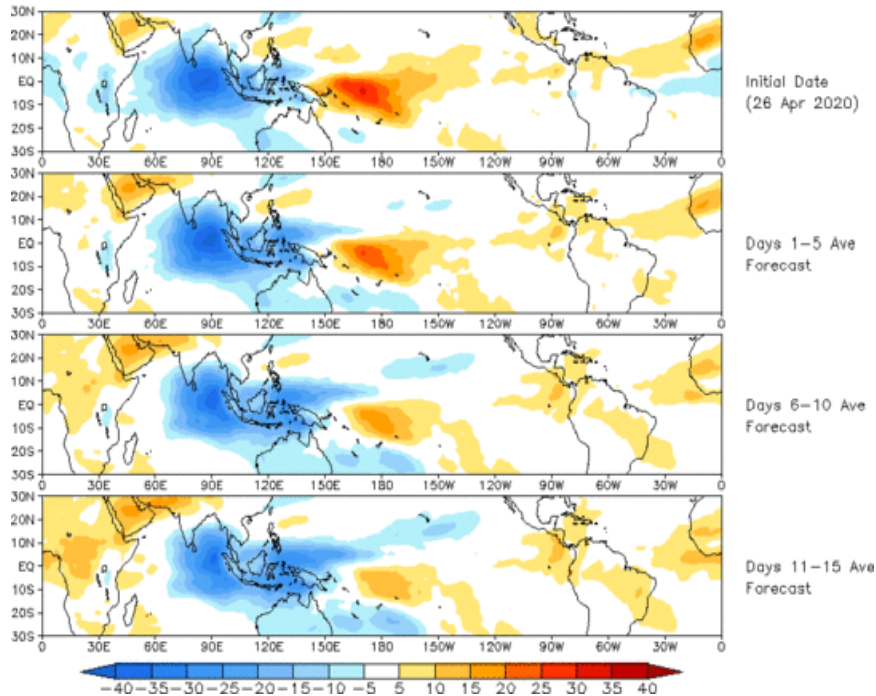
MJO: Constructed Analog Forecast Evolution

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 (26 Apr 2020)

Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:26−Oct−2019 to 26−Apr−2020
The unfilled contours are CA forecast reconstructed anomaly for 15 days

- The constructed analog forecast, which isn't subject to the same convection issues that dynamical models are, forecasts a strong MJO to pass over the Maritime Continent.
- The constructed analog forecast also appears to slow the MJO more than the dynamical models do.
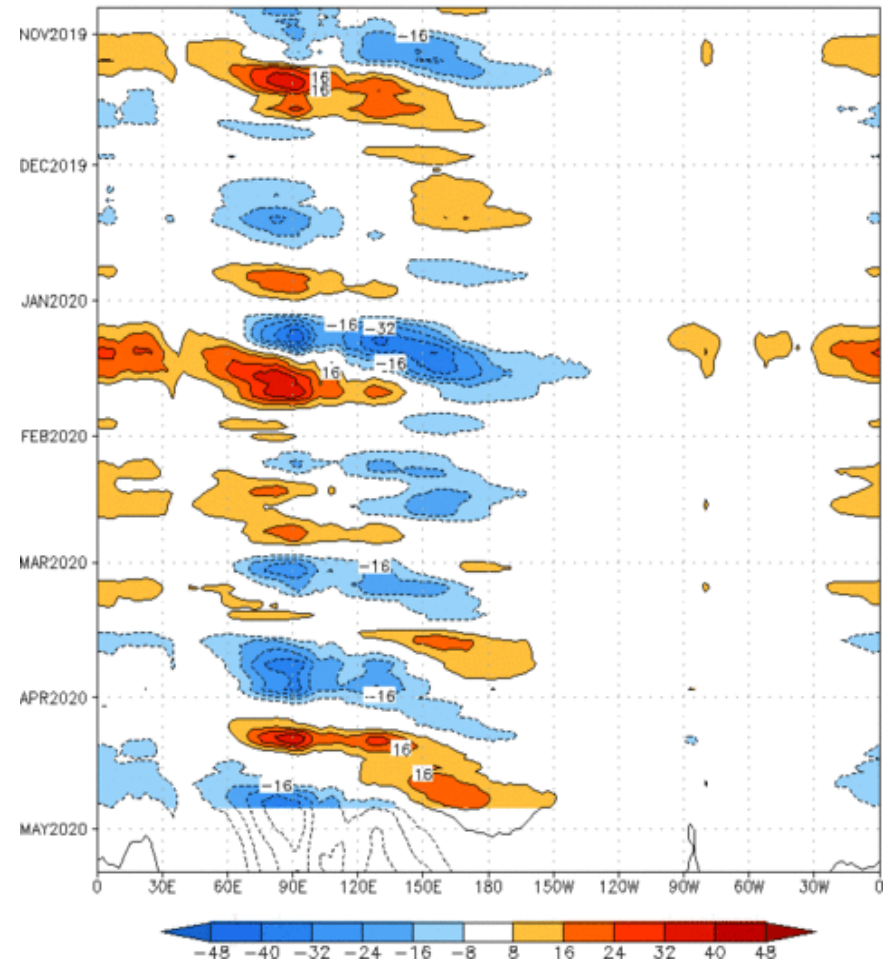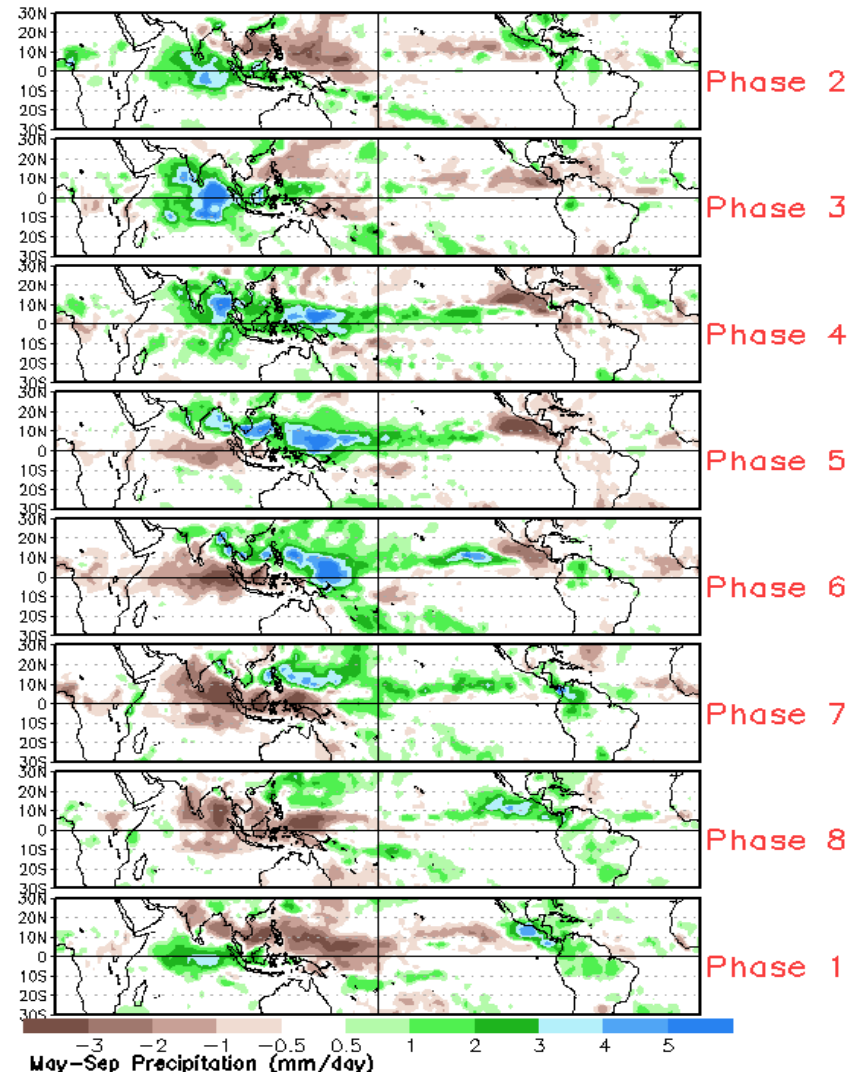
MJO: Tropical Composite Maps by RMM Phase

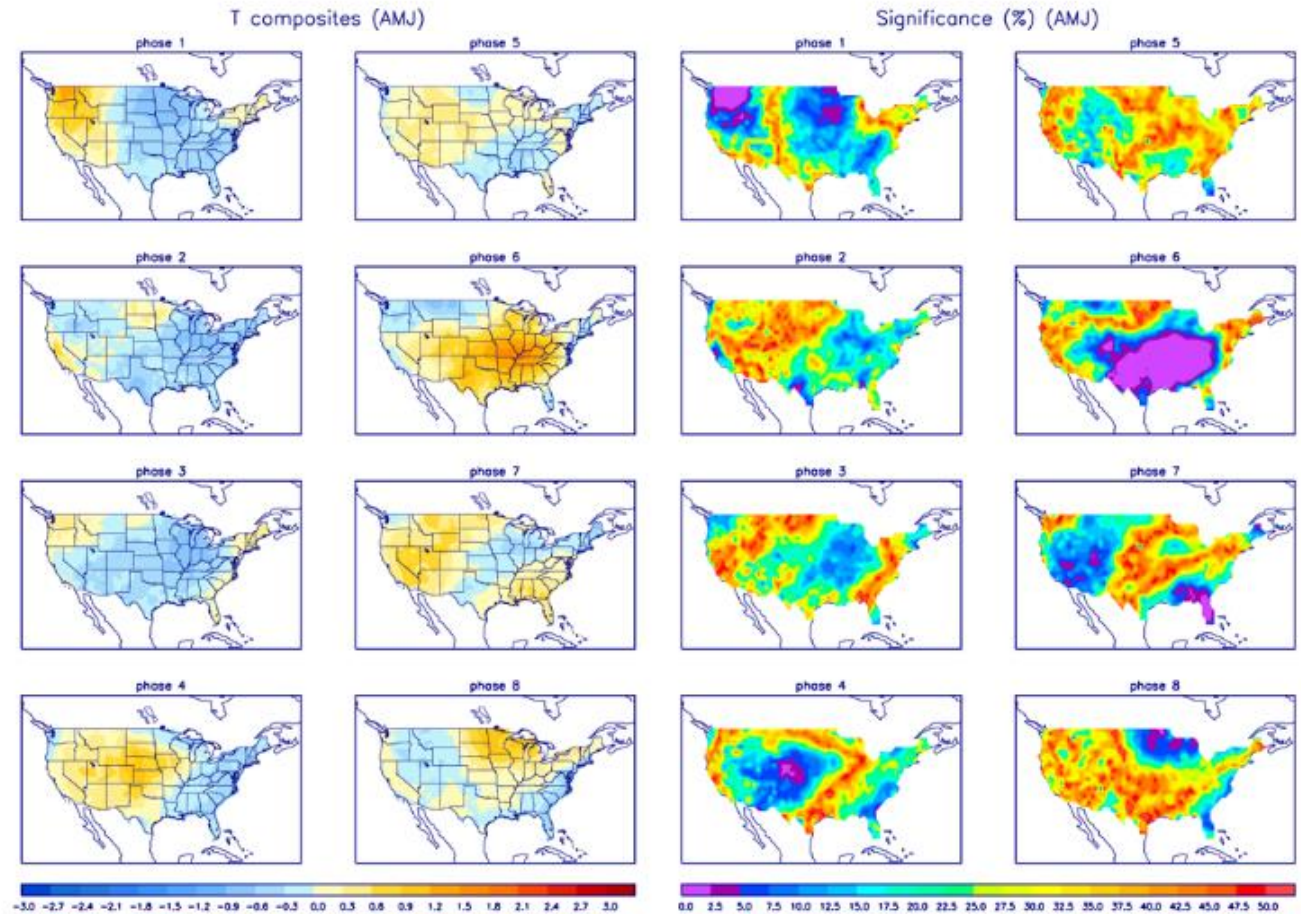850-hPa Velocity Potential and Wind Anomalies
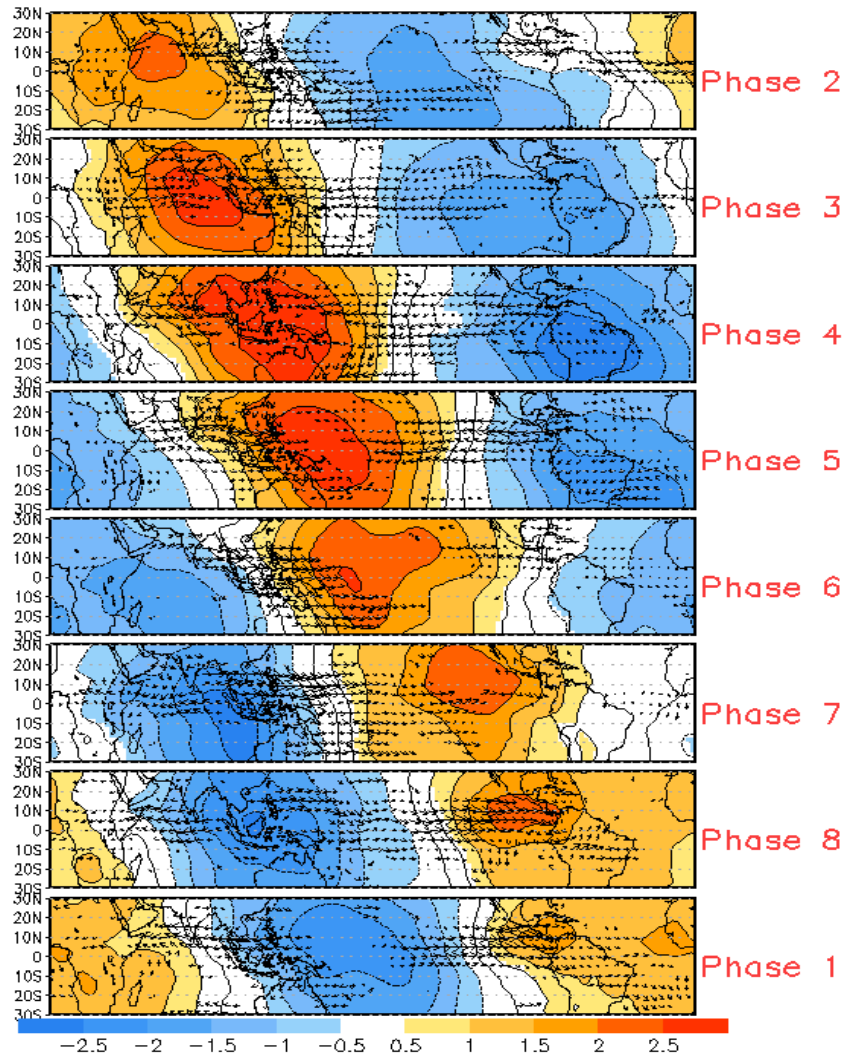
Precipitation Anomalies

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.

More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

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.

More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml