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

Update prepared by the Climate Prediction Center
Climate Prediction Center / NCEP
17 February 2020

Overview

- Enhanced convection over the Western Pacific amplified over the past week, becoming the more dominant center of action in the tropics. Constructive interference from a Kelvin wave moving eastward out of the Indian Ocean aided in this strengthening. Westward propagating Rossby waves and tropical cyclone activity has led to a stall in the eastward propagation of the convective envelope.

- Dynamical model guidance indicates that this enhanced convection is likely to decay over the next week, but possibly continue eastward propagation with the weakened signal. The ECMWF and GEFS guidance show differing solutions on the RMM index as we move into week-2; however, both signals are fairly unorganized, diminishing confidence in forecasts for any strong renewed signal for the MJO toward the end of the month.

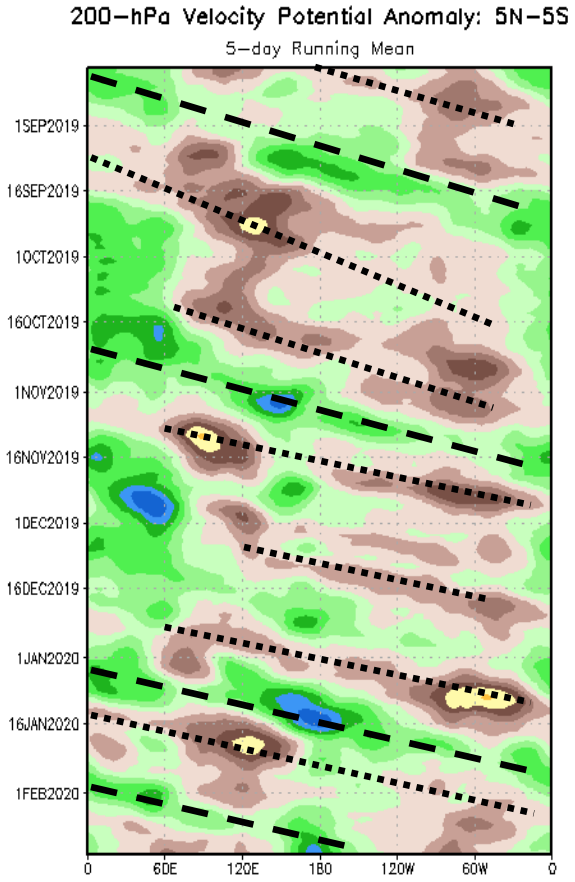
- Growing anomalous low-level westerly winds along the equator in the western Pacific is starting to show impacts on the upper-oceanic heat content anomalies. This could have further implications for the El Niño state if the downwelling continues, increasing the available warm water at depth across the basin.

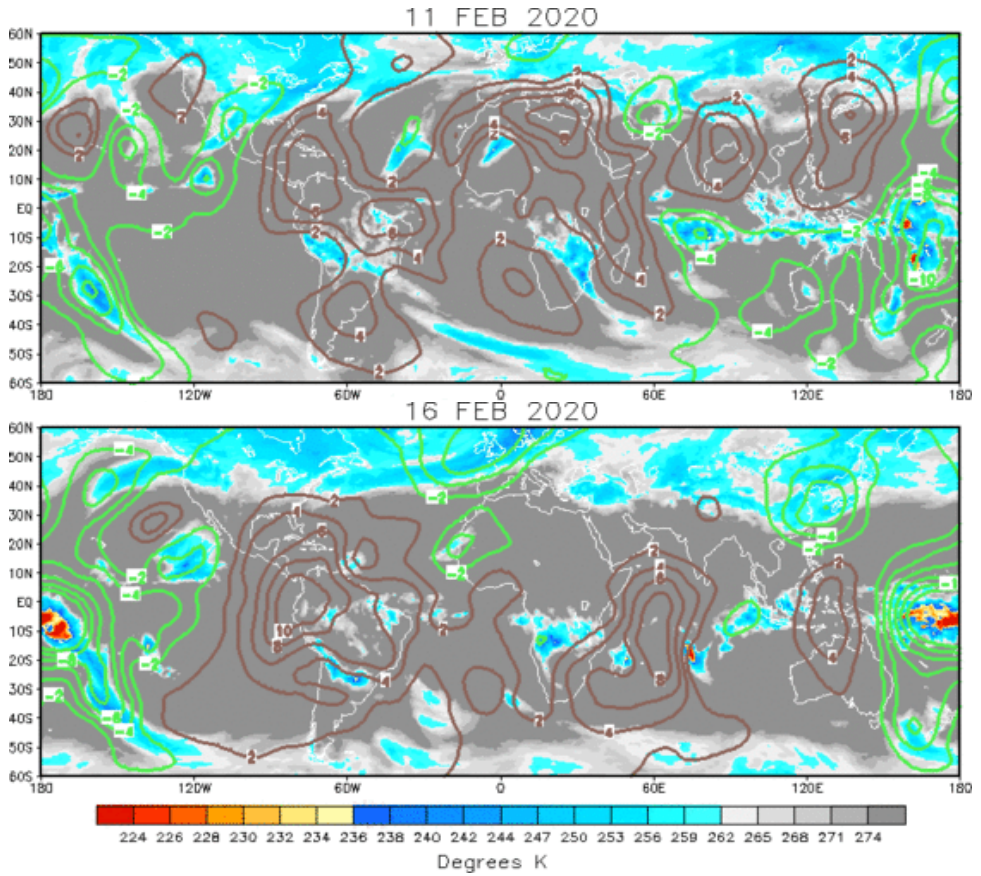
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation).

Brown shades: Anomalous convergence (unfavorable for precipitation).

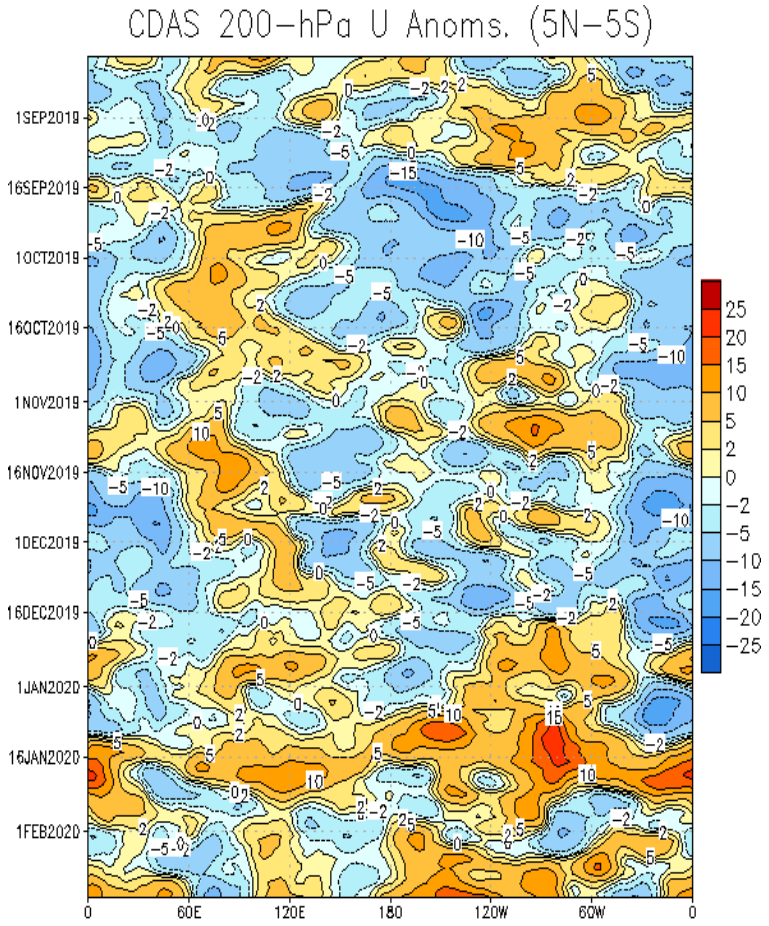


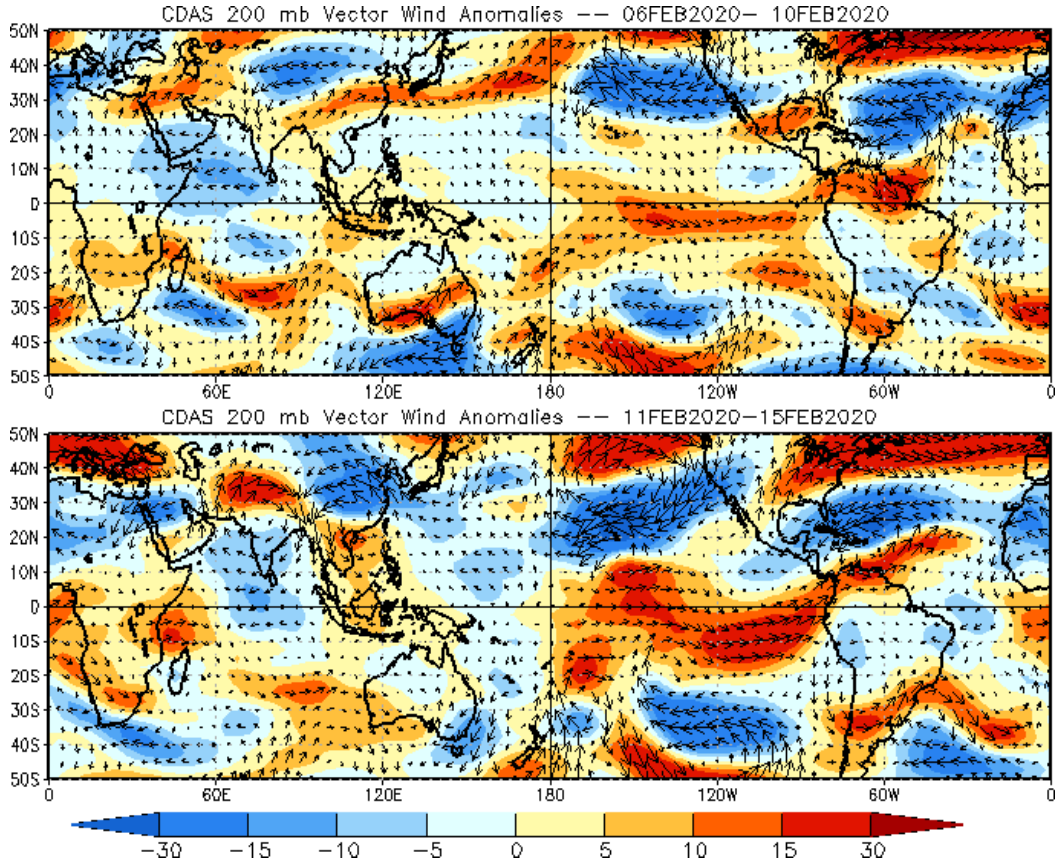


- The enhanced convective envelope that was seen earlier this month over the Western Hemisphere and Indian Ocean has continued its eastward propagation to the eastern Maritime Continent and western Pacific, where it has strengthened.
- The spatial plot of the upper level anomalies remains noisy through the past week, indicating several competing modes of variability are likely in play for the tropics. The Hovmöller diagram (left graphic) does show though that the enhanced convective envelope has persisted since the start of 2020.

200-hPa Wind Anomalies

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

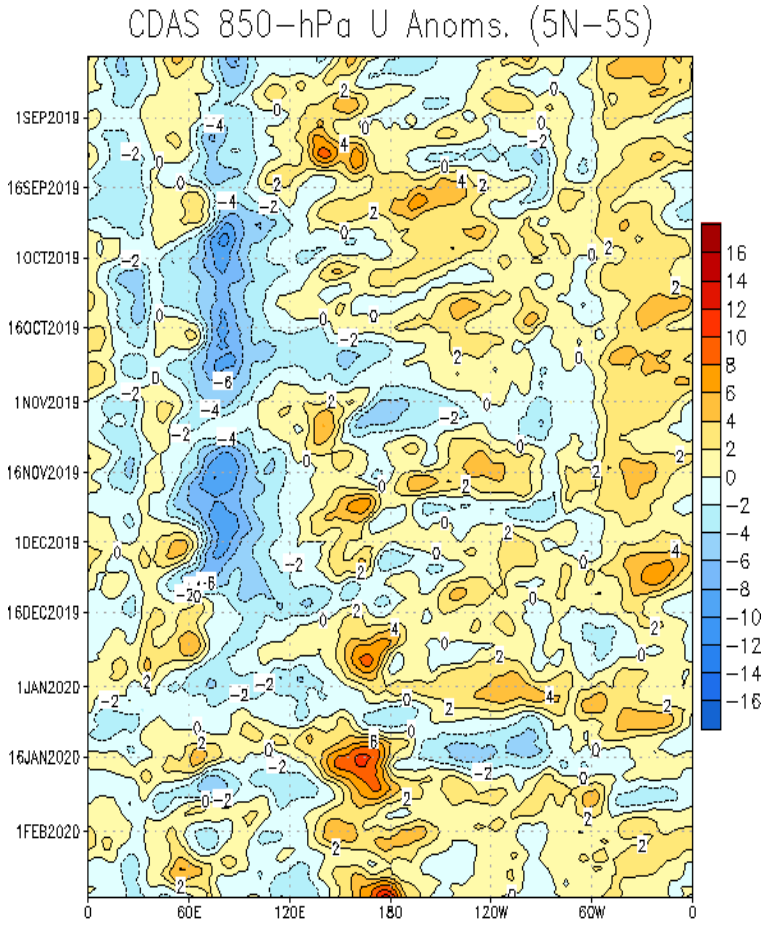


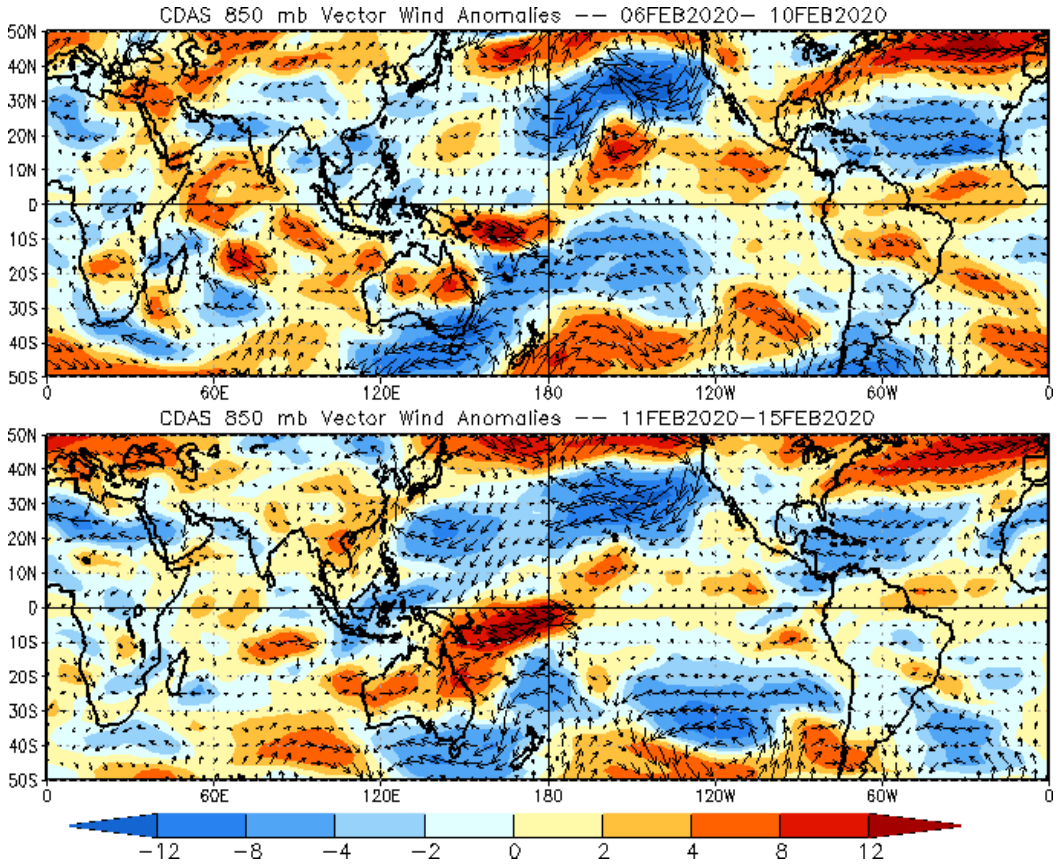


- Strong anomalous westerlies east of the Date Line have strengthened over the past week. These anomalous westerlies have been mostly dominant over the eastern Pacific since the start of the year.
- Other anomalous flow along the equator remains fairly weak. In the extratropics, strong cyclonic flow can be seen north of the anomalous easterlies, near Hawaii.

850-hPa Wind Anomalies

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

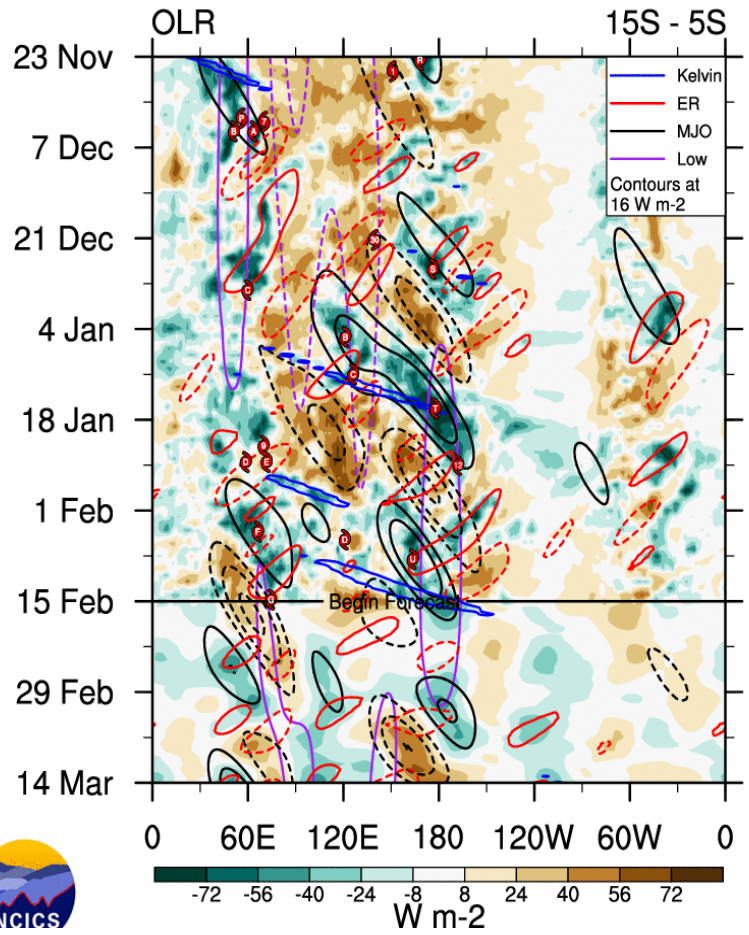


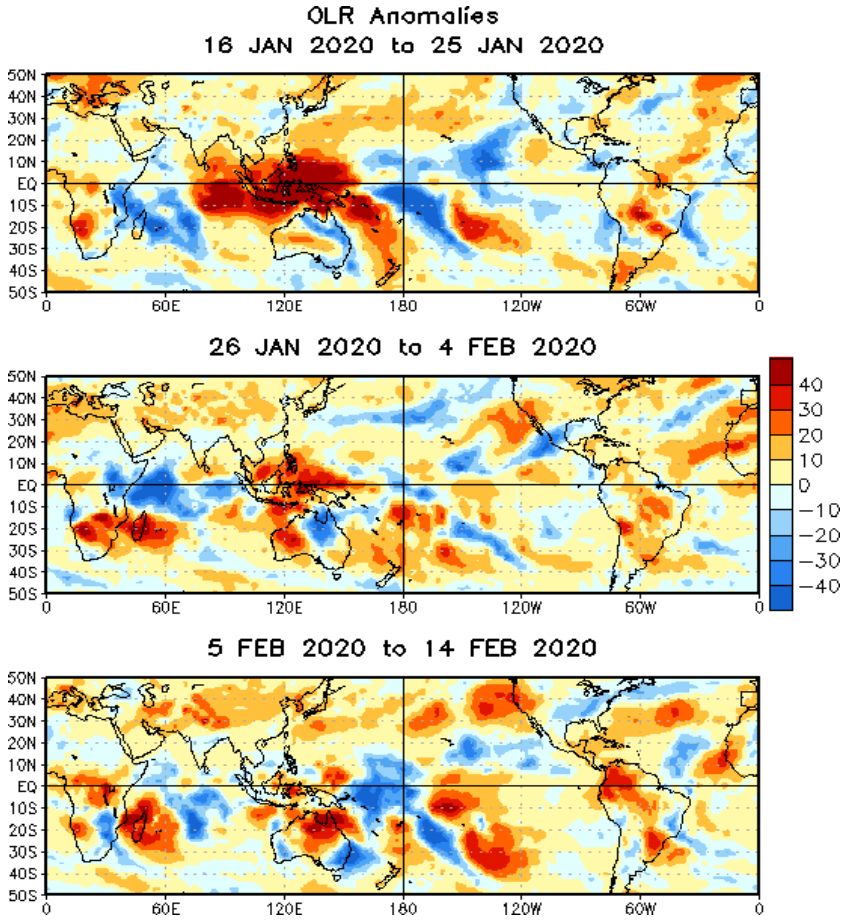


- The small region of strong anomalous westerlies expanded over the western Pacific during the past week, with anomalous easterlies to its north and south. These westerlies could impact ocean heat content along the equatorial Pacific if a downwelling oceanic Kelvin wave is triggered.
- Amplified anticyclonic flow over the northeastern Pacific has been persistent over the last two weeks, leading to increased moisture transport into the Pacific Northwest. Precipitation totals are over 150% of normal for this region in the past month. Meanwhile, California has seen little/no precipitation.

Outgoing Longwave Radiation (OLR) Anomalies

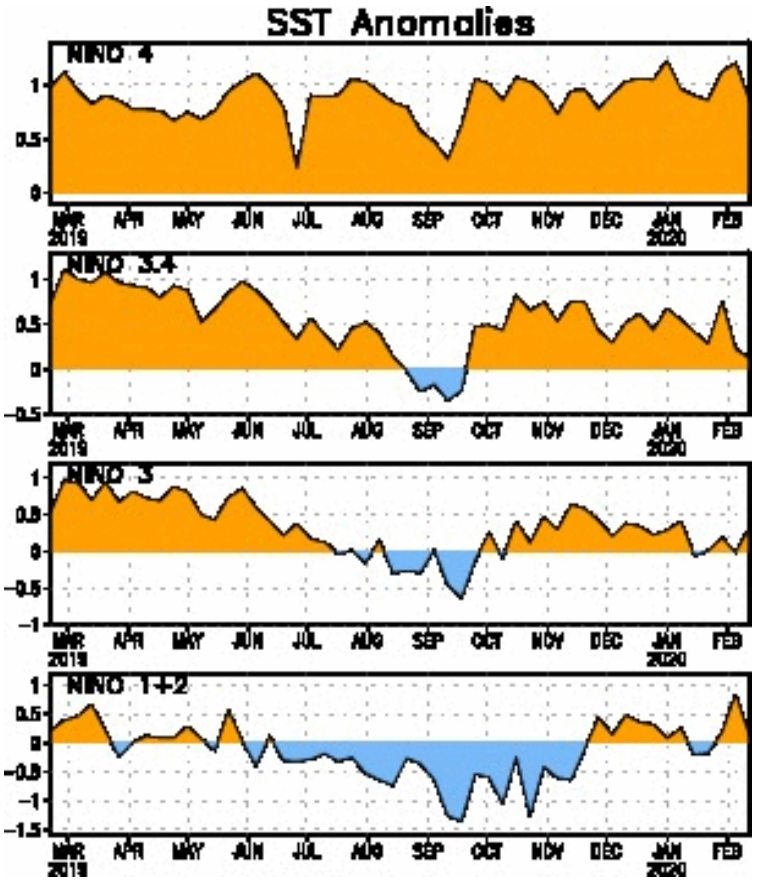
Blue shades: Anomalous convection (wetness). Red shades: Anomalous subsidence (dryness).

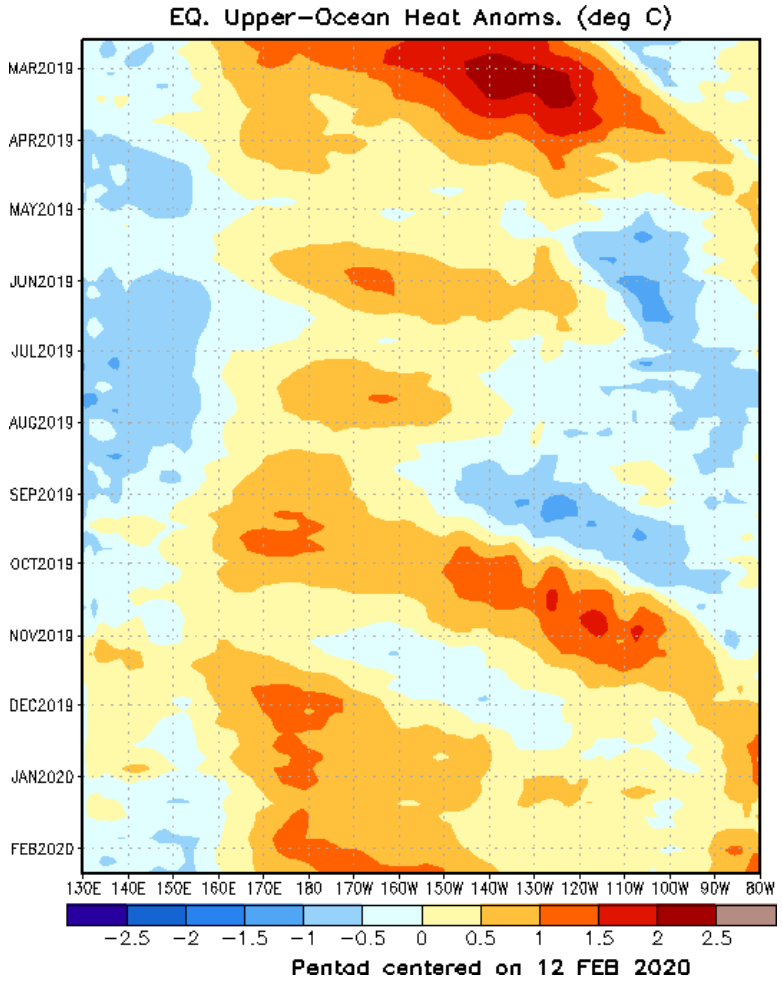




- The OLR hovmöller shows a very noisy field, with several modes of variability active across the tropics. The enhanced convective signal has organized and strengthened in the West Pacific. Eastward propagation of the second center of action in the Indian Ocean was aided by a Kelvin wave.
- Tropical cyclone activity (an equatorial Rossby wave) over the southern Indian Ocean contributed to a slight enhancement of convection across the basin.

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

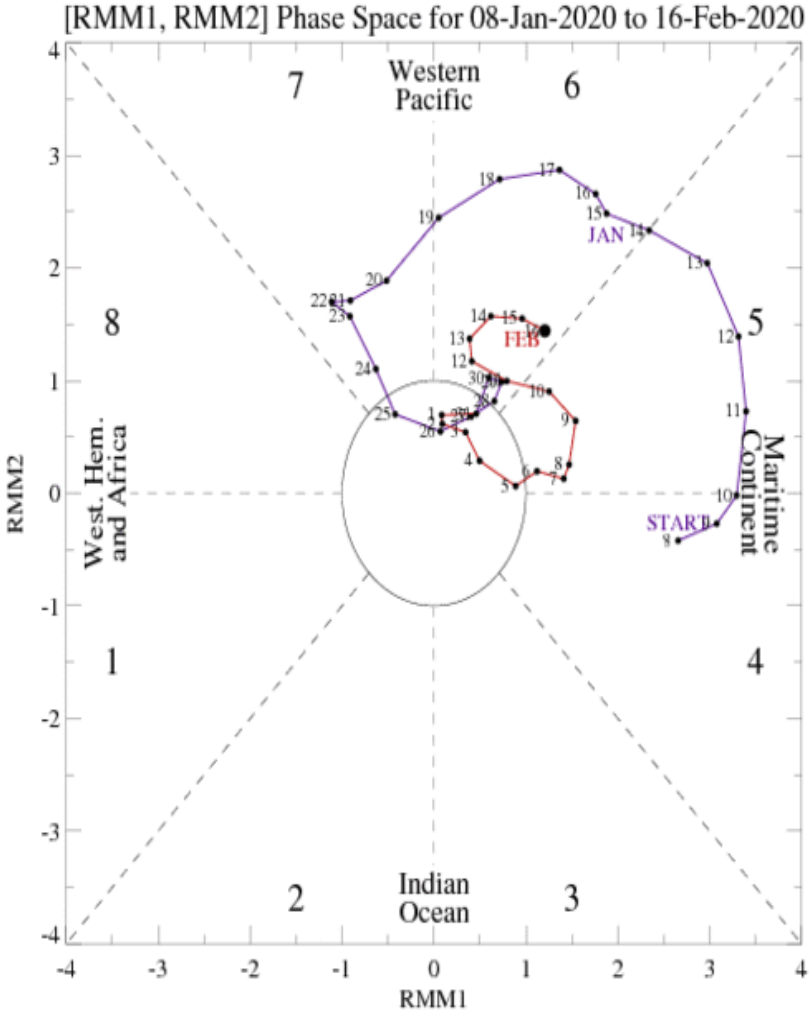




- Upper-oceanic heat content anomalies remain slightly above-normal across most of the basin.
- Several episodes of westerly wind bursts west of the Date Line have contributed toward a downwelling event that has been ongoing since mid-December. The ongoing event seems to be contributing to a push of the highest temperature anomalies further east across the basin.

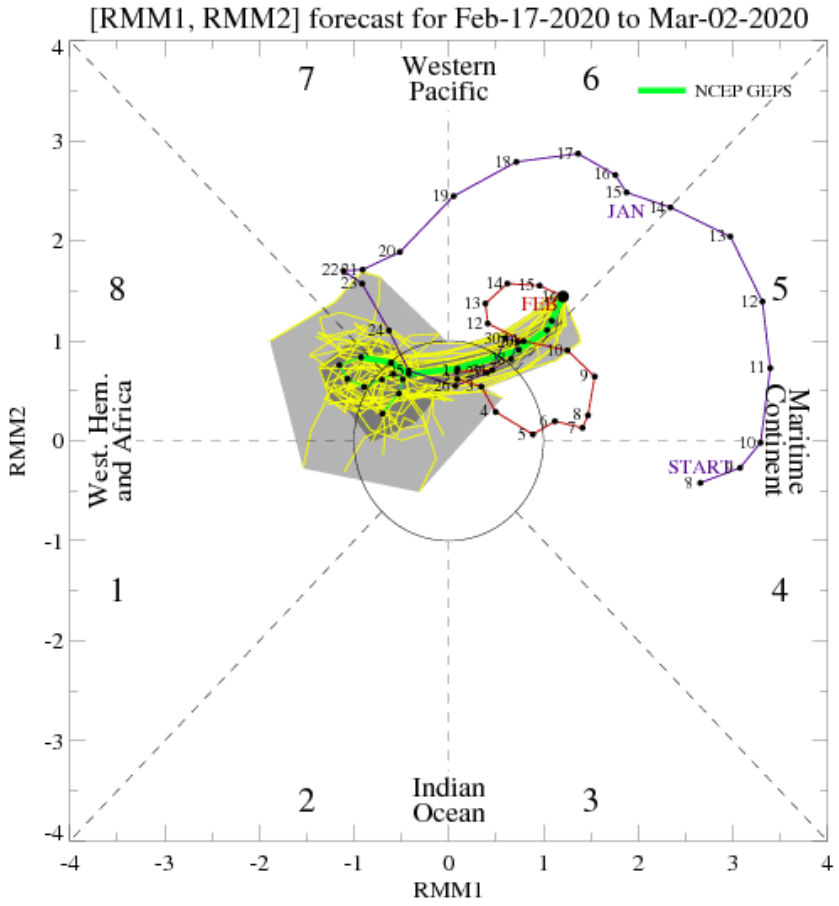
MJO Index: Recent Evolution

- In early February, renewed signal strength on the RMM index indicated the MJO signal emerging over the Maritime Continent. Since then, there was consistent eastward propagation toward the western Pacific until mid-week last week.
- Interactions with a Rossby wave and tropical cyclone activity in the South Pacific has stalled the signal and retrograded it westward.

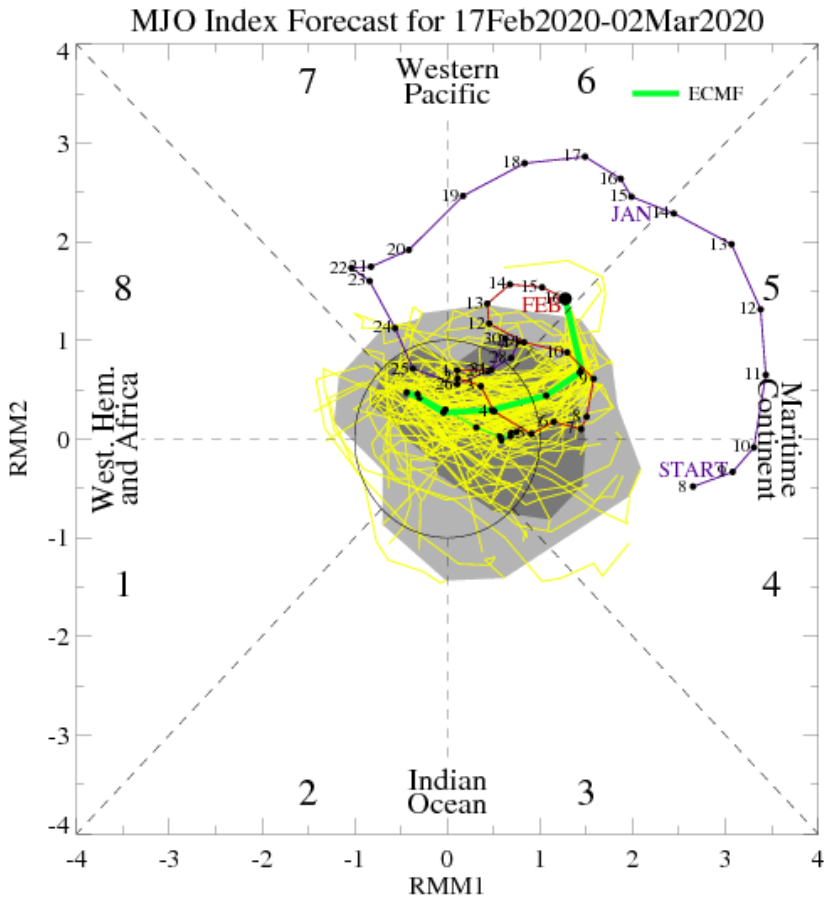


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast

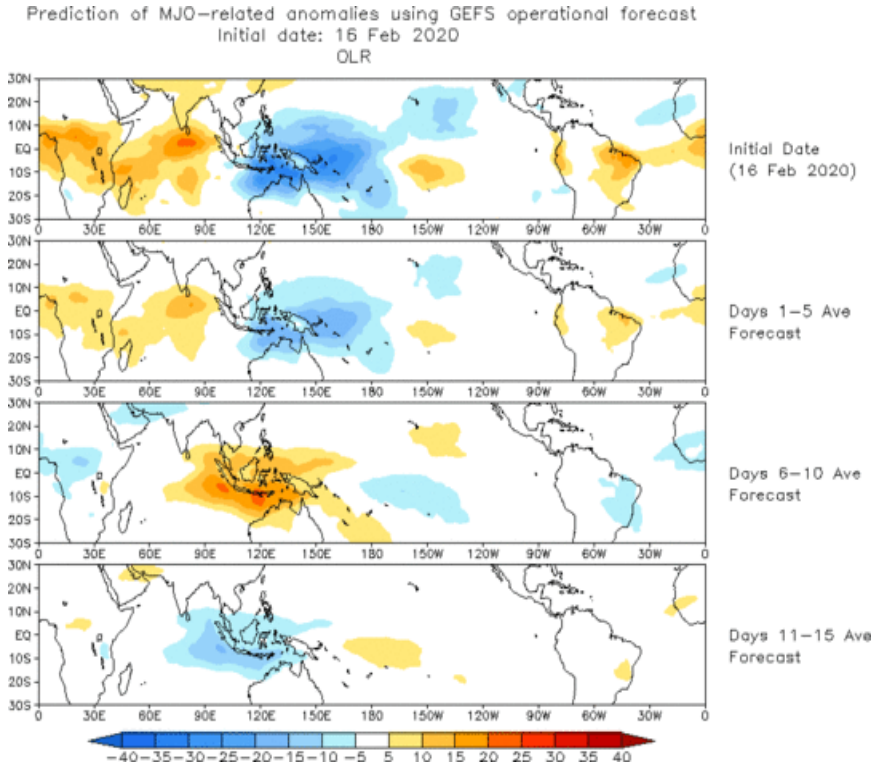


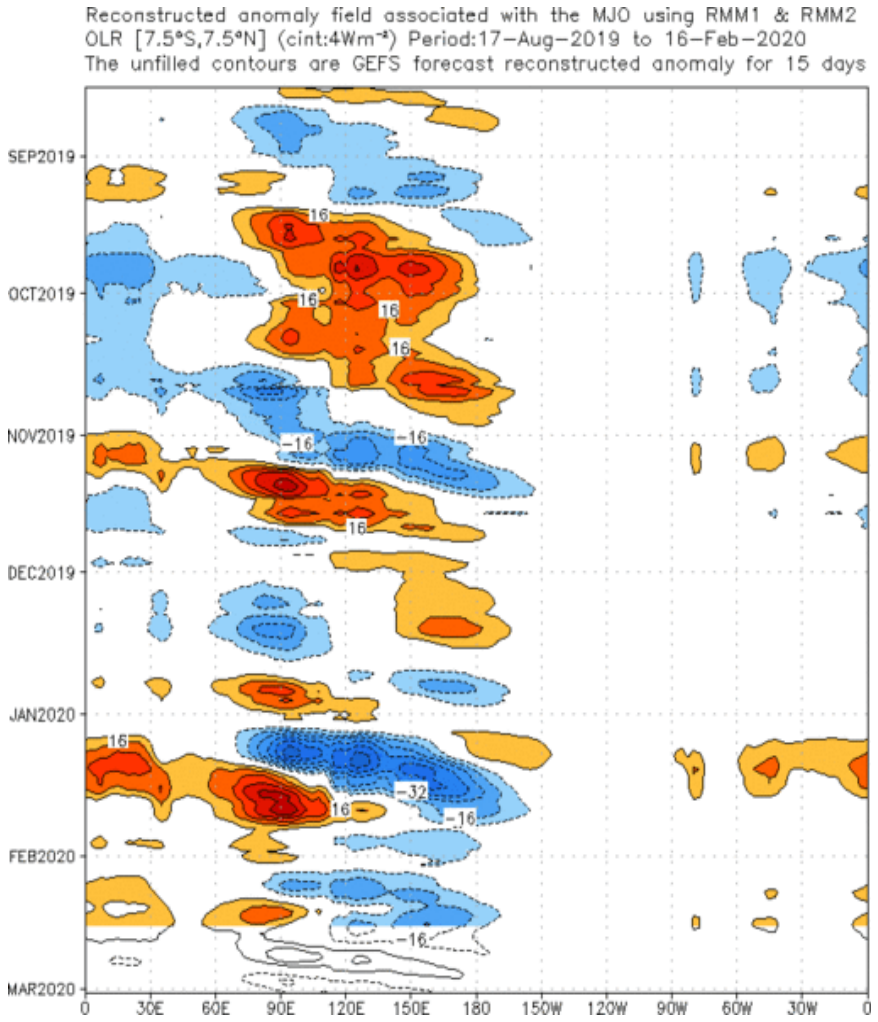
ECMWF Forecast

- The GEFS and ECMWF both indicate that interference with the eastward moving signal is likely to continue through the next two weeks, leading to a disorganized signal on the RMM index.
- Both models forecast some retrograding of the signal early in week-1, with a decay in signal strength. The weak signal may resume eastward propagation toward the eastern Pacific in week-1. However, by week-2, the signal again becomes incoherent.

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.)

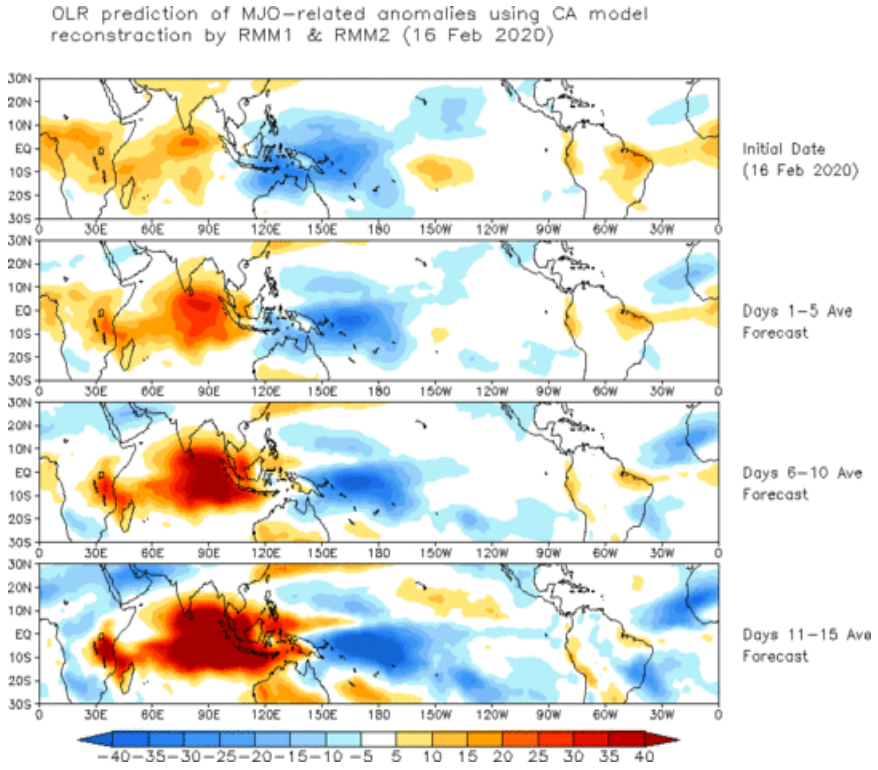


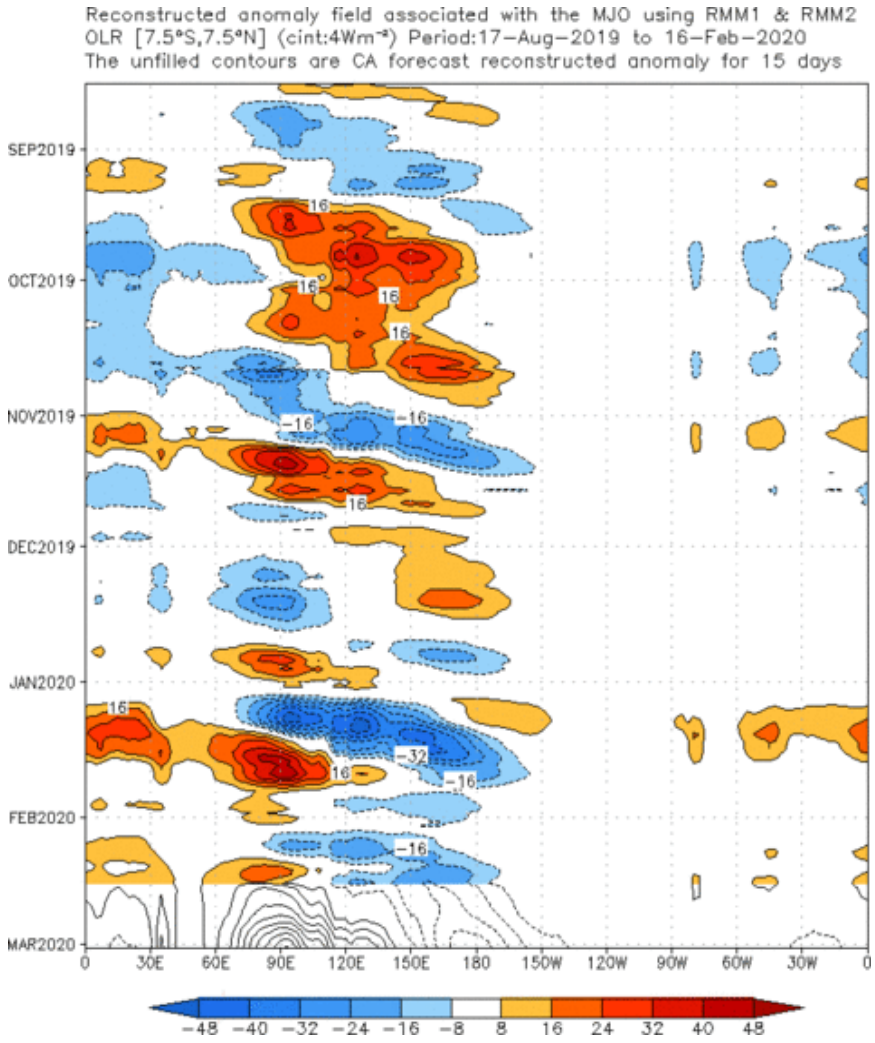


- The GEFS spatial forecast of the MJO shows a weakening of the convection over the Maritime Continent and western Pacific in week-1, before suppressed convection emerges toward the start of week-2. The enhanced convection slides eastward, but rapidly deamplifies.
- Late Week-2 shows a return to enhanced convection over the Maritime Continent toward; this is likely unrelated to MJO activity.

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.)

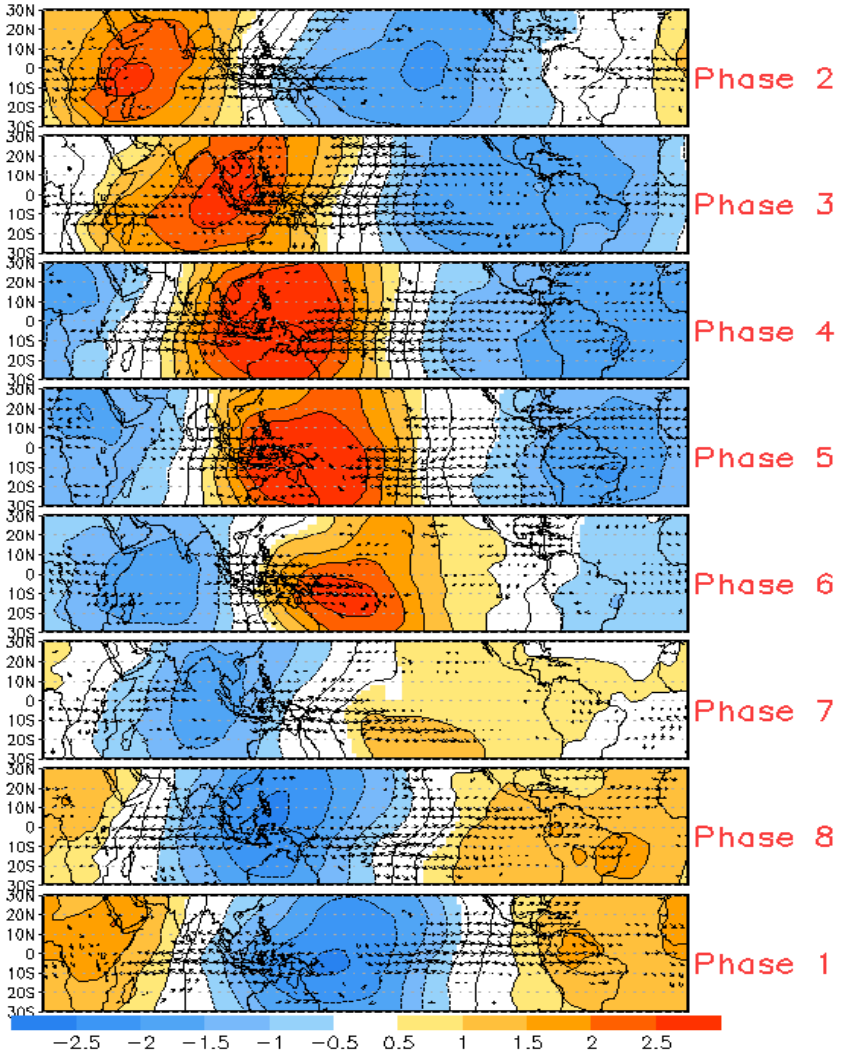




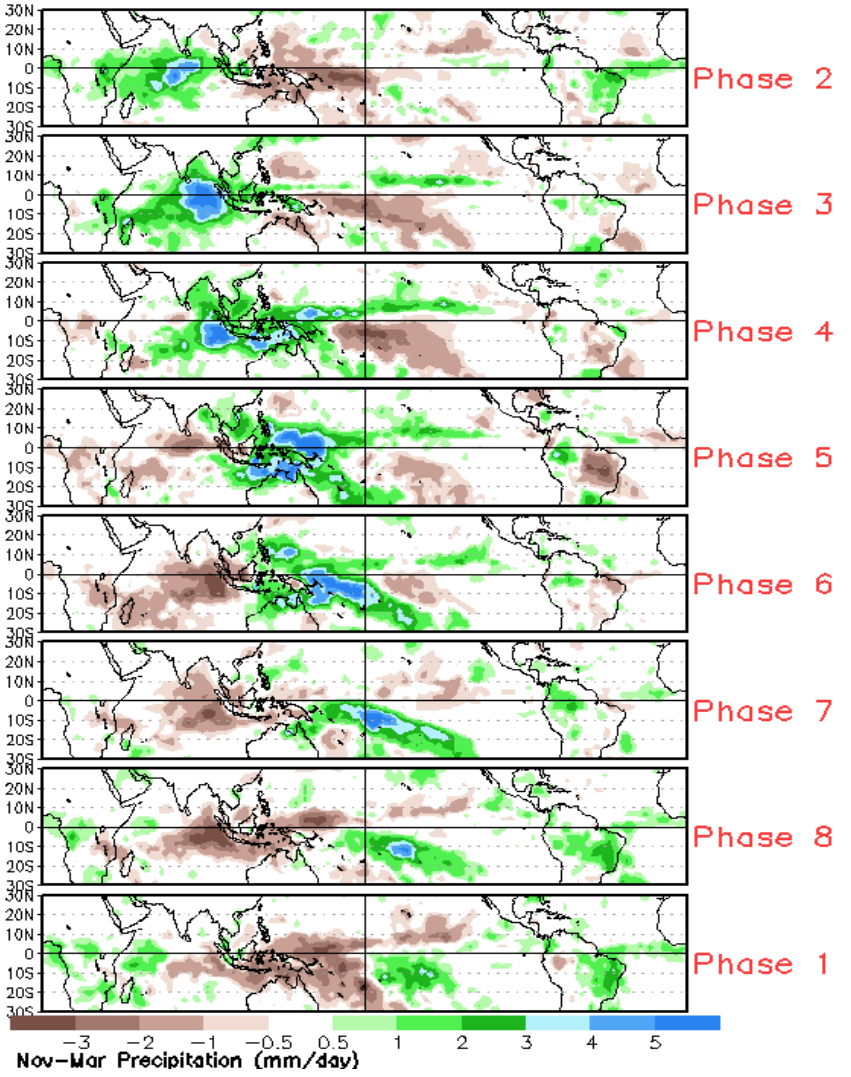
- The constructed analog MJO forecast shows a continued eastward propagation to the enhanced convection, with the two envelopes amplifying as they reach week-2. This strong signal is likely overdone and not supported by the rest of the forecast guidance.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



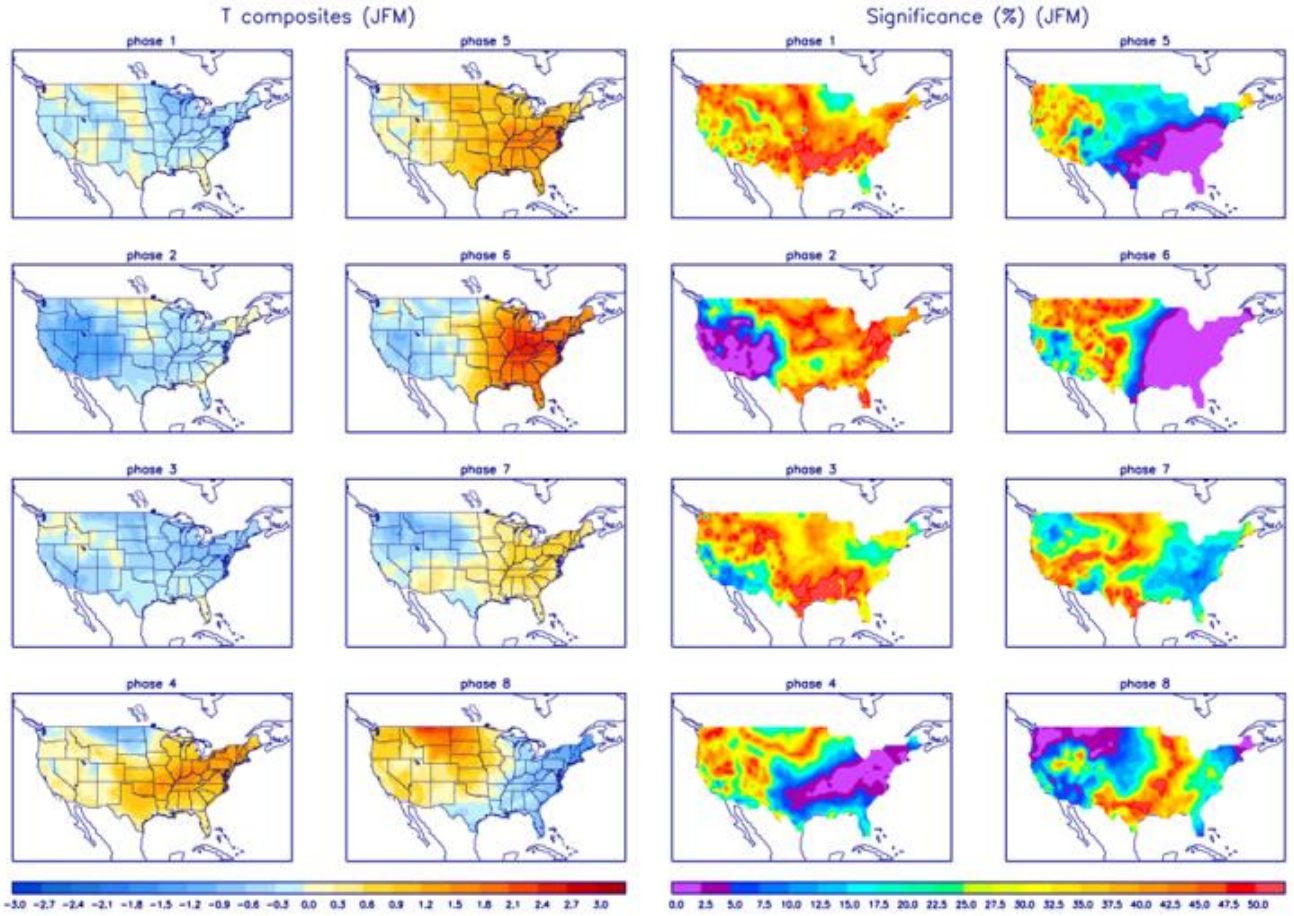
Precipitation Anomalies



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.

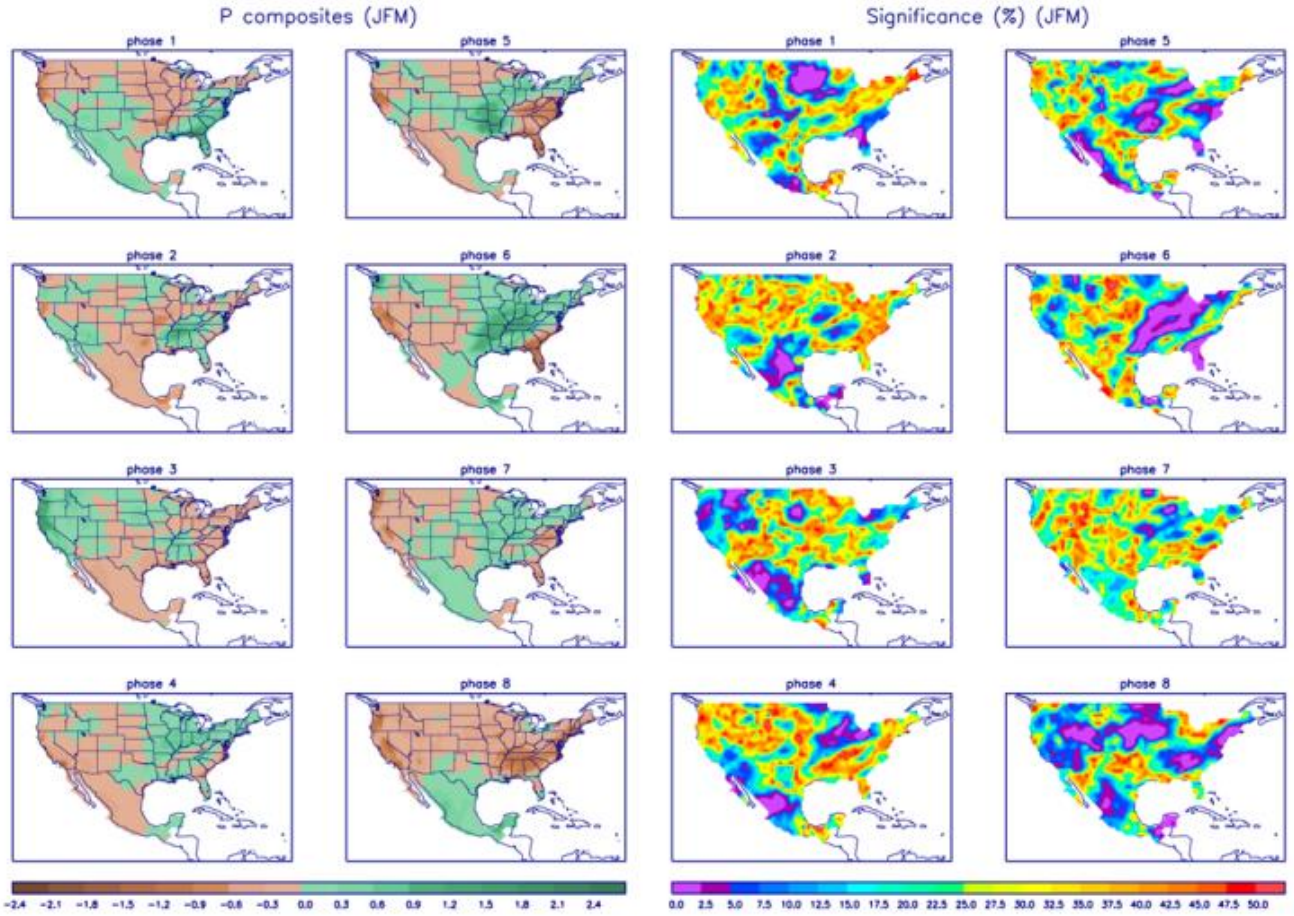


More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

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.



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