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

Update prepared by the Climate Prediction Center
Climate Prediction Center / NCEP
25 May 2020

Overview

- Recent observations depict an eastward propagating signal in the global tropics.

- The signal is presenting in a bi-modal fashion, with a Kelvin wave crossing the Pacific and a slower evolving signal remaining over the Maritime Continent.

- The convective response to the Pacific Kelvin wave appears limited to the North Pacific ITCZ, as enhanced trade winds prevail over much of the basin. This activity may provide a favorable environment for East Pacific tropical cyclogenesis during Week-1, with the favorable area expanding to include the western Caribbean and Bay of Campeche by Week-2.

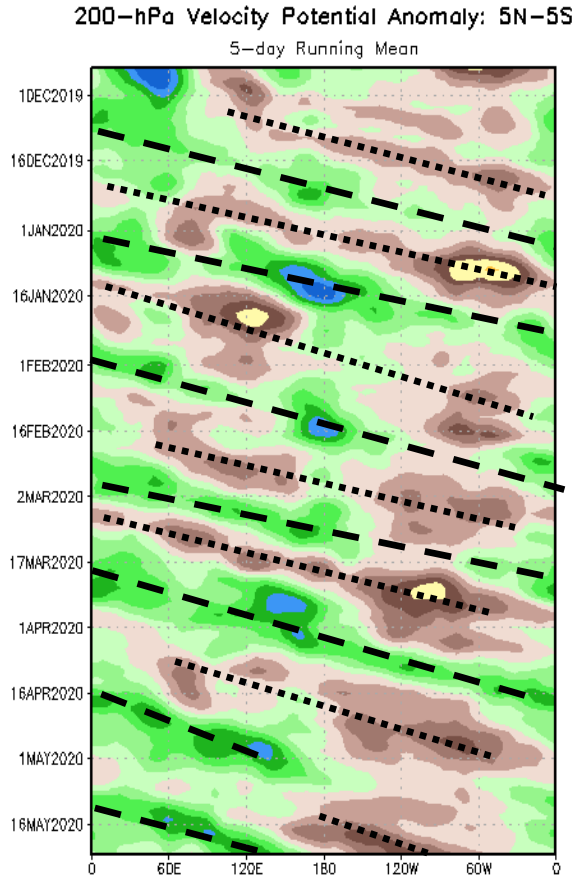
- The Kelvin wave is projecting on the RMM index, and dynamical model MJO forecasts are not consistent with an intraseasonal signal propagating from the Maritime Continent to the Pacific. The evolving low frequency base state may be influencing the signal.

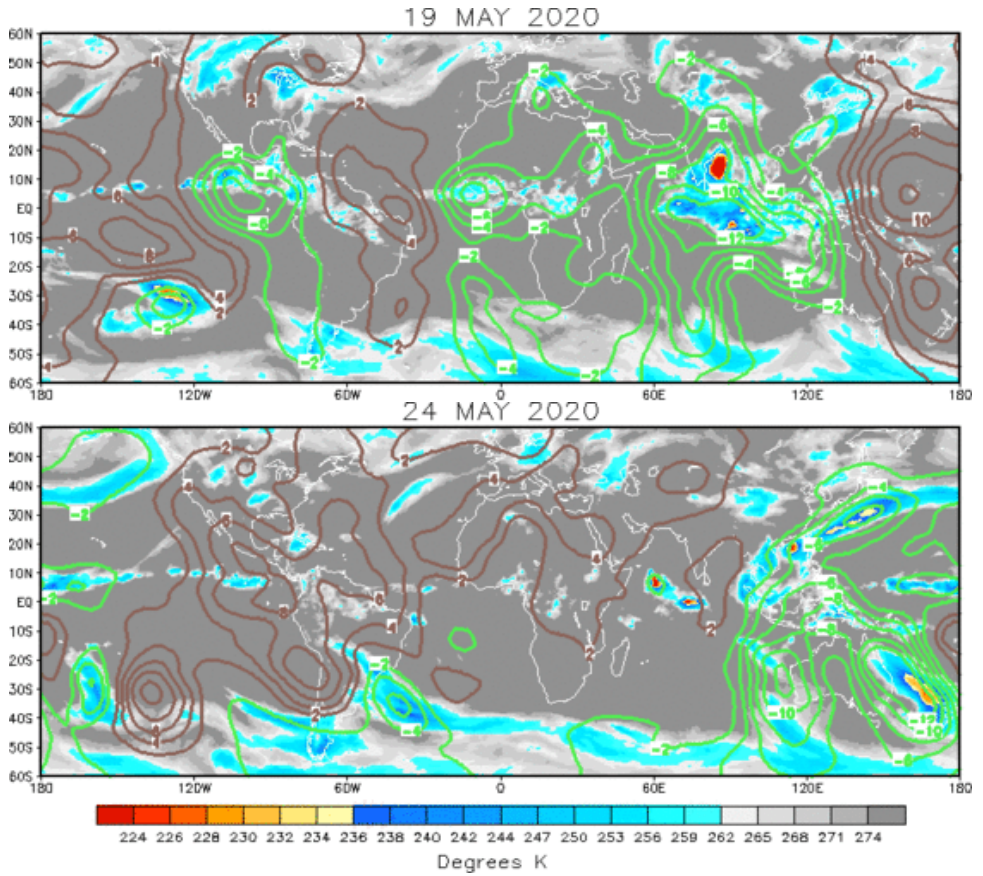
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation).

Brown shades: Anomalous convergence (unfavorable for precipitation).

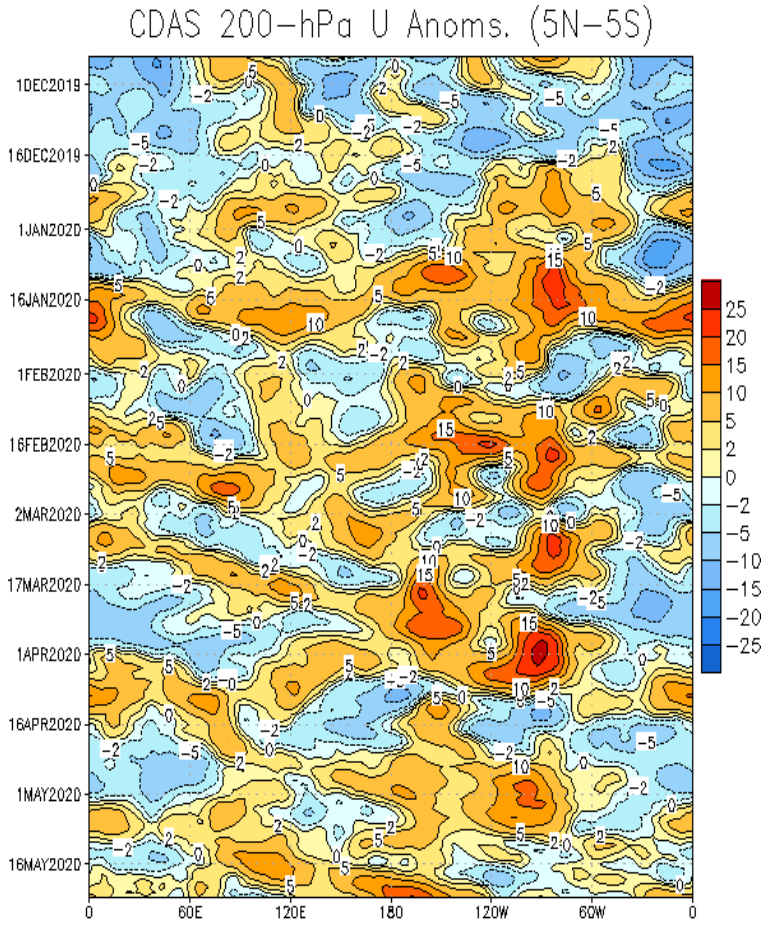


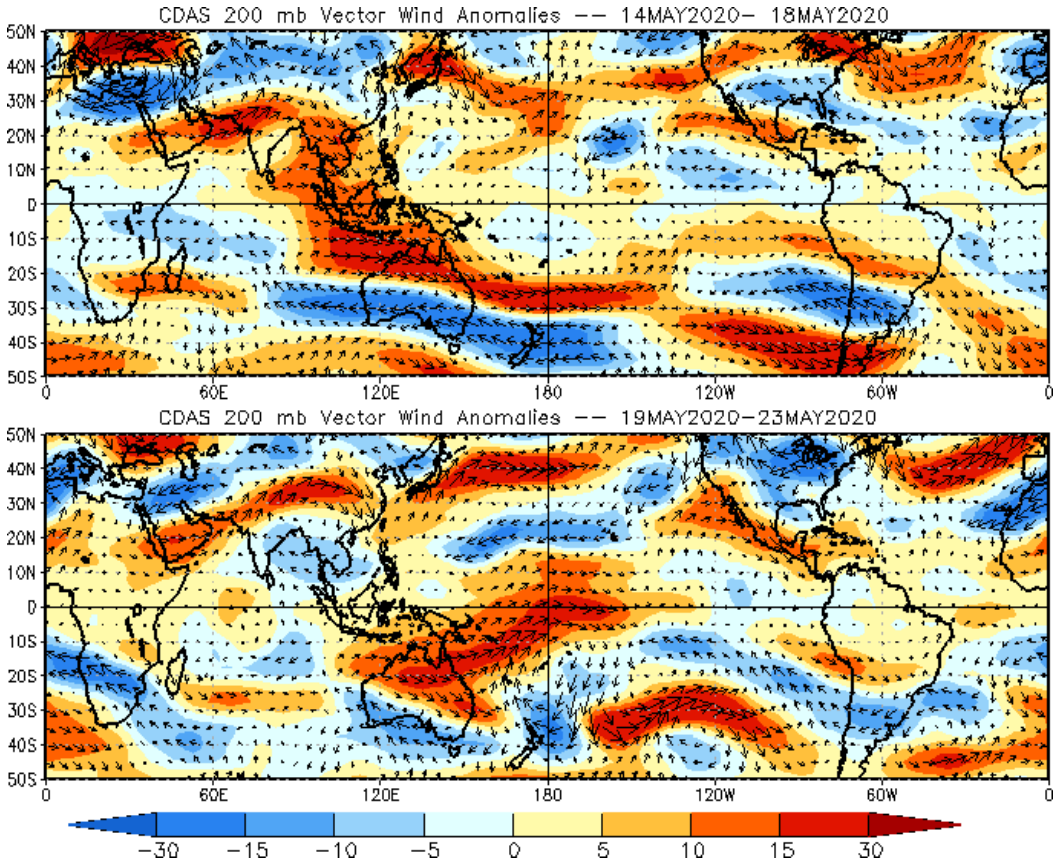


- The enhanced convective envelope propagated rapidly eastward over the past week, shifting from the Indian Ocean to the Maritime Continent and West Pacific.
- The enhanced convective envelope has become narrower both zonally and meridianally, with the leading edge limited to an area of enhanced convection over the North Pacific ITCZ.

200-hPa Wind Anomalies

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

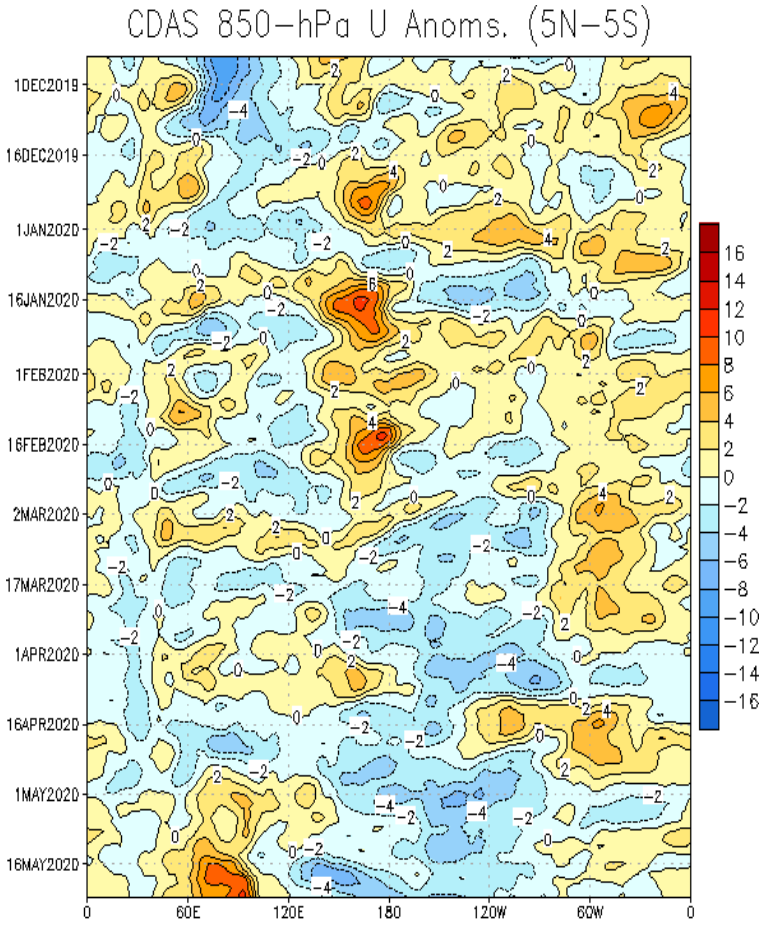


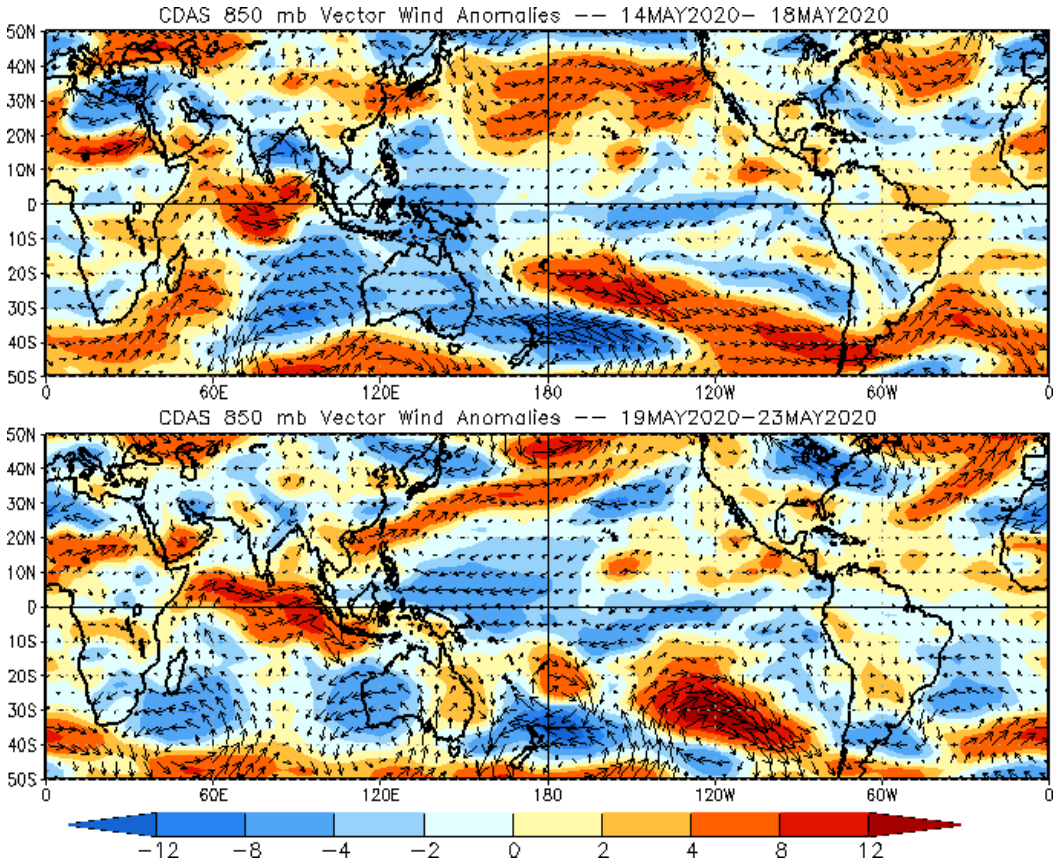


- An eastward propagating envelope of westerly anomalies aloft has been evident since mid May. The strongest westerly anomalies over the tropics are currently centered just east of the Date Line.
- Robust anticyclonic circulation over the Middle East that helped drive a record breaking heat wave began to break down by late May.
- An upper-level high over the East Pacific tropical cyclone basin may provide a favorable environment for TC genesis.

850-hPa Wind Anomalies

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

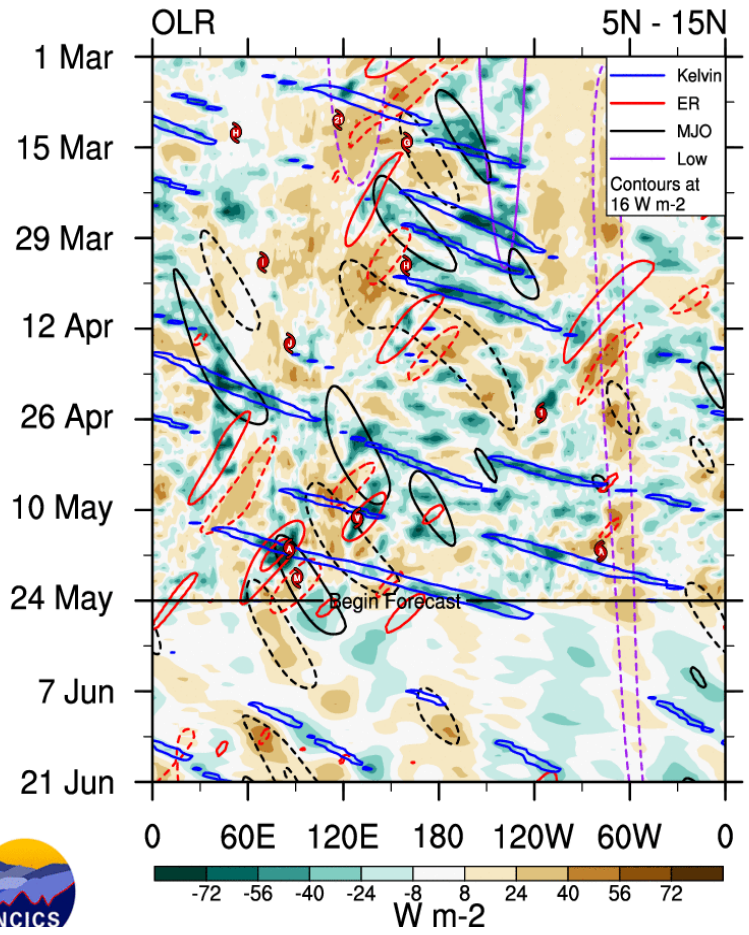


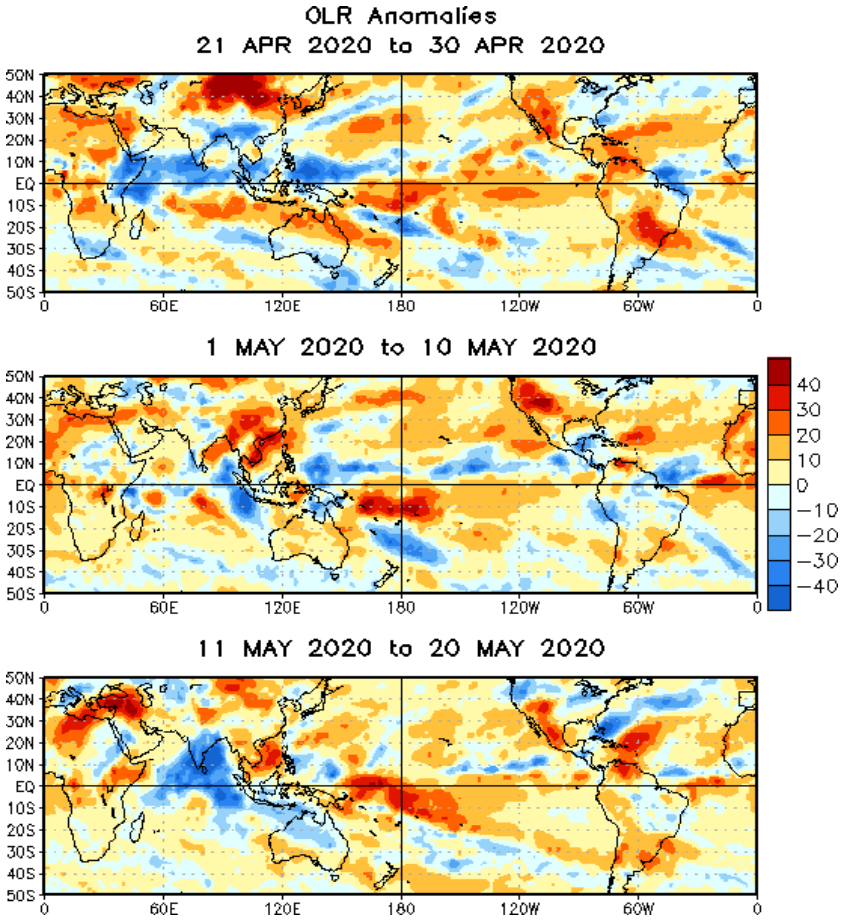


- Westerly anomalies intensified over the tropical Indian Ocean, creating a region of strong low-level convergence over the Maritime Continent.
- Trade winds remain enhanced over much of the Pacific, which may drive a change in the low frequency base state.
- Westerly anomalies persist over the East Pacific tropical cyclone basin, where conditions may become more favorable for tropical cyclogenesis.

Outgoing Longwave Radiation (OLR) Anomalies

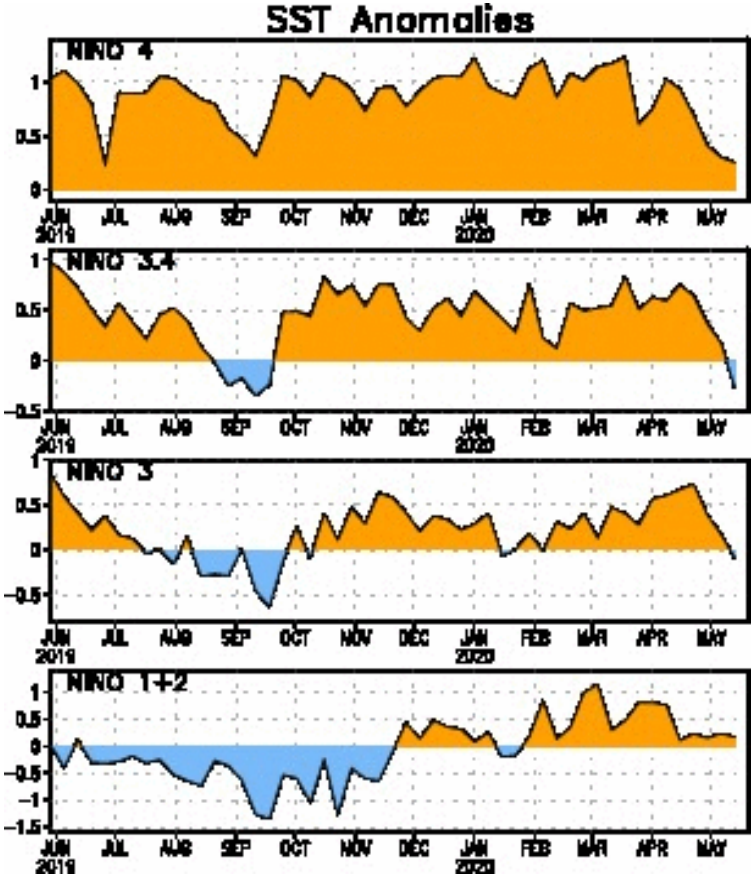
Blue shades: Anomalous convection (wetness). Red shades: Anomalous subsidence (dryness).

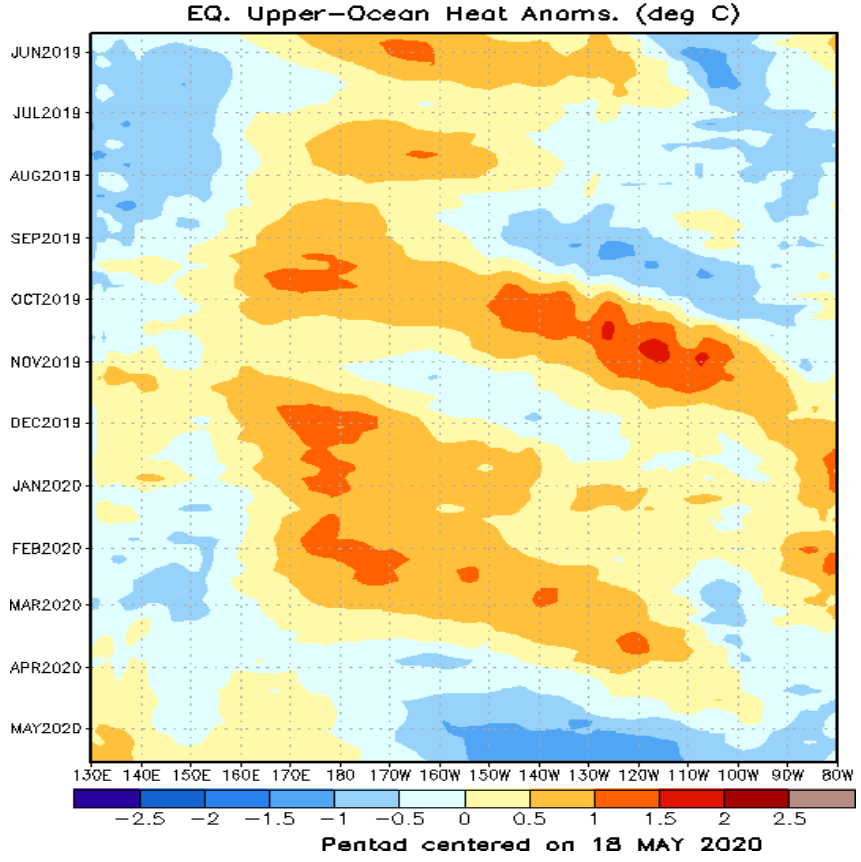




- The OLR filtering tool indicates a possible slower-moving intraseasonal signal consistent with MJO phase speed propagating from the Indian Ocean to the Maritime Continent during late May.
- A robust Kelvin wave is currently crossing the Pacific. This signal is confined to the northern tropics, and appears much weaker on equator-centered OLR bands.

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



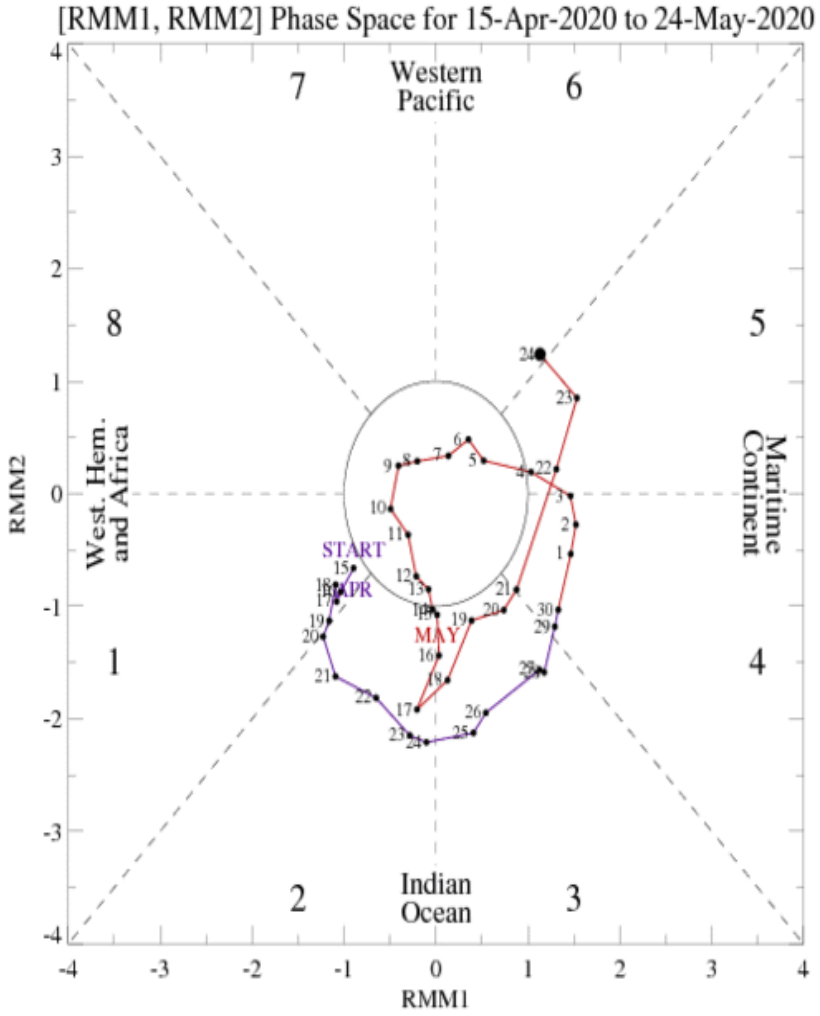


- Enhanced trade winds during May have generated an oceanic response, with negative upper-ocean heat content anomalies intensifying across much of the east-central Pacific.
- SST anomalies in the Nino 3.4 region have become negative for the first time since mid September 2019.
- SSTs have fallen with respect to climatology in all of the Nino basins since mid-April.

MJO Index: Recent Evolution

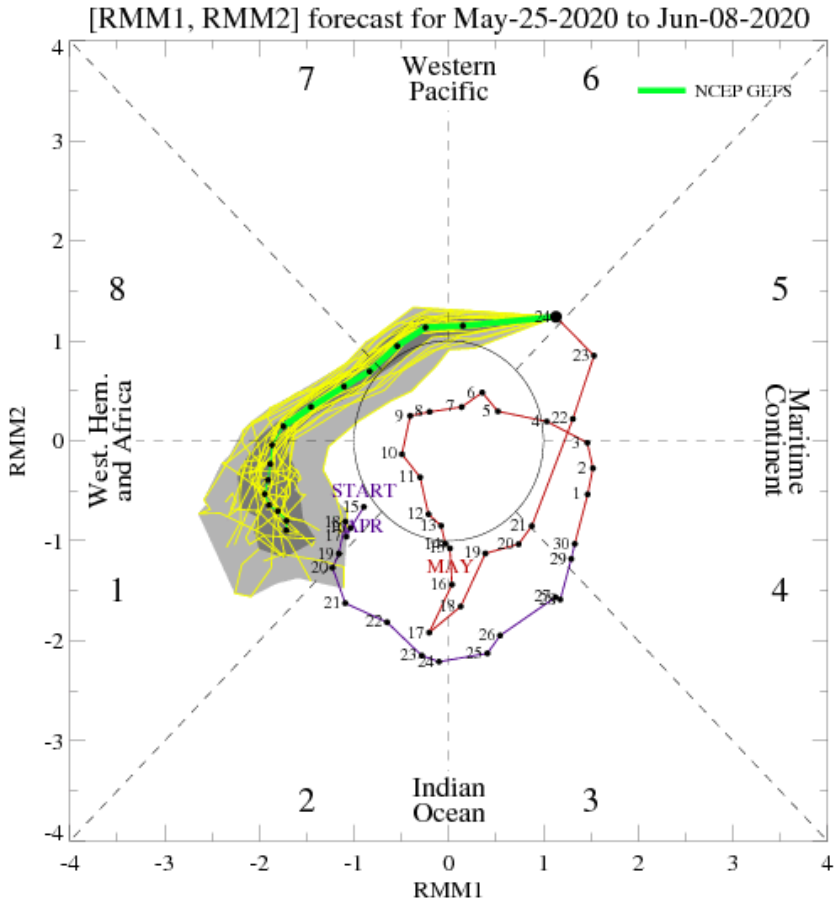
- The RMM index propagated over the Indian Ocean beginning in mid-May, and recently made a quick jump to the West Pacific.

- The quick transition of the index is likely due to robust Kelvin wave activity that is convectively coupled over the tropical North Pacific.

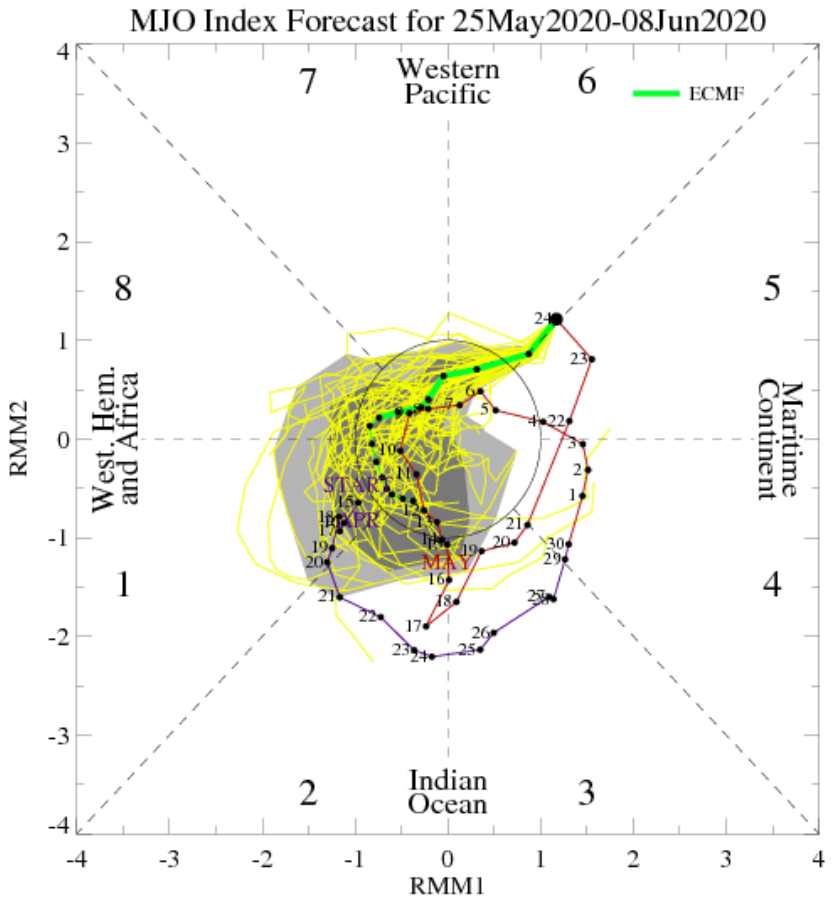


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast

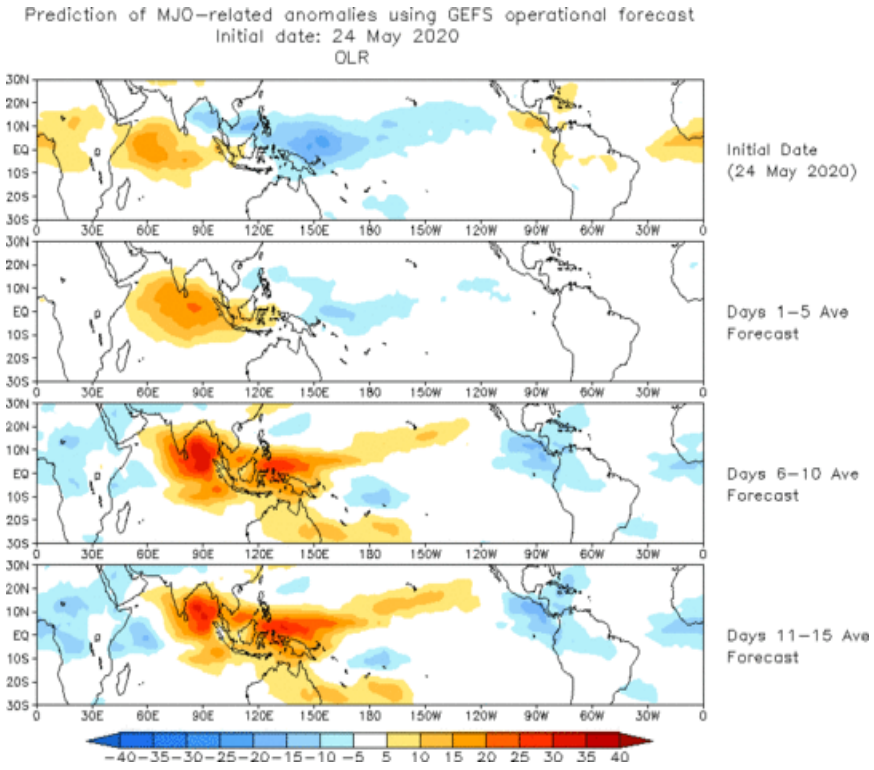


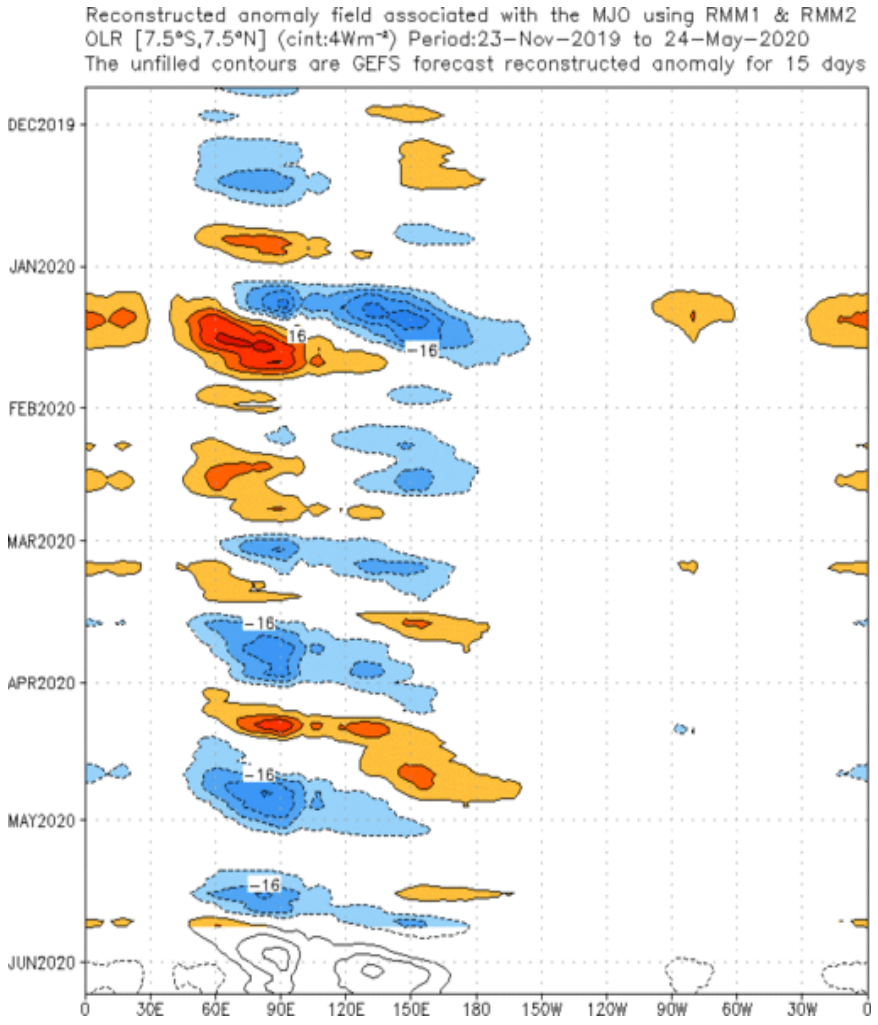
ECMWF Forecast

- The GEFS and ECMWF both depict a fast eastward propagation of the RMM index to the Western Hemisphere during Week-1, likely tied to Kelvin wave activity.
- A much slower propagation is favored during Week-2, with the GEFS favoring an enhanced signal over Africa, while the ECMWF depicts a low-amplitude signal over the western Indian Ocean.

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.)

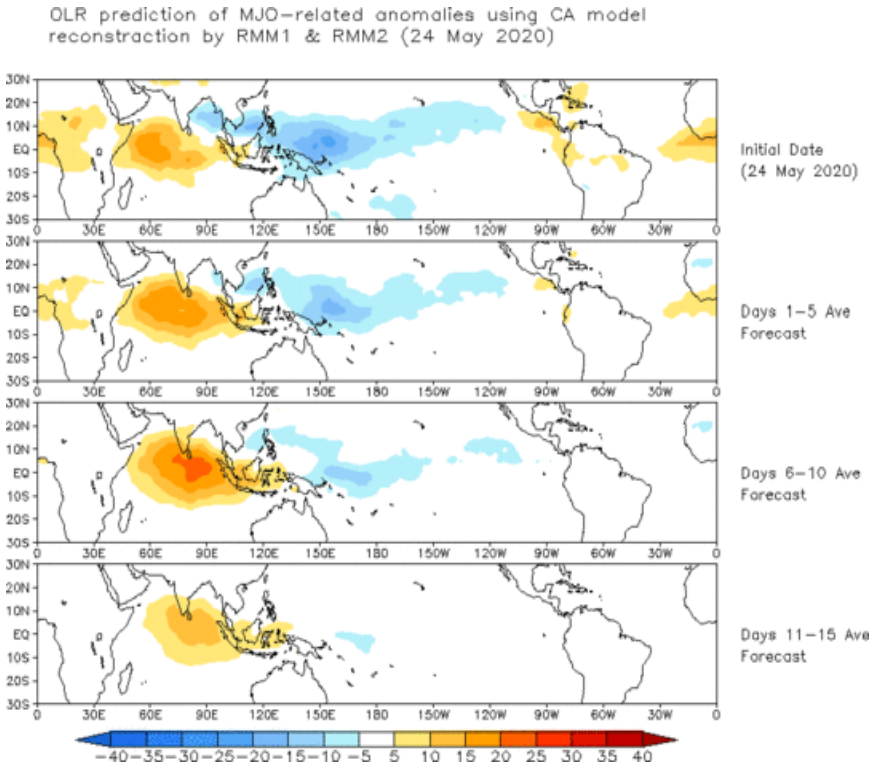


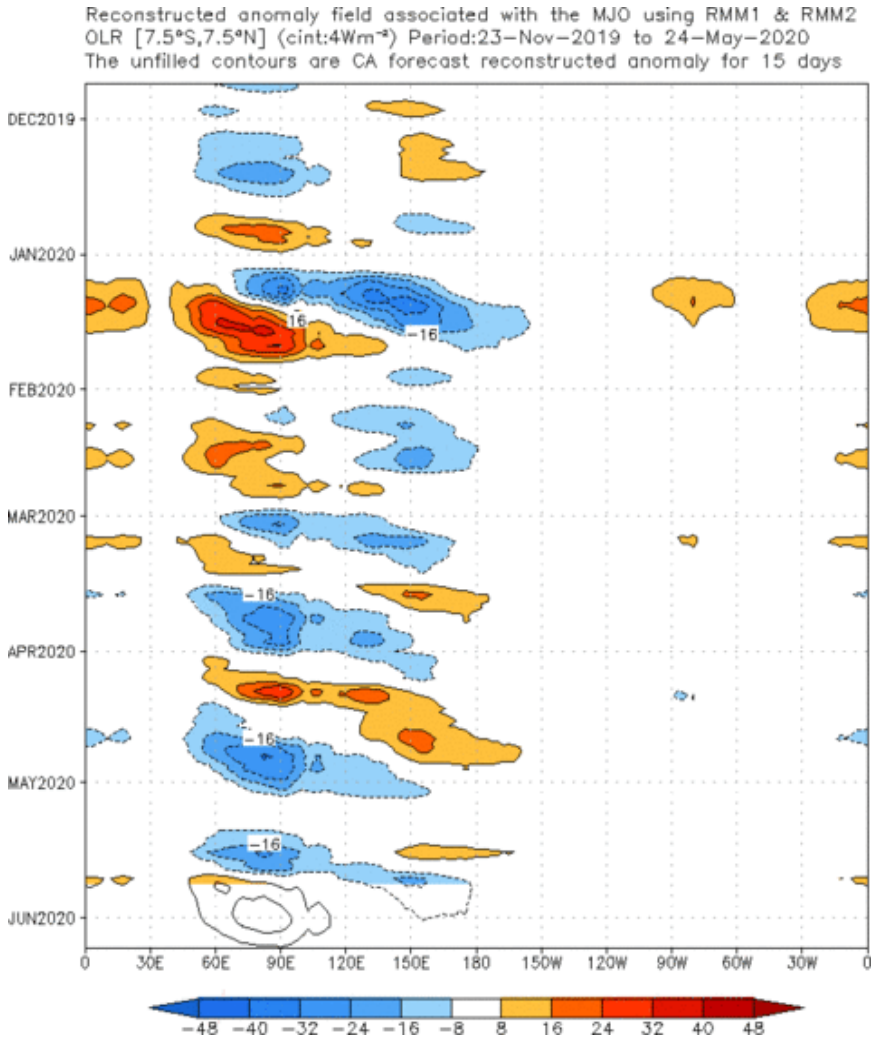


- OLR anomalies based on the GEFS RMM index forecast depict a rapid shift in the signal from the West Pacific to the Western Hemisphere over the next two weeks.
- The phase speed decreases considerably by the end of Week-2.

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.)

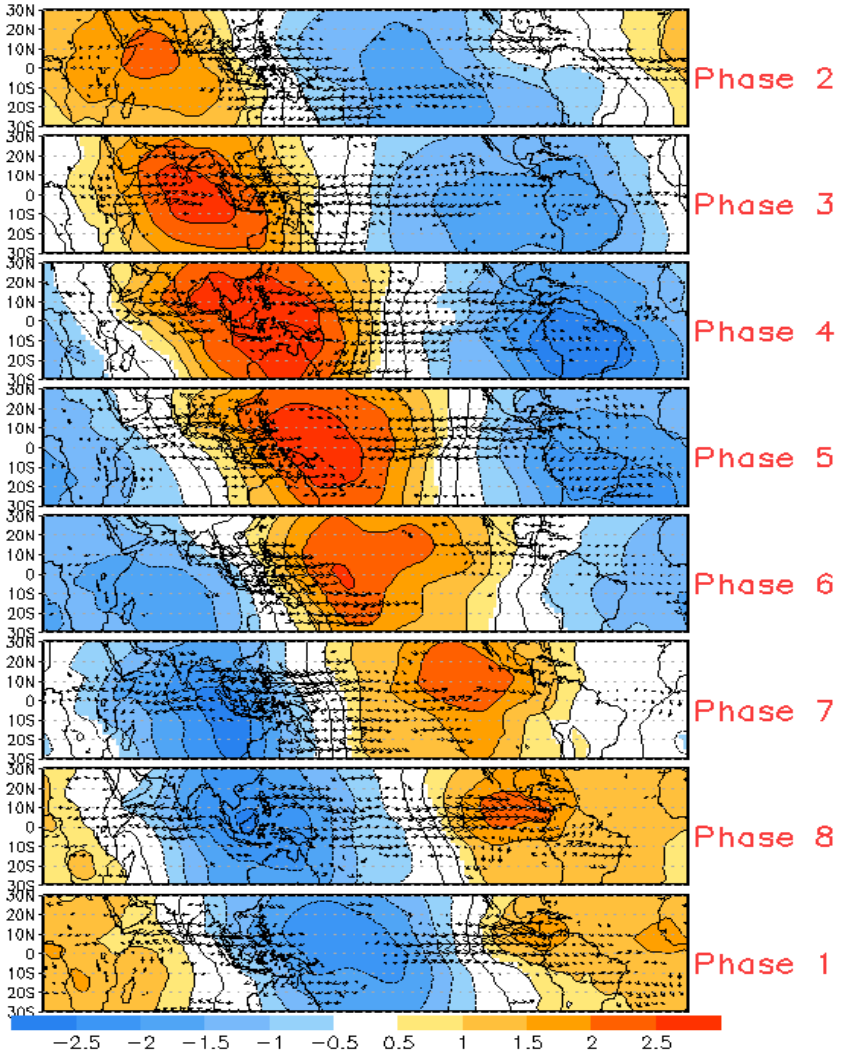




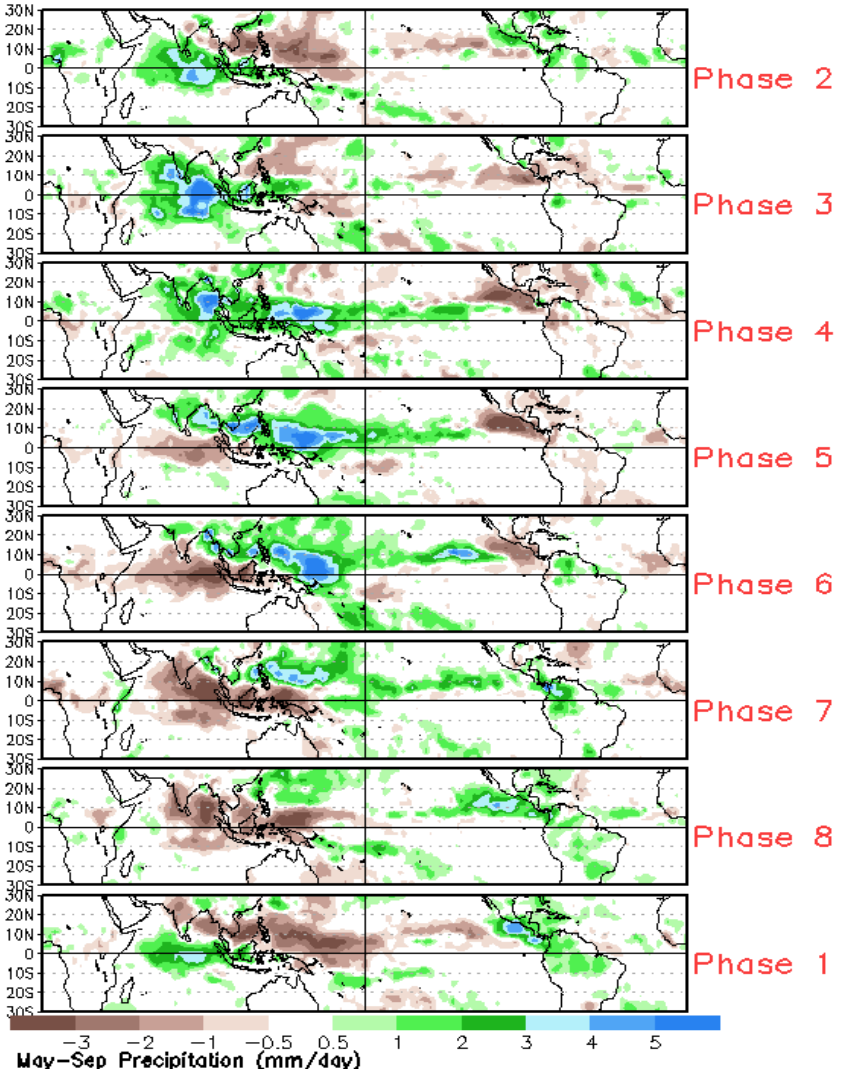
- The OLR anomalies based on the constructed analog forecast show a much slower evolution than the GEFS solution, with a gradual weakening of the signal over the Pacific by the end of Week-2.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



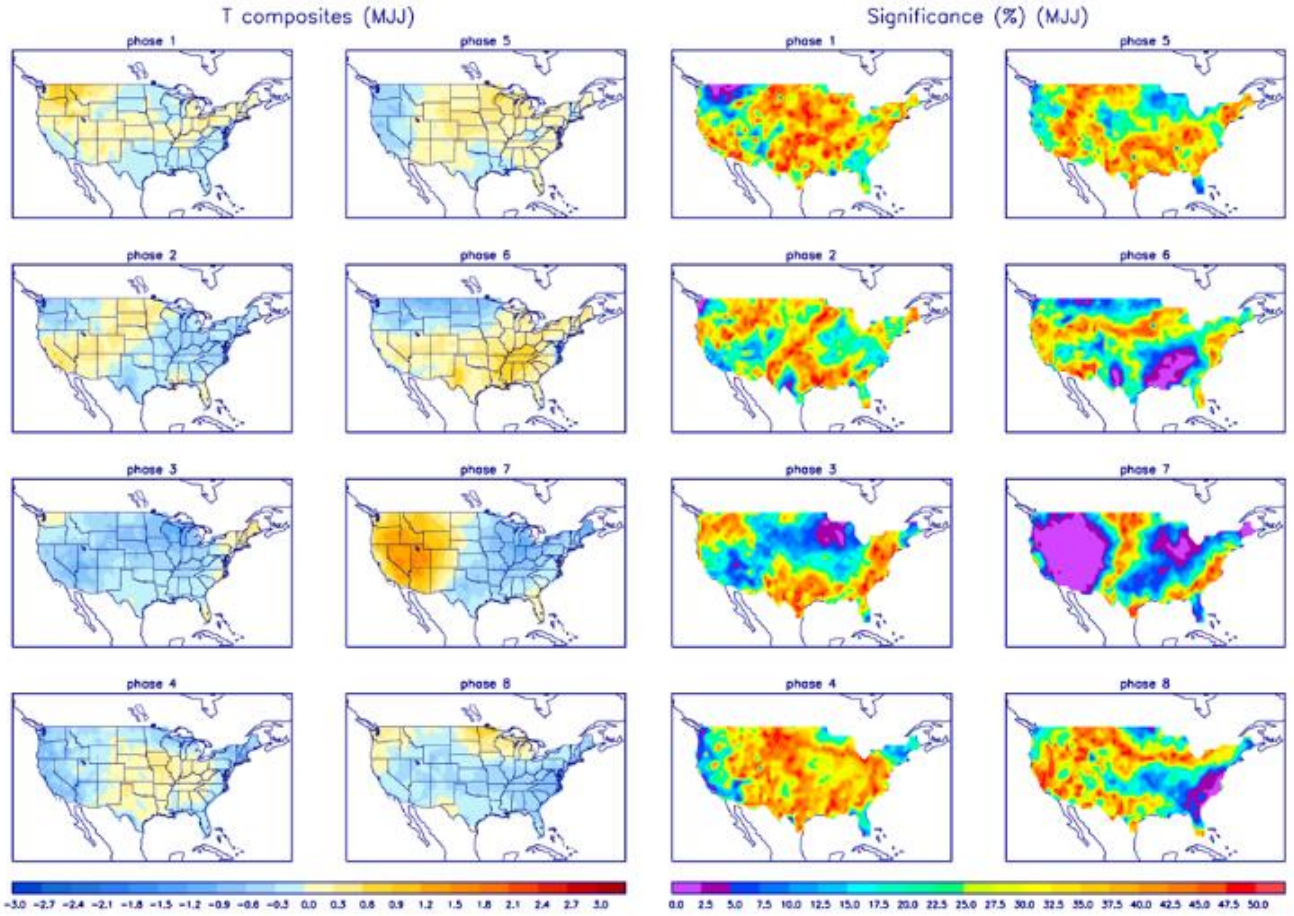
Precipitation Anomalies



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.

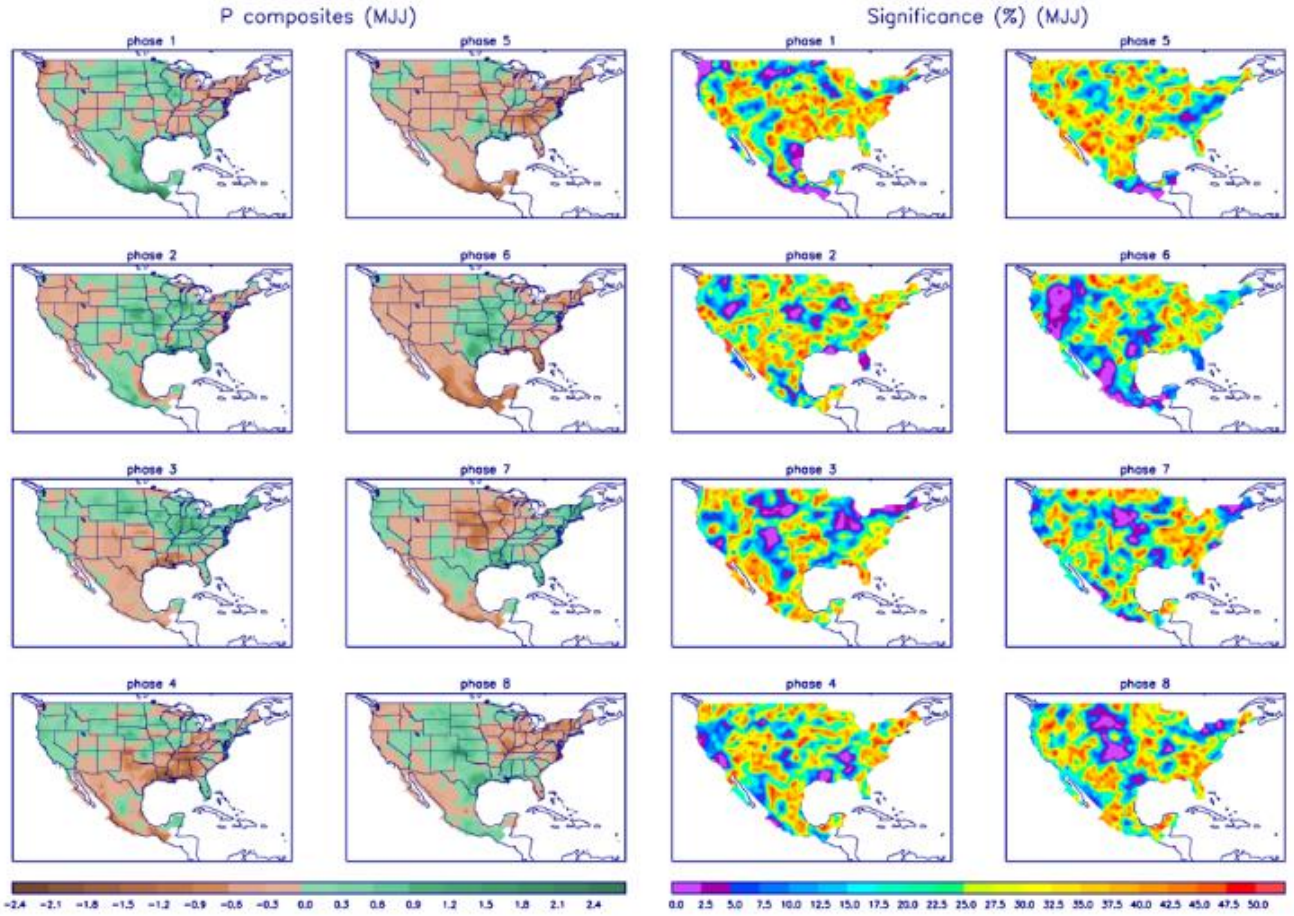


More information: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

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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