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

Update prepared by the Climate Prediction Center
Climate Prediction Center / NCEP
29 April 2019

Overview

- The MJO strengthened over the Indian Ocean during the past week, and is currently situated over the far western Maritime Continent.

- GEFS and ECMWF forecasts both indicate continued MJO activity through the next two weeks, with the active phase likely over the Maritime Continent during Week-1, and West Pacific during Week-2.

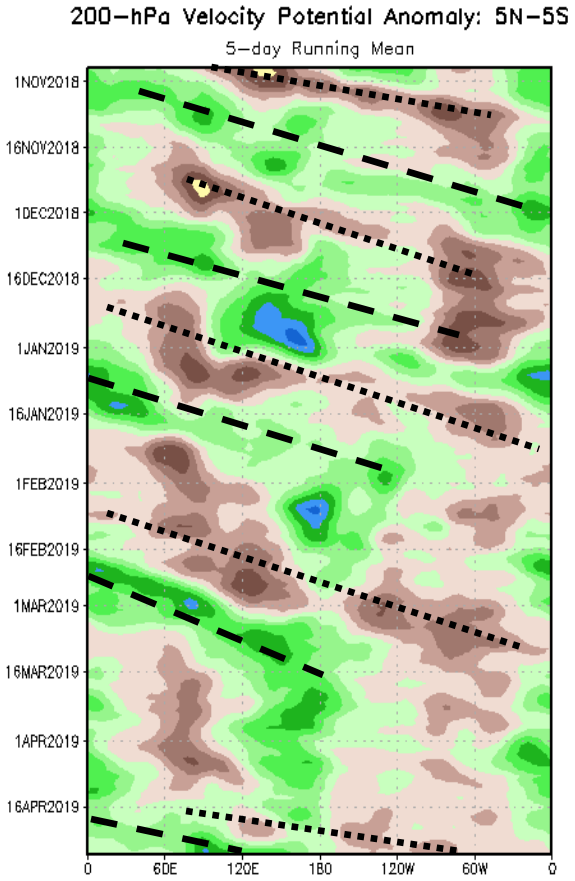
- Although the MJO is likely to affect the state of ENSO on subseasonal time scales, the low-frequency El Niño signal will continue to play a dominant role in the evolution of the global tropical convective pattern during the Boreal Spring months. The extratropical circulation over North America shows more influence from high latitude teleconnections (e.g. the Arctic Oscillation), supporting such a perspective.

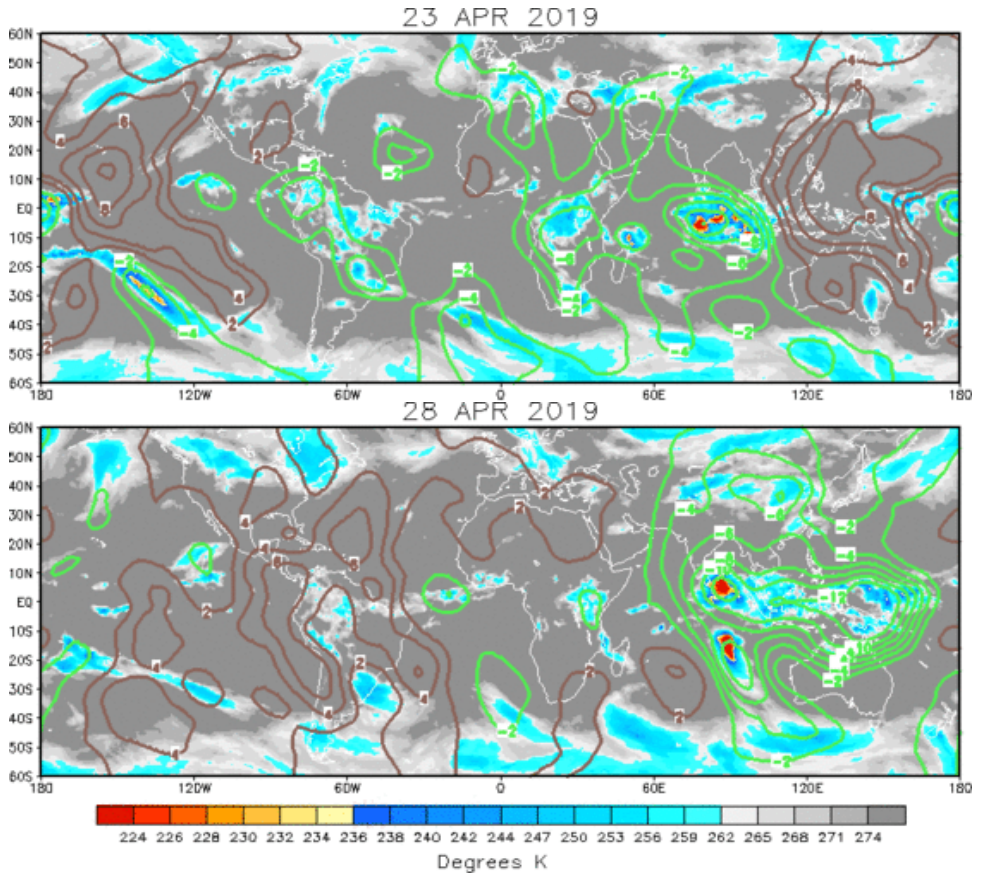
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation).

Brown shades: Anomalous convergence (unfavorable for precipitation).

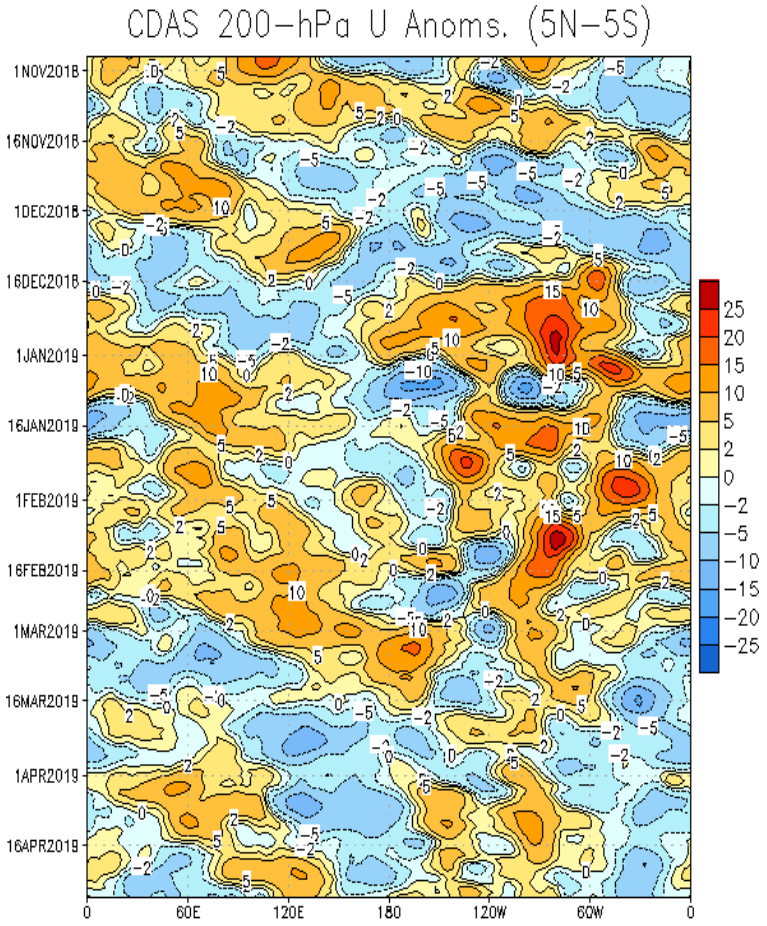


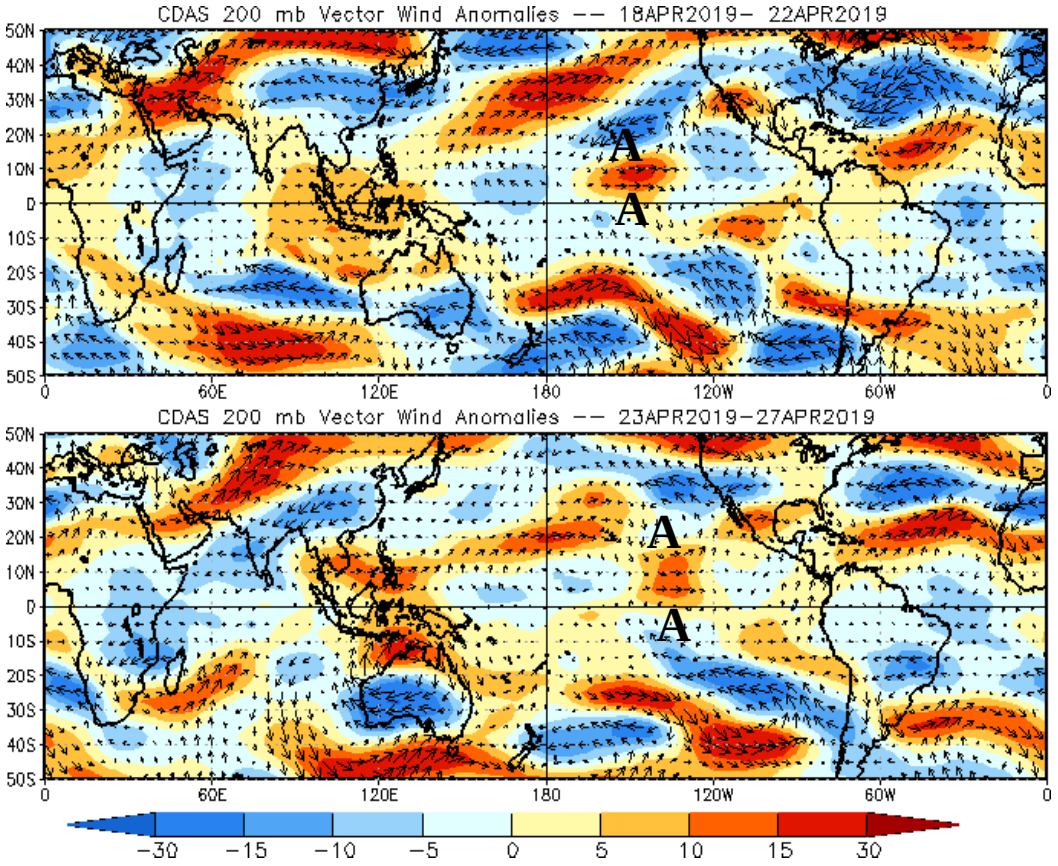


- The MJO, which was consistently active throughout boreal fall and winter, quieted during mid-March.
- Since the beginning of March, the pattern has been dominated by low-frequency signals, with some modulation by Rossby and Kelvin wave activity.
- Mid-April shows the beginning of renewed eastward propagation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

200-hPa Wind Anomalies

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

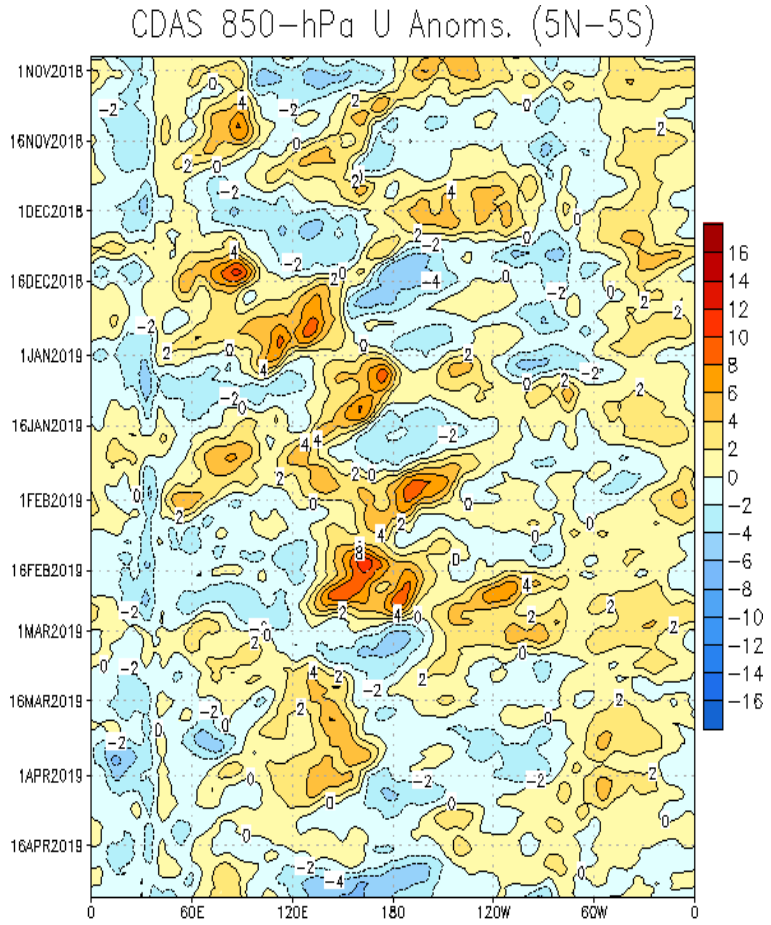


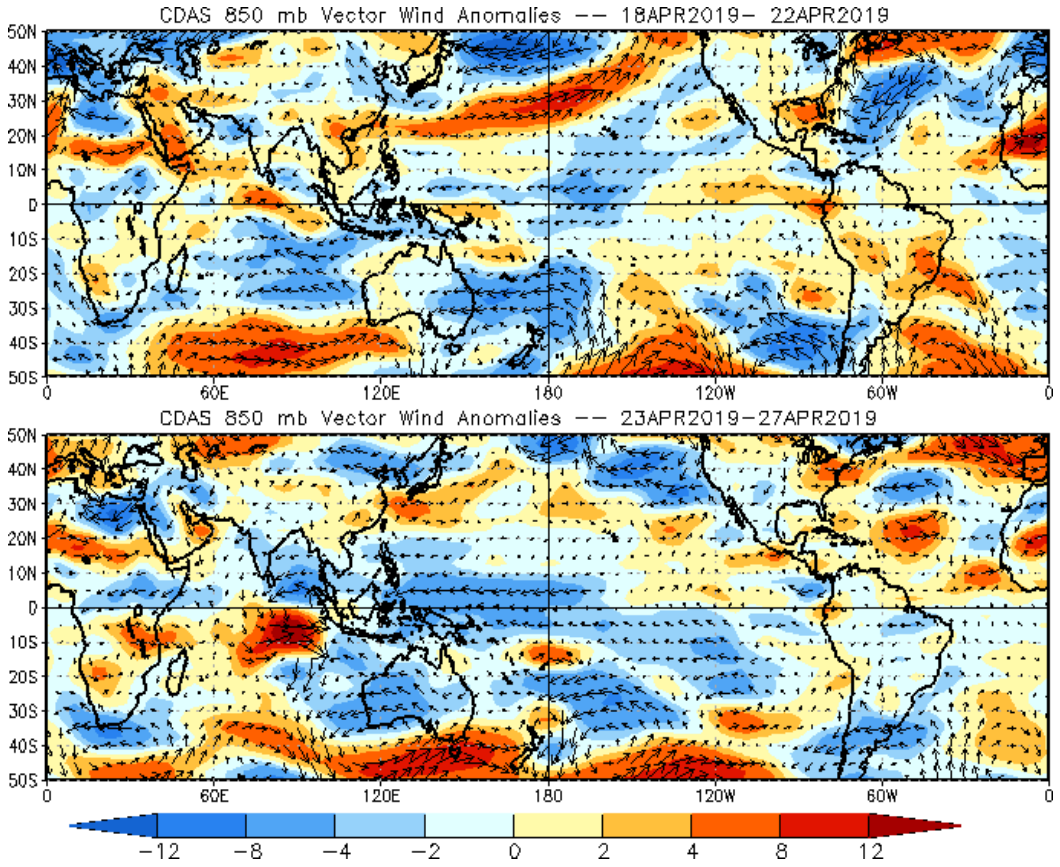


- As seen in the upper-level VP field on the previous slide, the MJO became inactive during mid-March.
- Anomalous westerlies shifted from the western to the eastern Maritime Continent during the past week, tied to the eastward progression of the MJO.
- Twin anticyclonic anomalies existed in both hemispheres over the tropical East Pacific, consistent with the low frequency response to El Niño, with some eastward displacement observed in the most recent period.

850-hPa Wind Anomalies

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

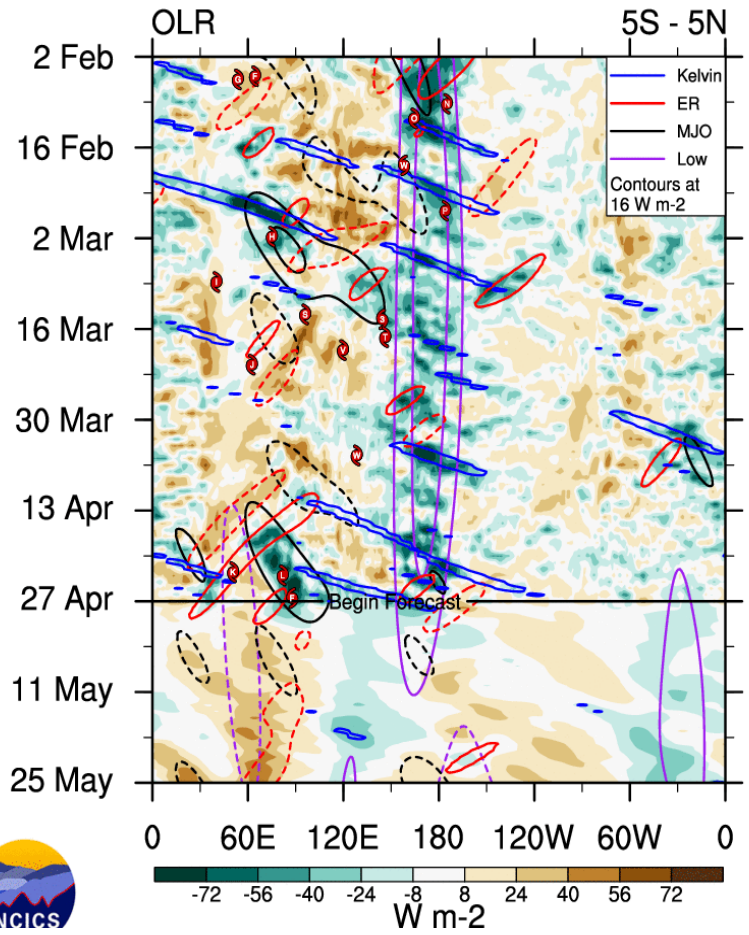


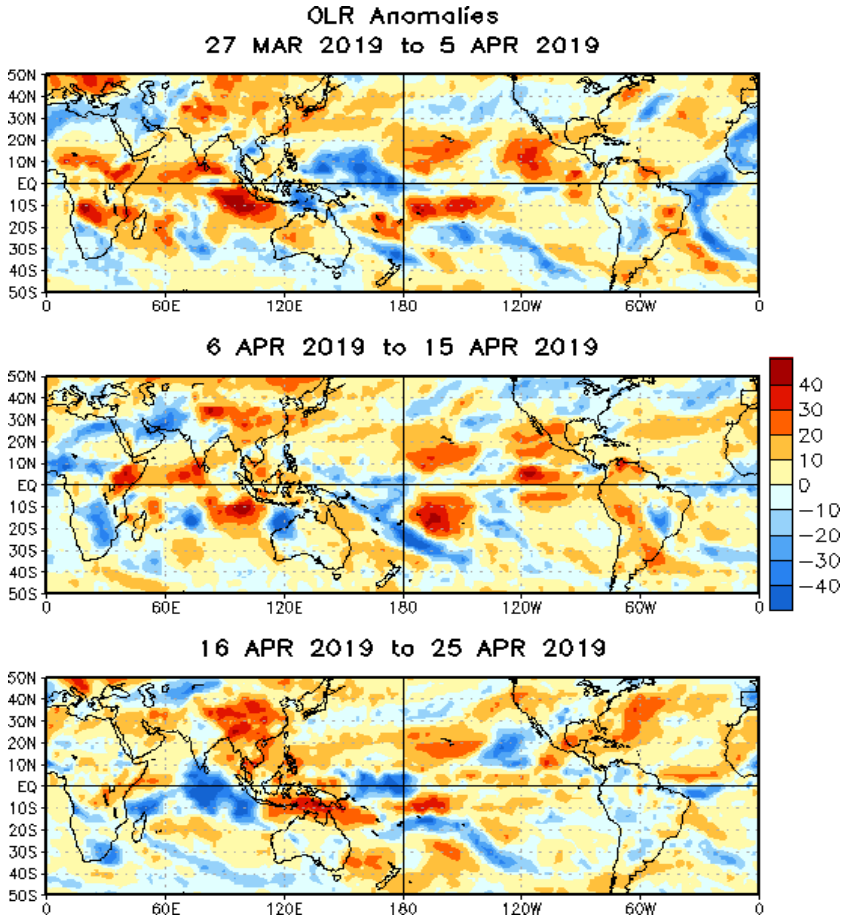


- Anomalous westerlies tracked eastward from south of India to just west of the Maritime Continent this week while strengthening, in association with the building MJO signal.
- Anomalous easterlies filled in across much of the West and Central Pacific, in addition to much of the Maritime Continent, tied to the suppressed phase of the MJO envelope. This signal even managed to disrupt the persistent westerly anomalies near 150E forced by the ongoing El Niño.
- If/when these westerlies reach the West Pacific, they may kick off another downwelling oceanic Kelvin wave to reinforce the ongoing El Niño.

Outgoing Longwave Radiation (OLR) Anomalies

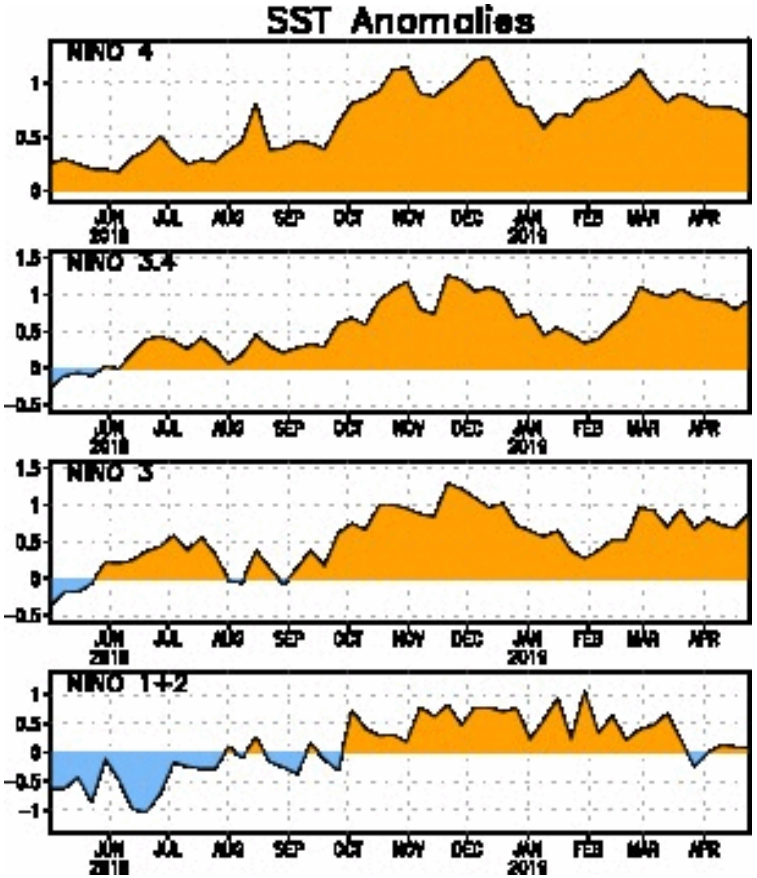
Blue shades: Anomalous convection (wetness). Red shades: Anomalous subsidence (dryness).

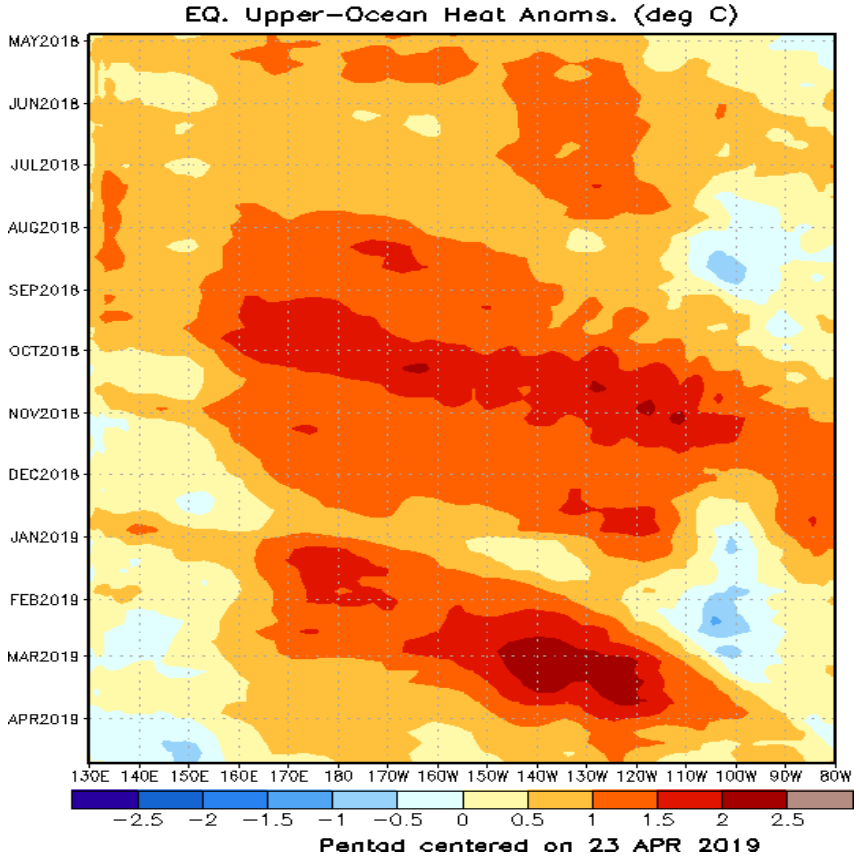




- The low-frequency enhancement of convection just west of the Date Line has been the most consistent signal during 2019.
- This field shows a slower progression of the MJO envelope across the Indian Ocean during the past 2 weeks, likely delayed by westward moving features across the basin (i.e. equatorial Rossby waves and Tropical Cyclones). This combination did cause a substantial jump in Indian Ocean convection during the second half of April.

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific

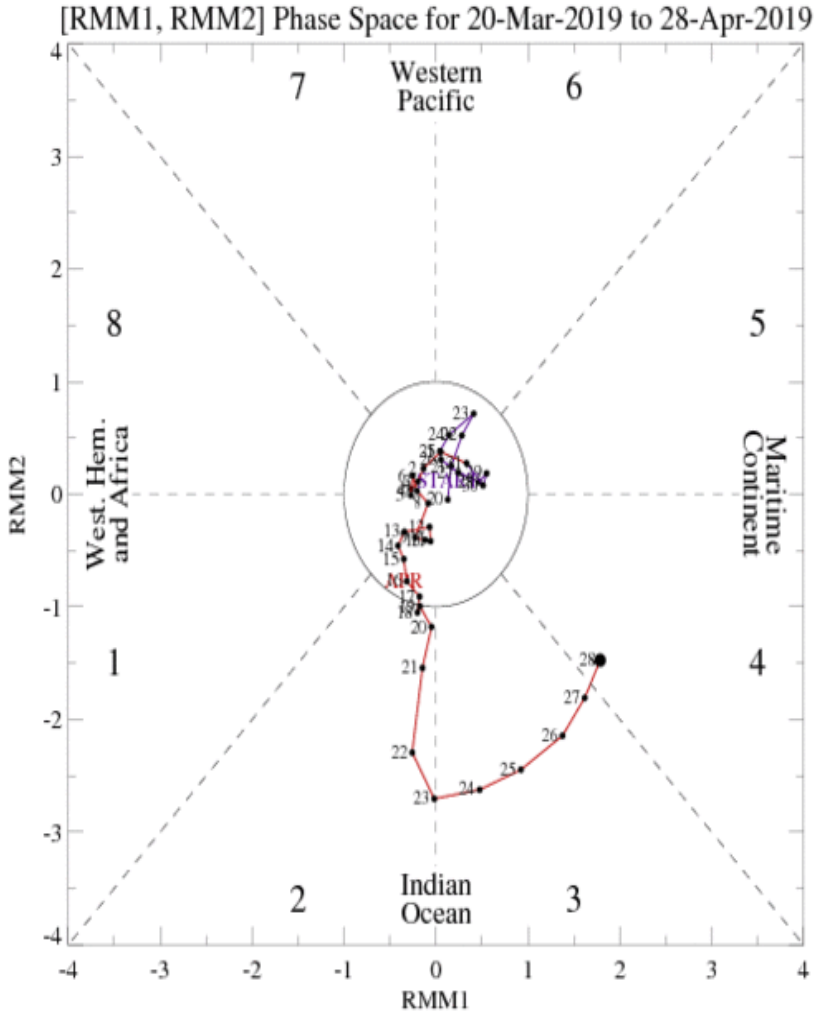




- SST anomalies remain above climatology across much of the equatorial Central and East Pacific, consistent with the ongoing El Niño event.
- Some erosion of upper ocean heat content is apparent east of the Maritime Continent, although all eyes will be on whether the active MJO can trigger a westerly wind burst over the West Pacific. This would increase chances for a downwelling oceanic Kelvin wave to reinforce the heat content near the Date Line and prolong the current El Niño.

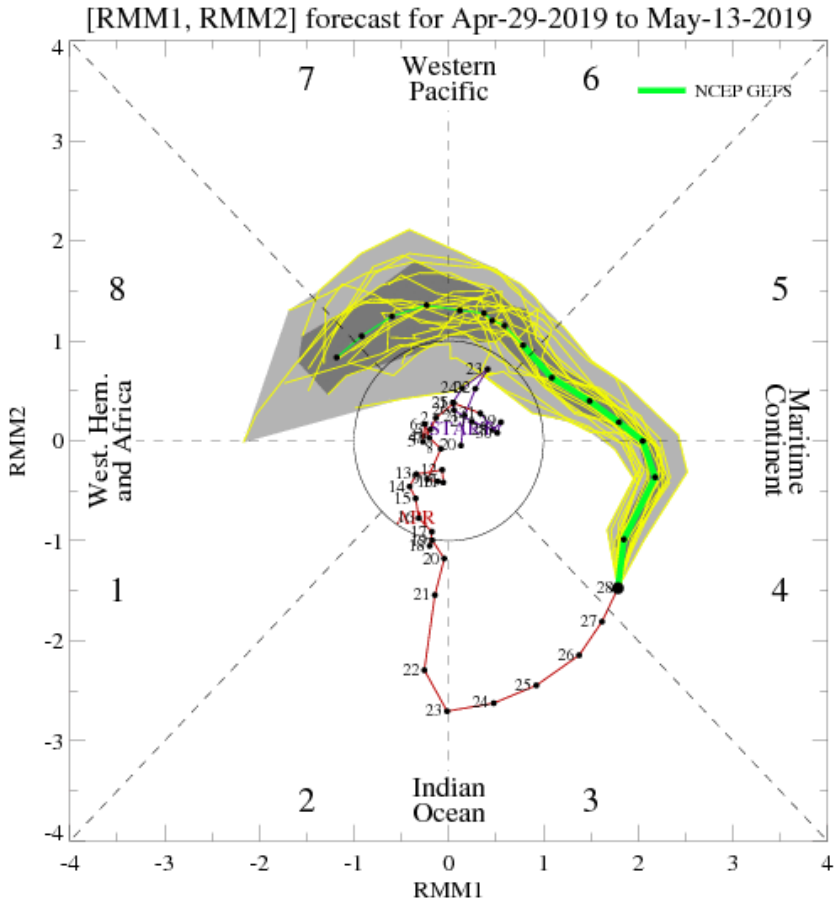
MJO Index: Recent Evolution

- The RMM index depicts a strengthening MJO and eastward propagation across the Indian Ocean during the past week, with the signal recently reaching the Maritime Continent.
- This emergence comes after a fairly quiet late-March and early-April, indicated by the observed values within the unit circle during that period.

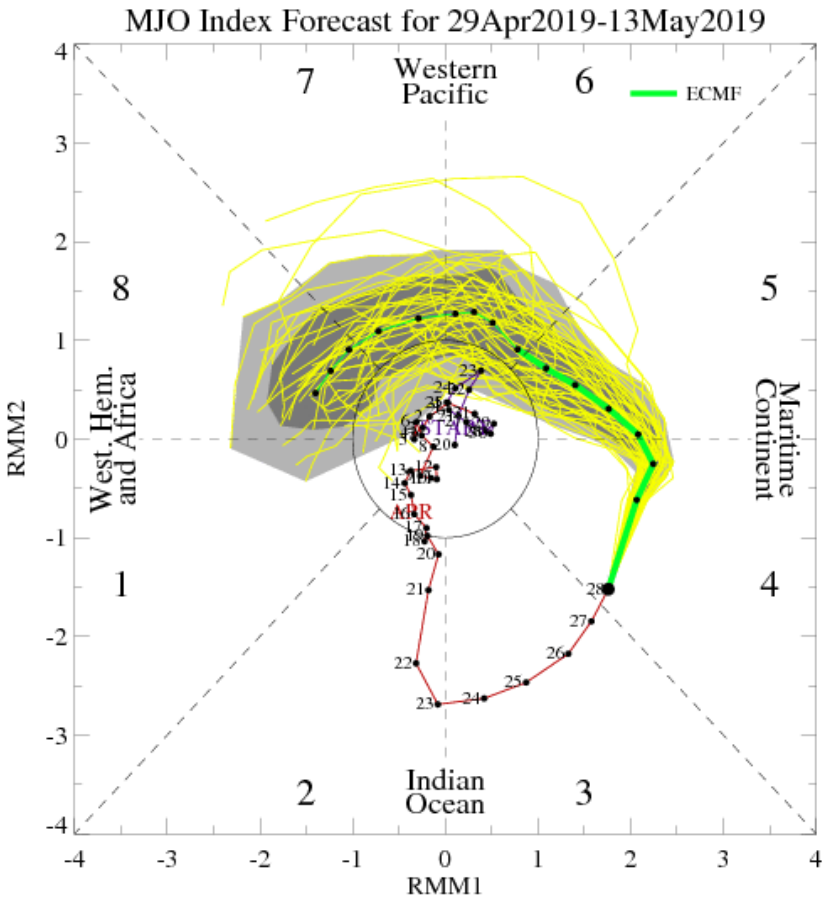


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast

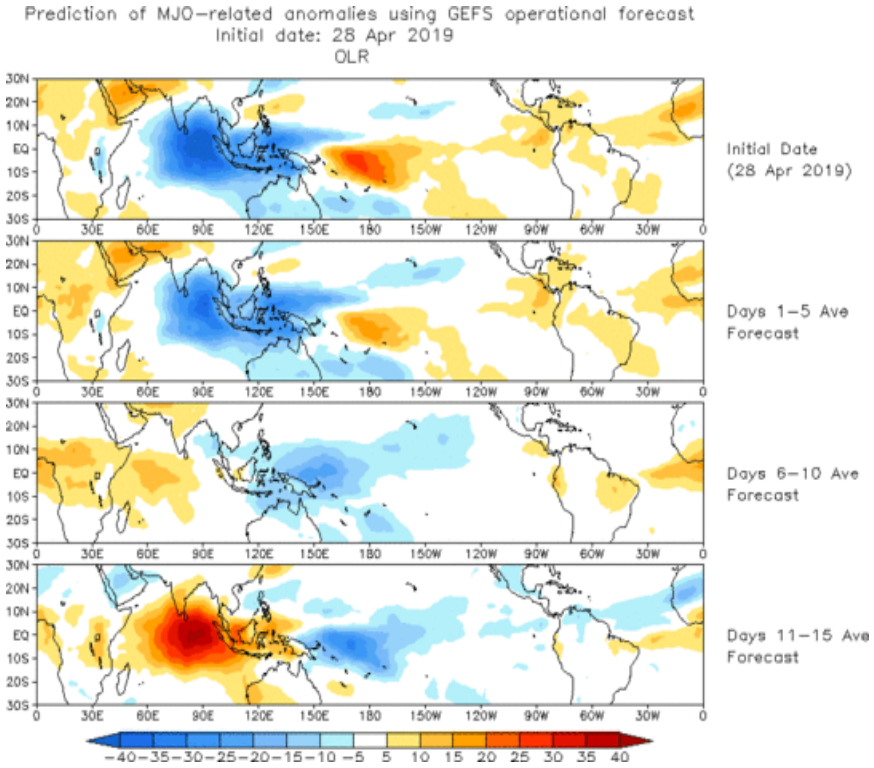


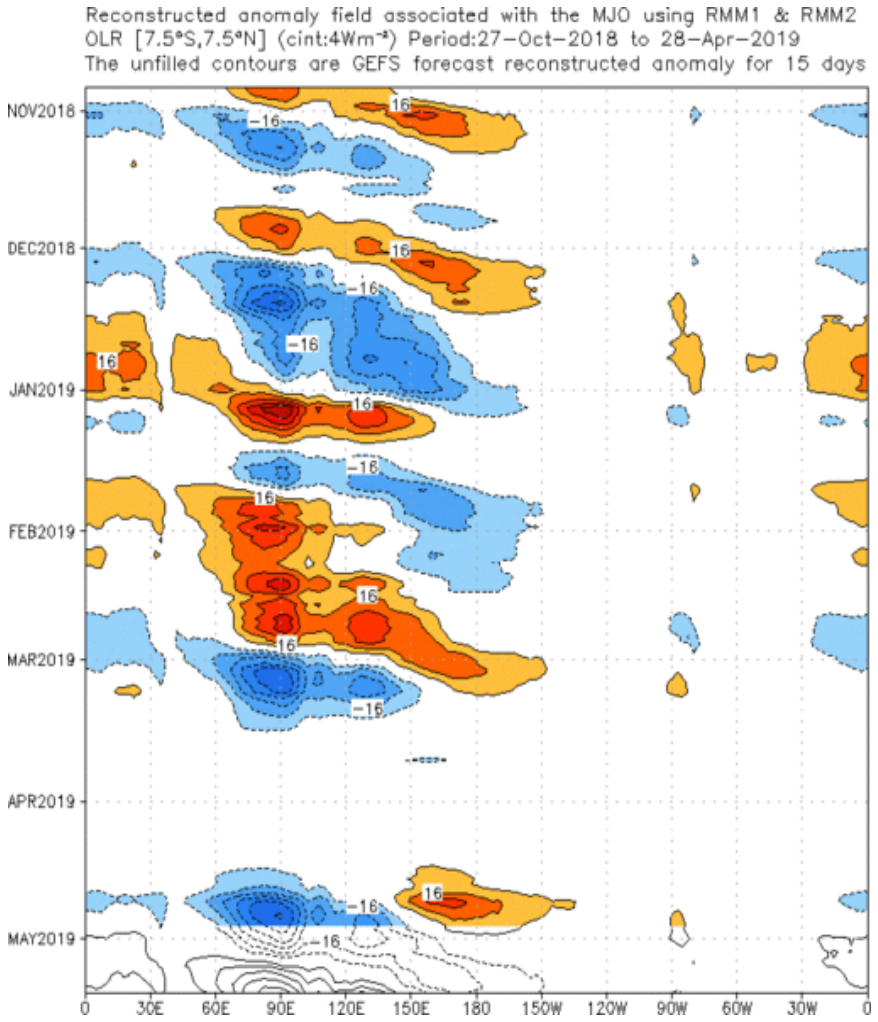
ECMWF Forecast

- Both models are consistent in showing a rapid eastward propagation of the MJO envelope. They take the MJO across the Maritime Continent during the first week of May, and across the West Pacific during the following week.
- The ECMWF model is slightly faster and weaker than the GEFS with its MJO signal. The weaker amplitude in the ECMWF could simply be differences among the phase speed of its ensemble members, given its much larger ensemble size relative to the GEFS.

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.)

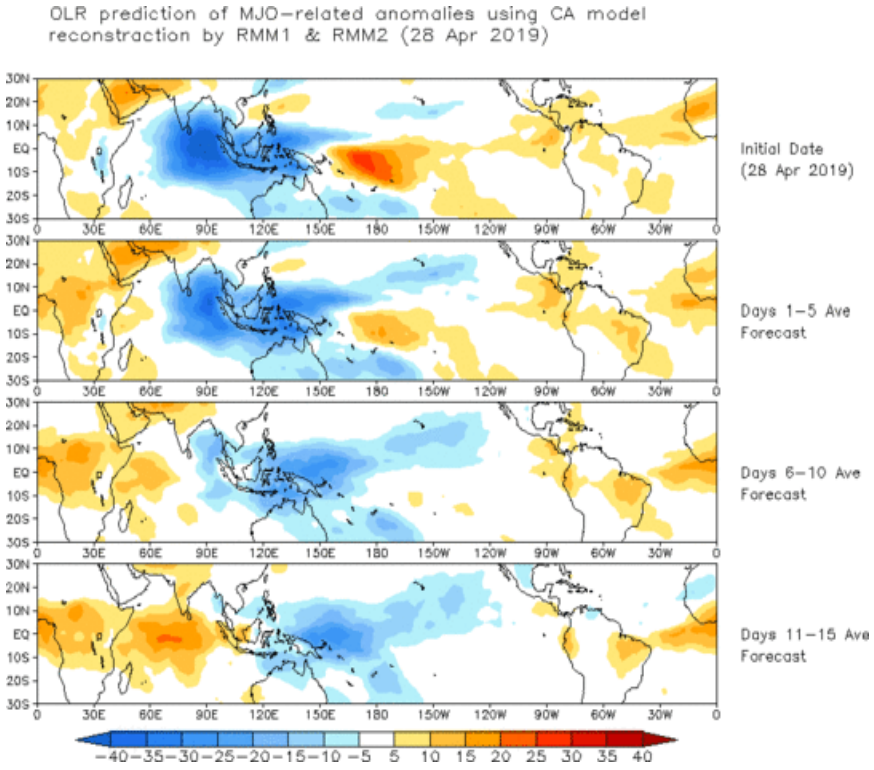


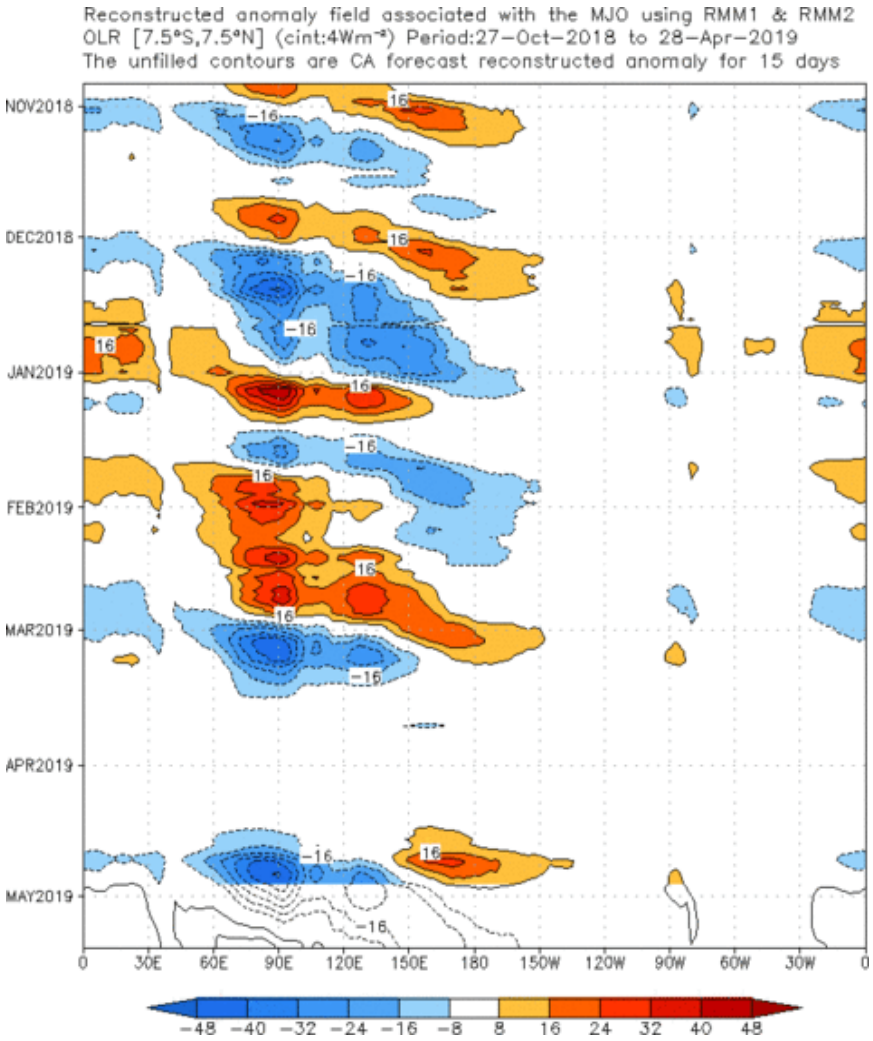


- Consistent with the RMM forecasts, enhanced convection is forecast to cross the Maritime Continent during early May.
- By Mid-May suppressed convection is forecast to grow across the Indian Ocean in association with the suppressed phase of the MJO, while its active phase is focused over the Pacific.

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.)

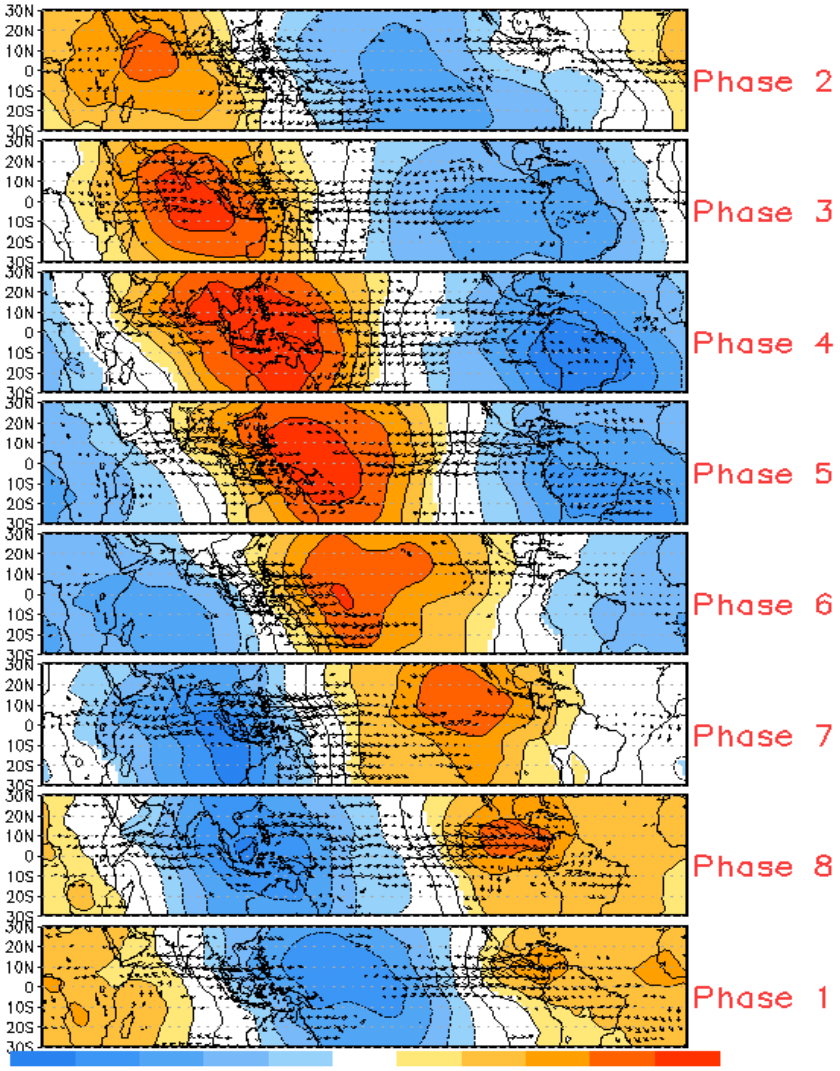




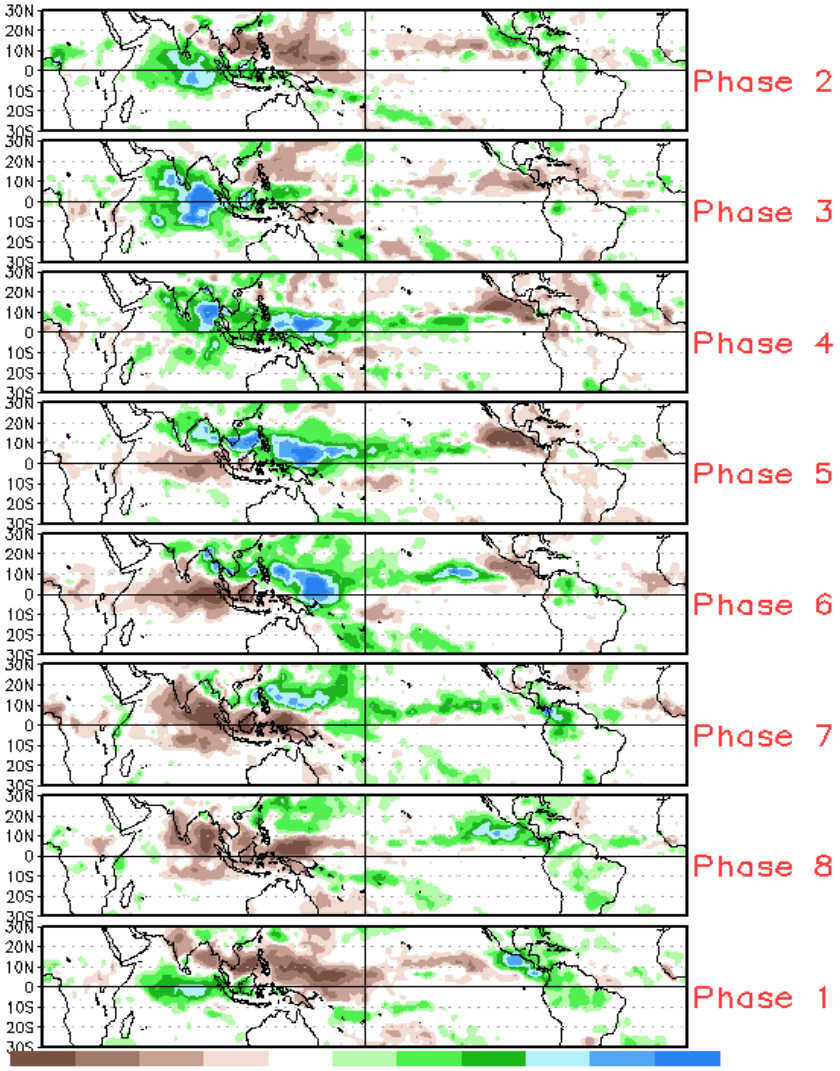
- The constructed analog features a very similar solution as the GEFS, but at a slightly reduced rate of progression.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



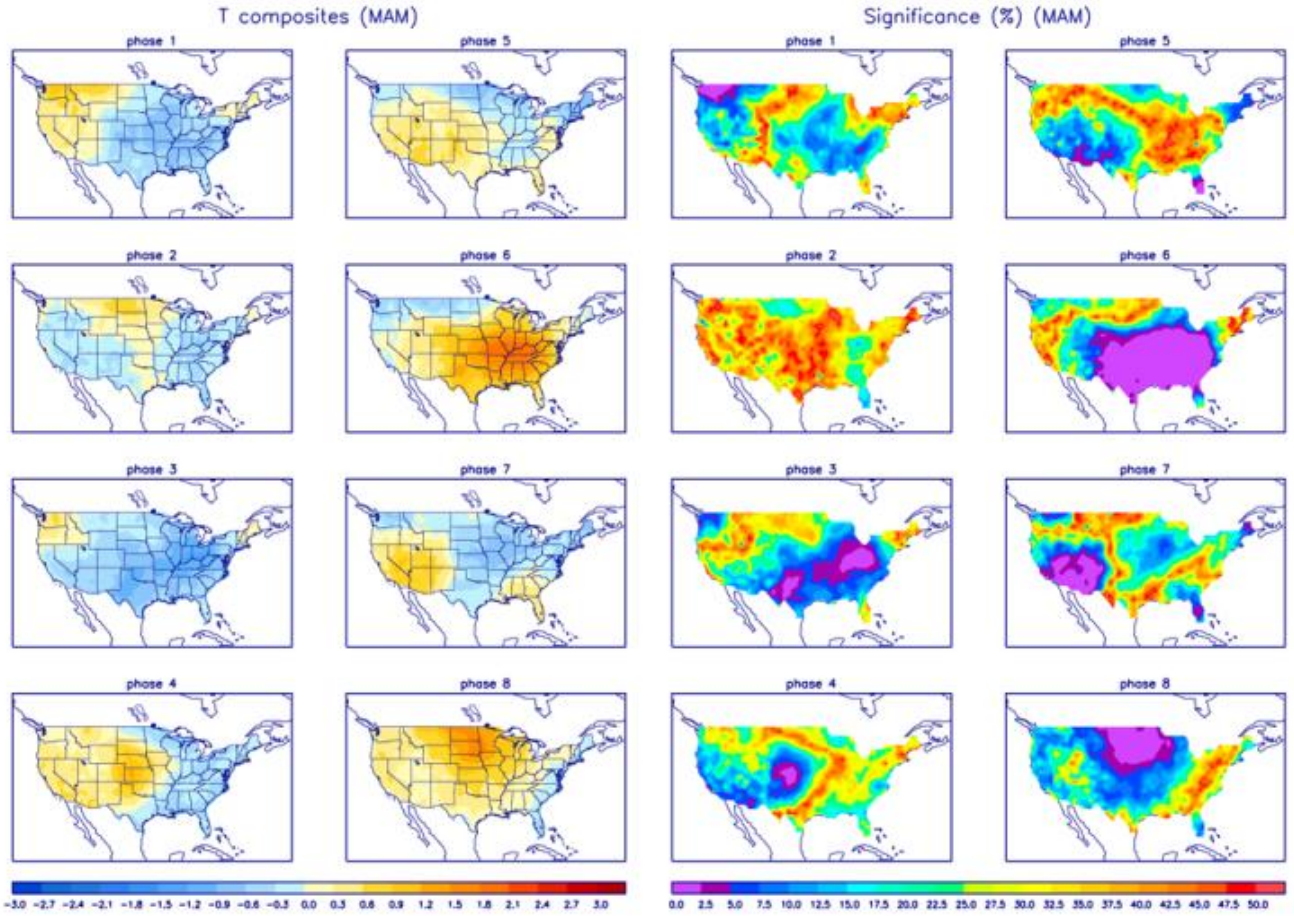
Precipitation Anomalies



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.

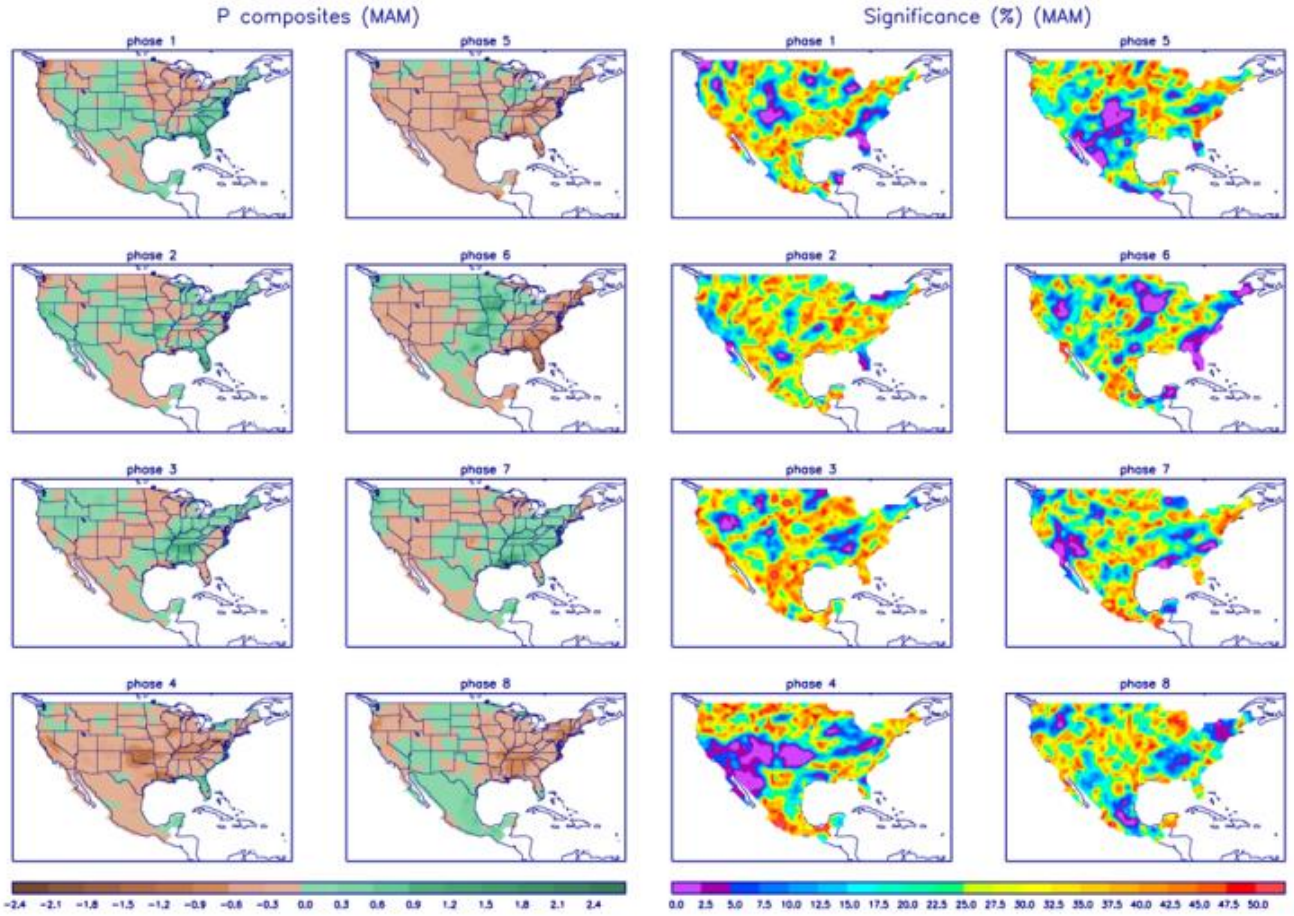


More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

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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