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

Update prepared by the Climate Prediction Center
Climate Prediction Center / NCEP
14 June 2021

Overview

- The RMM index recently emerged over Africa, coincident with an intraseasonal envelope that can be traced back in the upper-level velocity potential and outgoing longwave radiation fields to the primary MJO envelope over the Eastern Hemisphere during late May.

- Model guidance generally favors a weakening of this signal, and instead emphasizing a new intraseasonal feature over the Western Hemisphere by late June. This novel feature appears linked to atmospheric Kelvin wave activity.

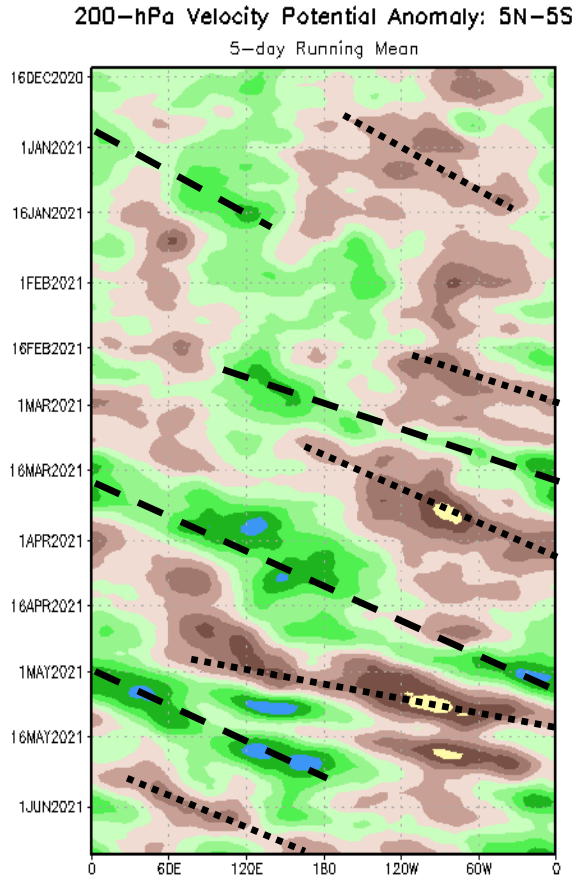
- The intraseasonal activity presently over Africa is likely supportive of a favorable large-scale environment for tropical cyclone formation over the Atlantic in the near-term.

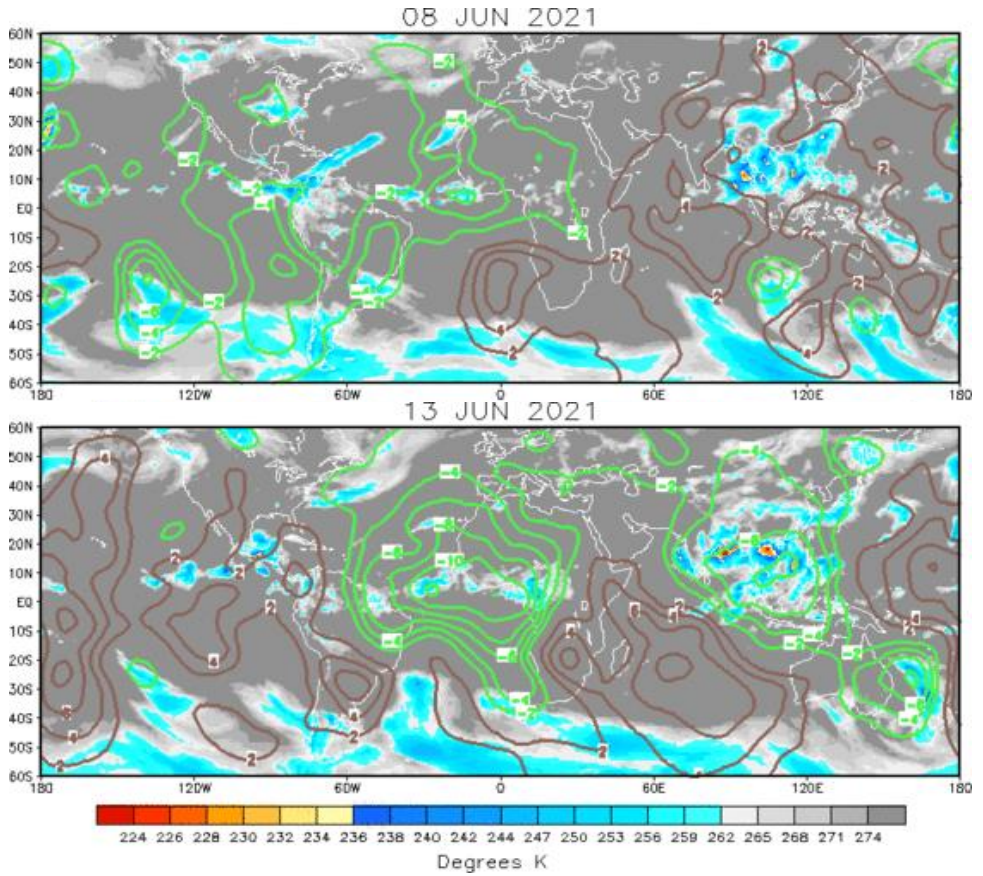
A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation).

Brown shades: Anomalous convergence (unfavorable for precipitation).



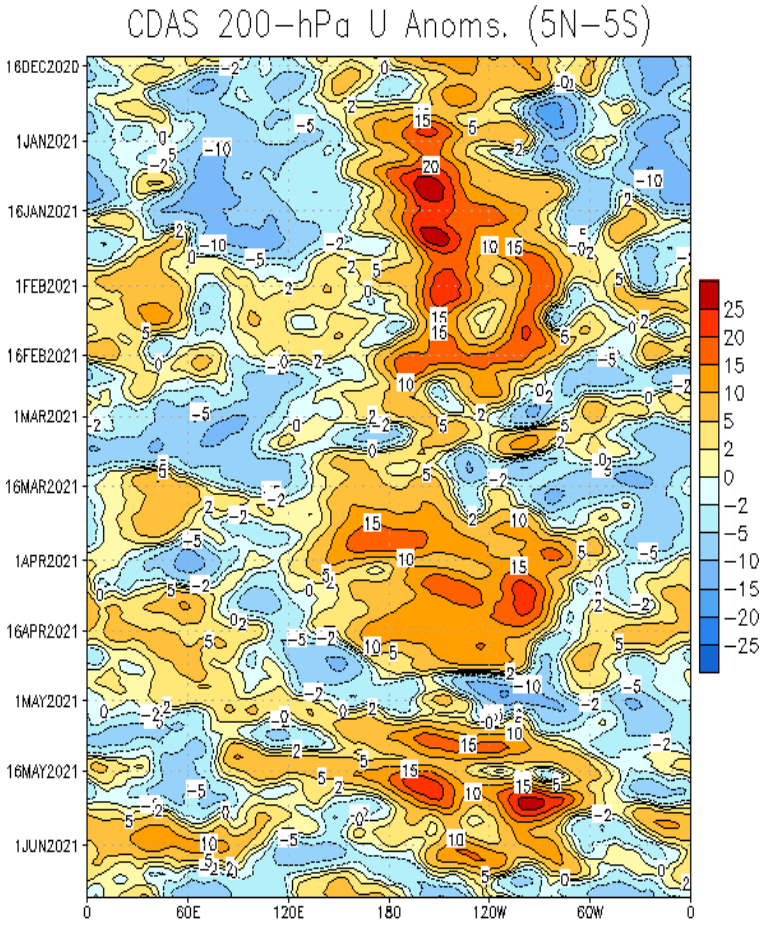


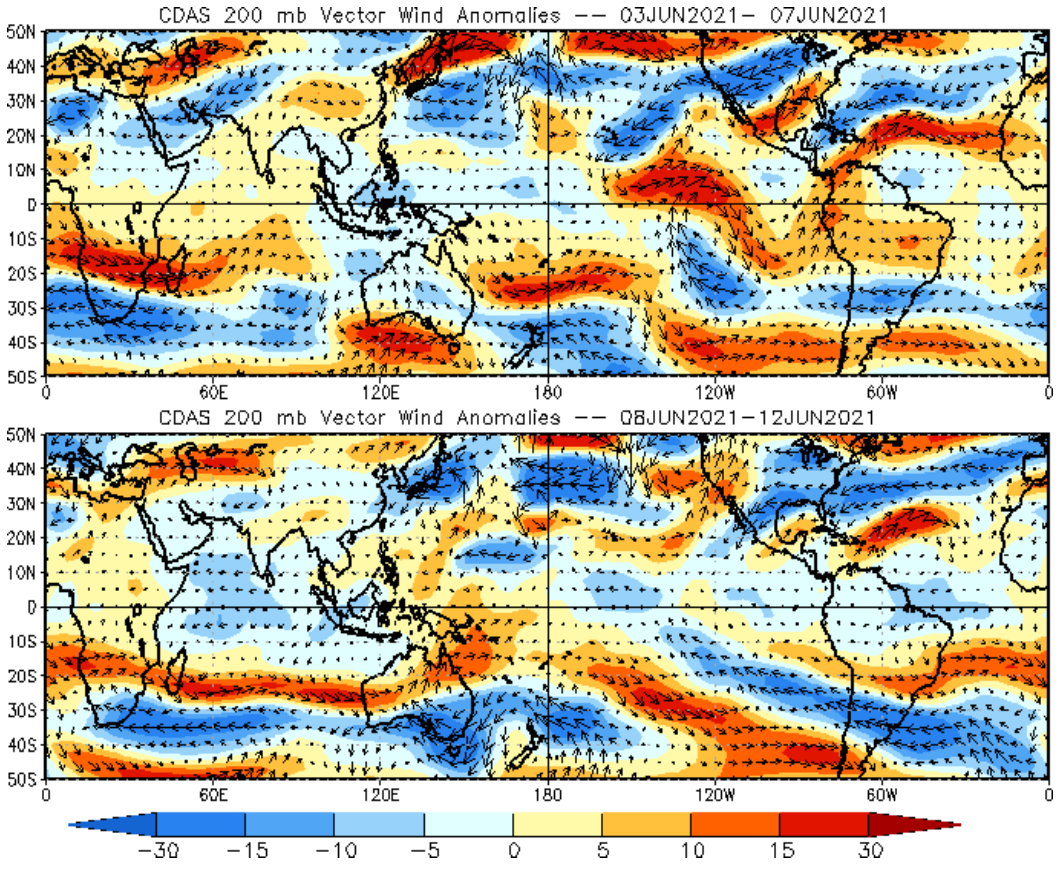
- The primary eastward-propagating enhanced envelope of intraseasonal convection is currently over the tropical Atlantic.

- The large-scale circulation pattern is wave-2 in nature, with another center of action across Southeast Asia, which appears linked to Kelvin wave activity that ejected from the primary MJO envelope during May.

200-hPa Wind Anomalies

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



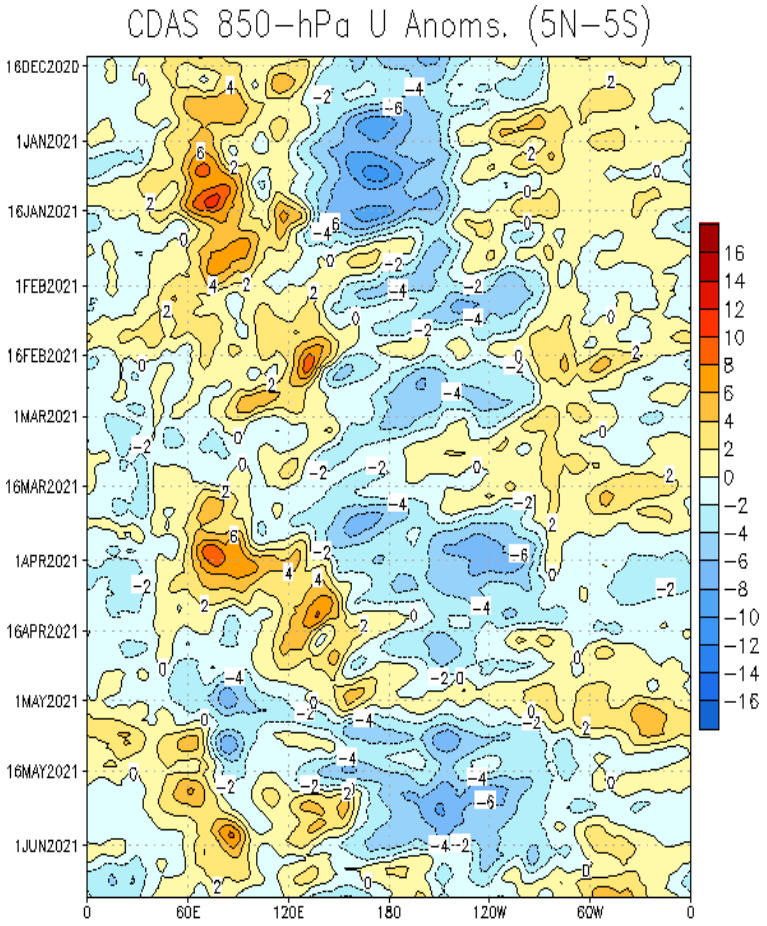


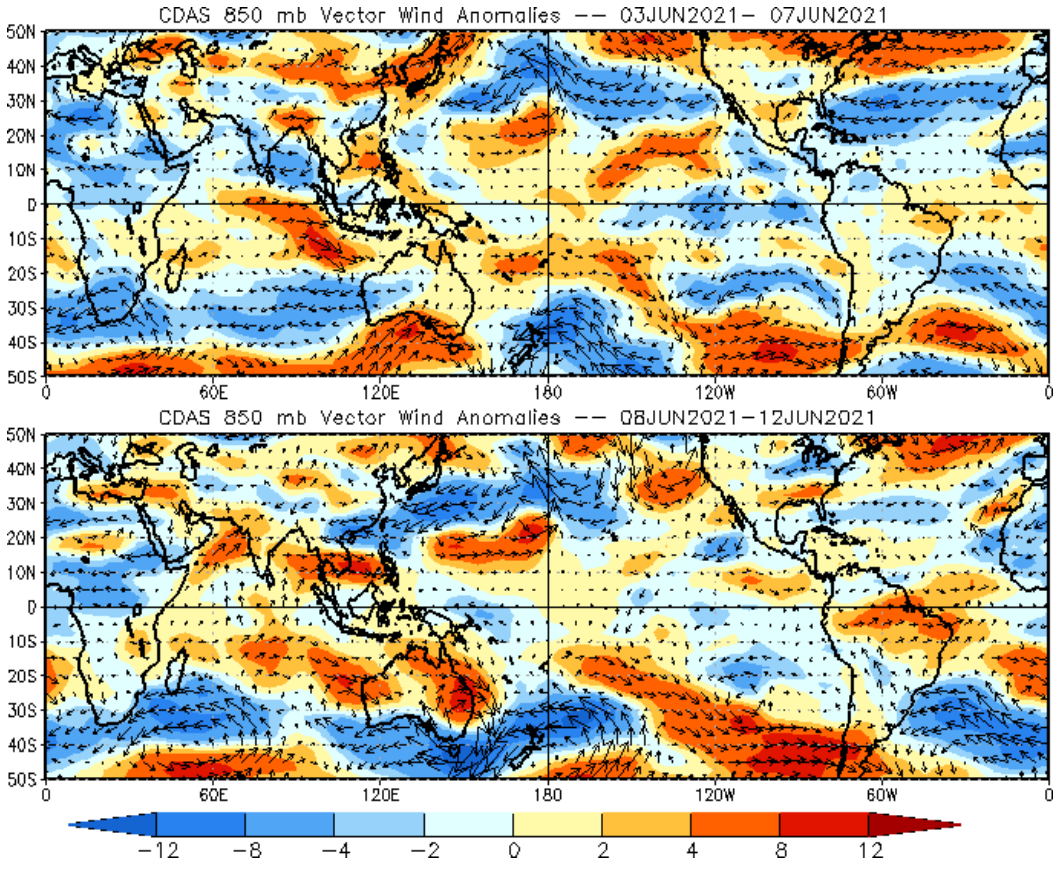
- A dipole of enhanced divergence (convergence) is situated along the equator over the Maritime Continent (Date Line). Both features appear to be at least partially driven by extratropical forcing.

- Anomalous easterlies are present across much of the Western Hemisphere along the equator. These appear linked to anomalous anticyclonic circulations centered near 10-15 degrees off equator and associated wavebreaking.

850-hPa Wind Anomalies

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



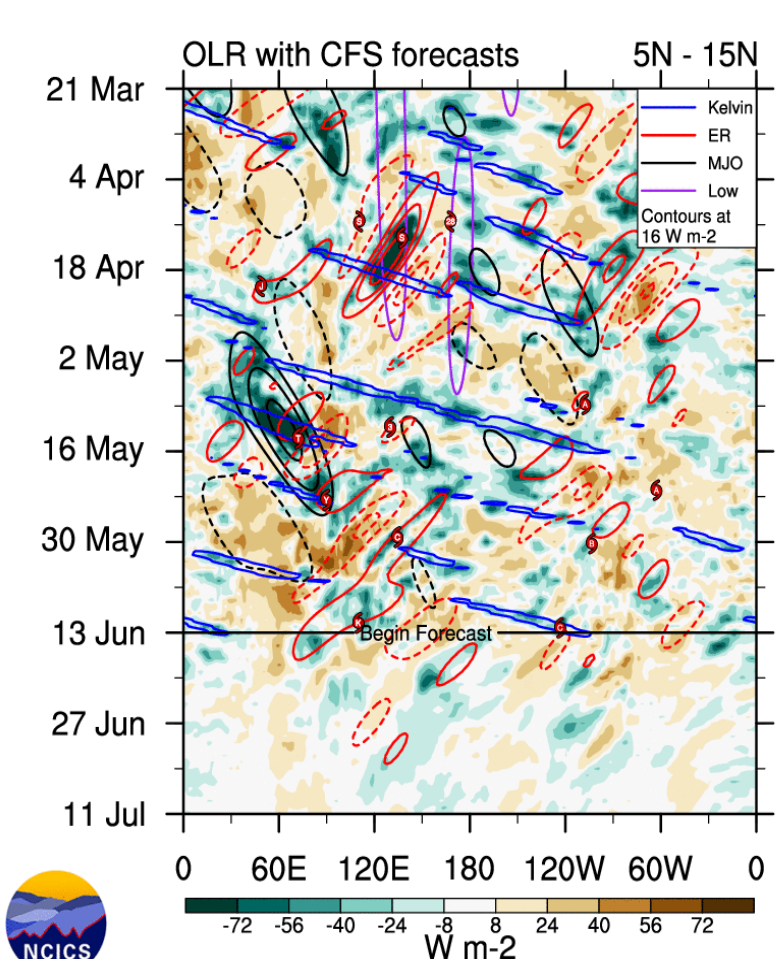


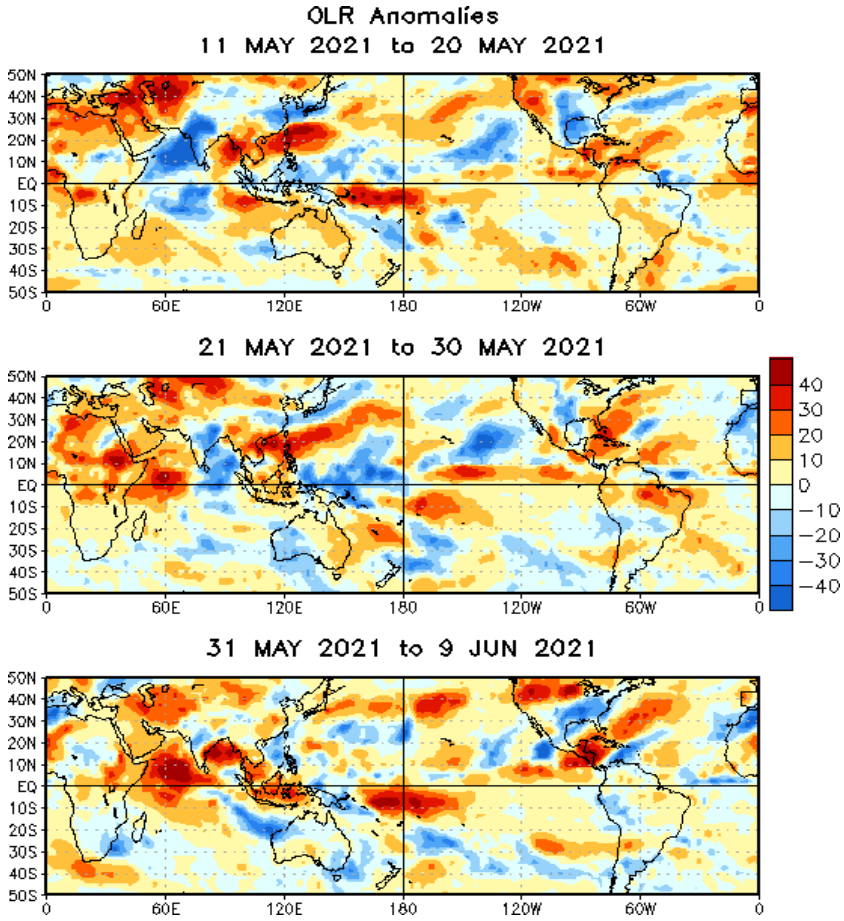
- The Indian Monsoon rapidly advanced during the most recent 5 days of analysis, as evidenced by strong anomalous flow over both the Arabian Sea and Bay of Bengal. Onset and progression of the feature is running slightly ahead of historical norms.

- Anomalous low-level westerlies over South America and the Atlantic appear to be sourced by extratropical wavebreaking from both hemispheres.

Outgoing Longwave Radiation (OLR) Anomalies

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

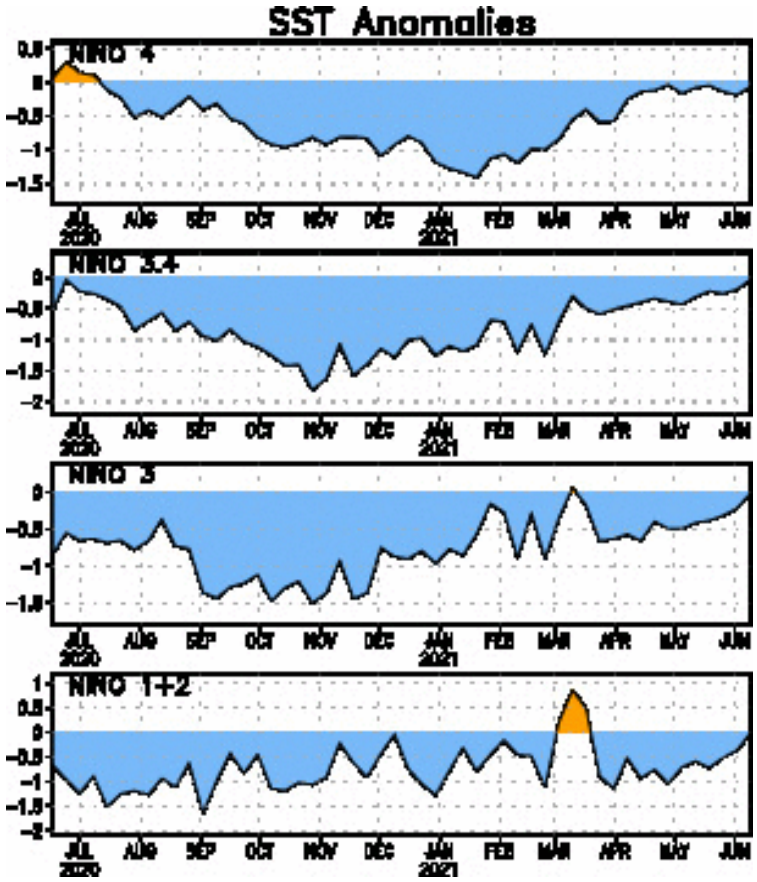


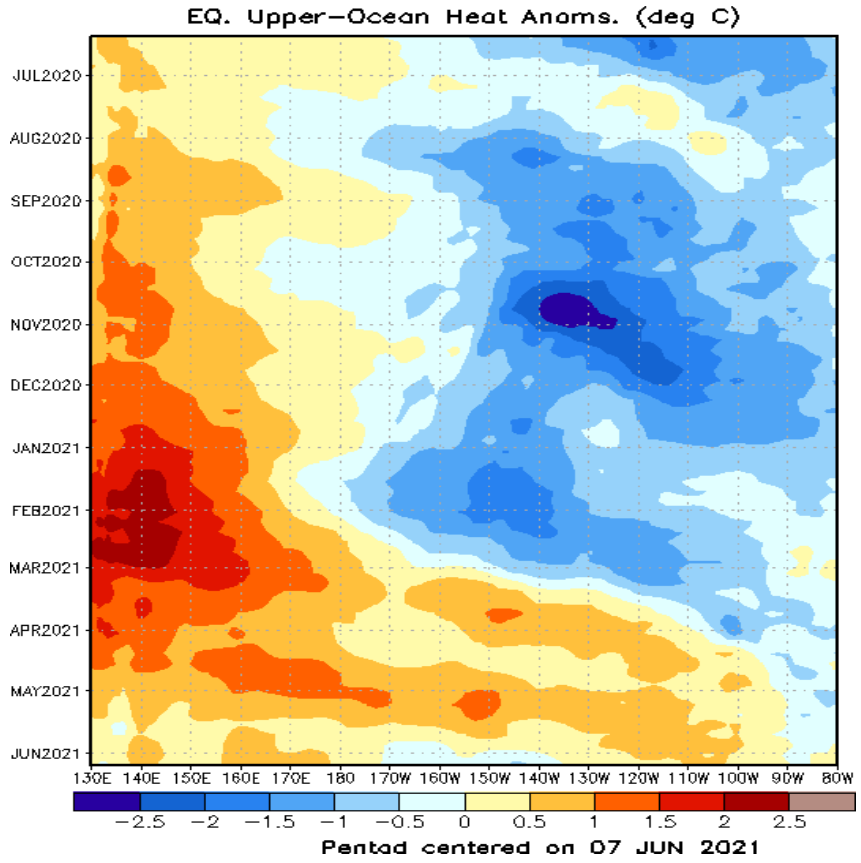


- The development of Tropical Storm Carlos over the Pacific appears coincident with the presence of an atmospheric Kelvin wave.

- Equatorial Rossby wave activity appears to be the primary mode of tropical variability lately, with this continuing for the remainder of June per CFS forecasts.

SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



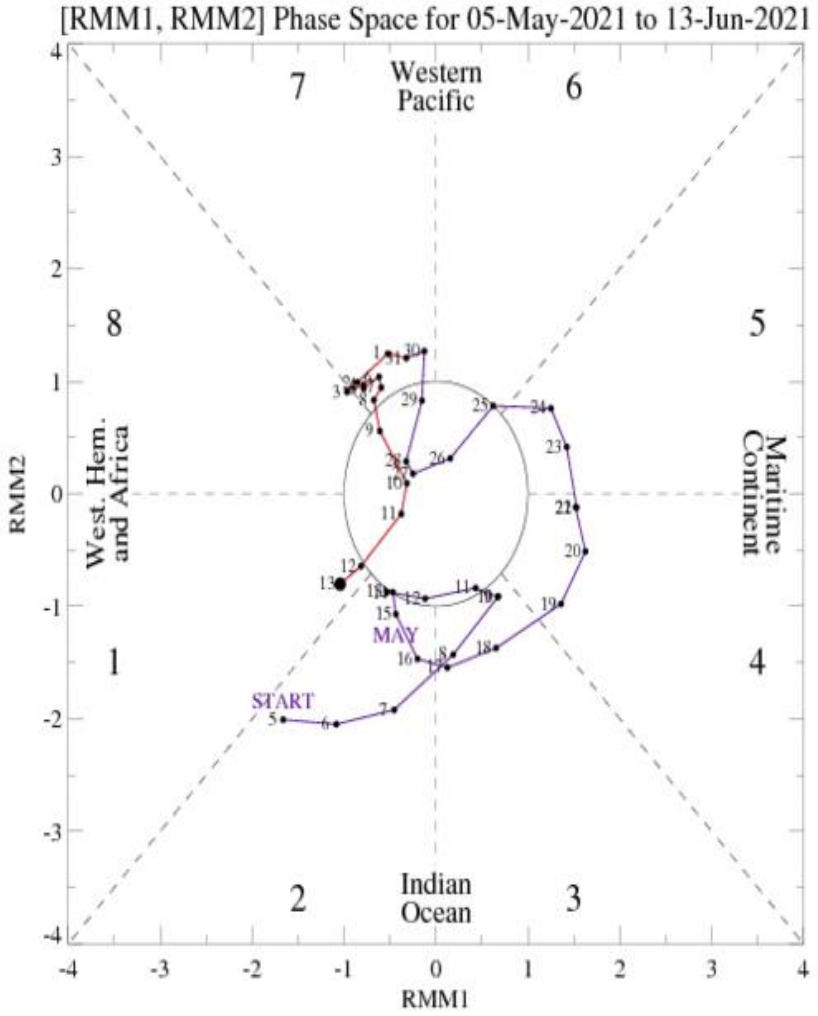


- Upper-ocean heat content is above-normal along the equator for areas west of 90°W as a result of multiple downwelling oceanic Kelvin waves since March.

- Niño indices continue to remain below-normal, although the vertically-integrated heat content near the surface suggests any cold water volume is extremely shallow.

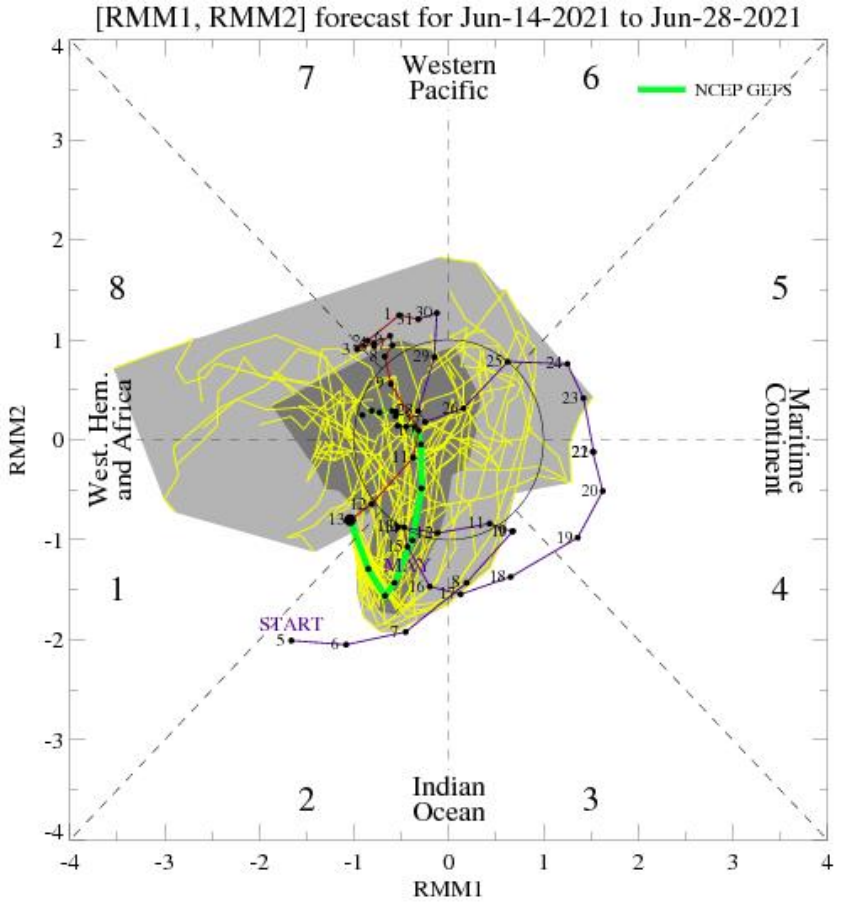
MJO Index: Recent Evolution

- The RMM index shows intraseasonal activity within the unit circle while crossing the Western Hemisphere over the past week, before emerging over Africa on the 12th of June.

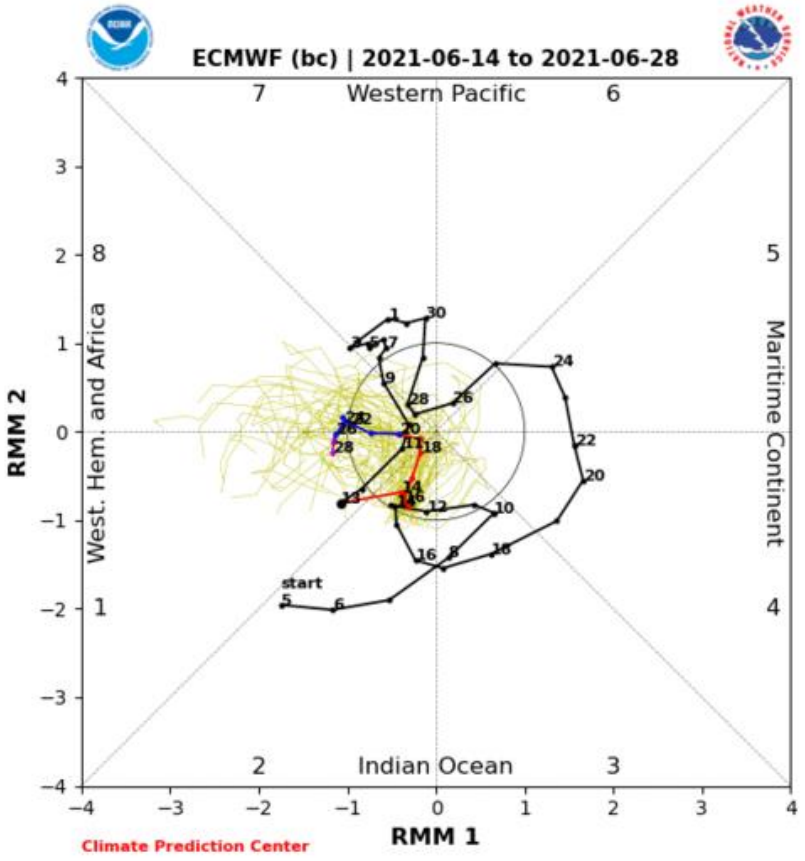


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast

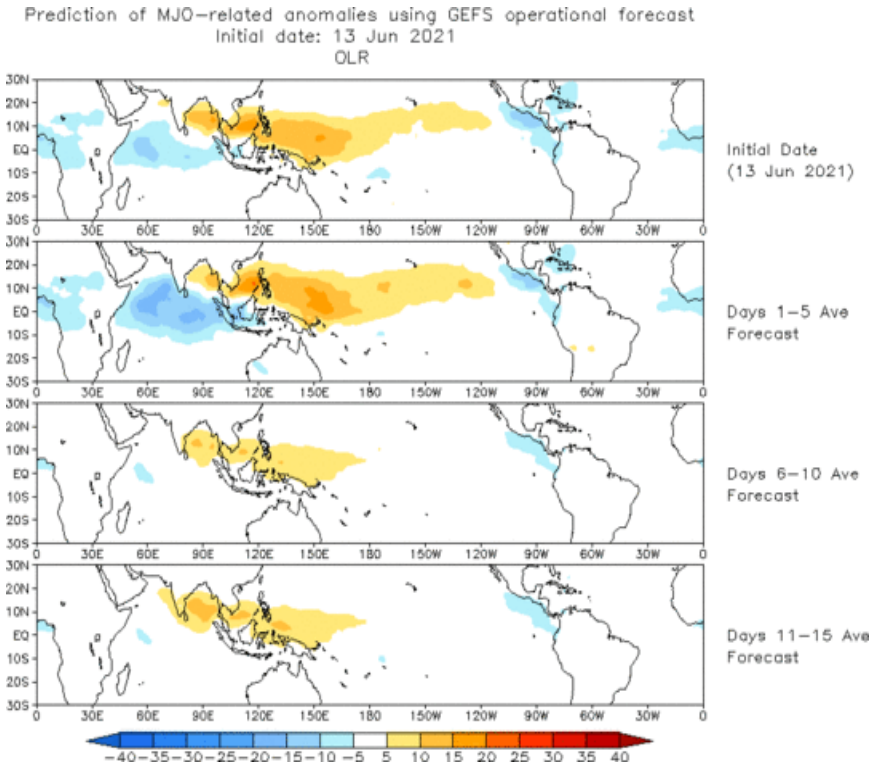


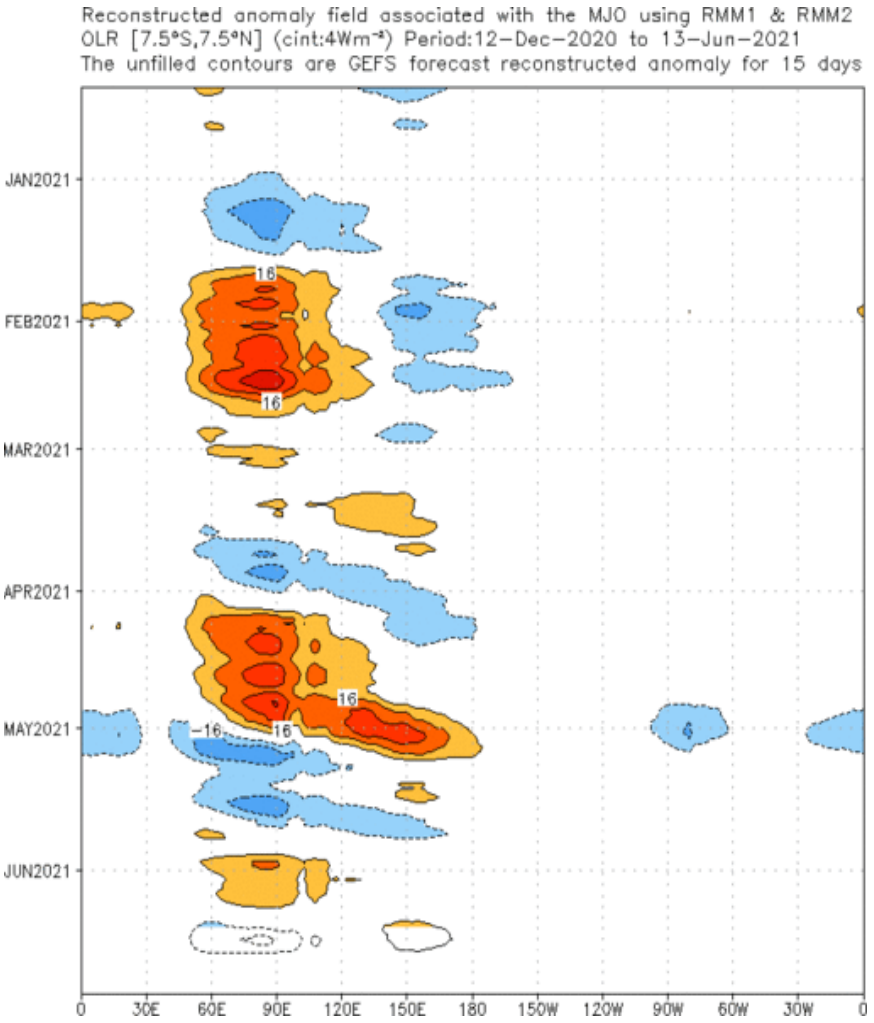
ECMWF Forecast

- Both the GEFS and ECMWF models show some limited propagation of the RMM index to the Indian Ocean over the next 2-3 days. Beyond this point in time, a period of weakness is anticipated, followed by subsequent re-emergence over the Western Hemisphere (ECMWF and roughly half the GEFS members) or Western Pacific (remaining GEFS members).

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.)

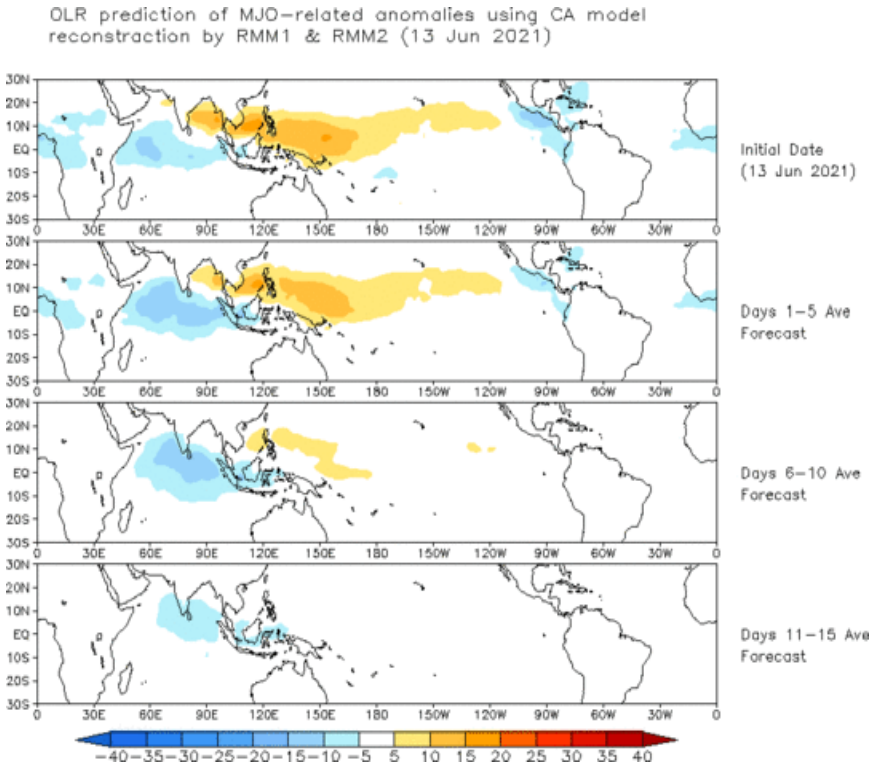


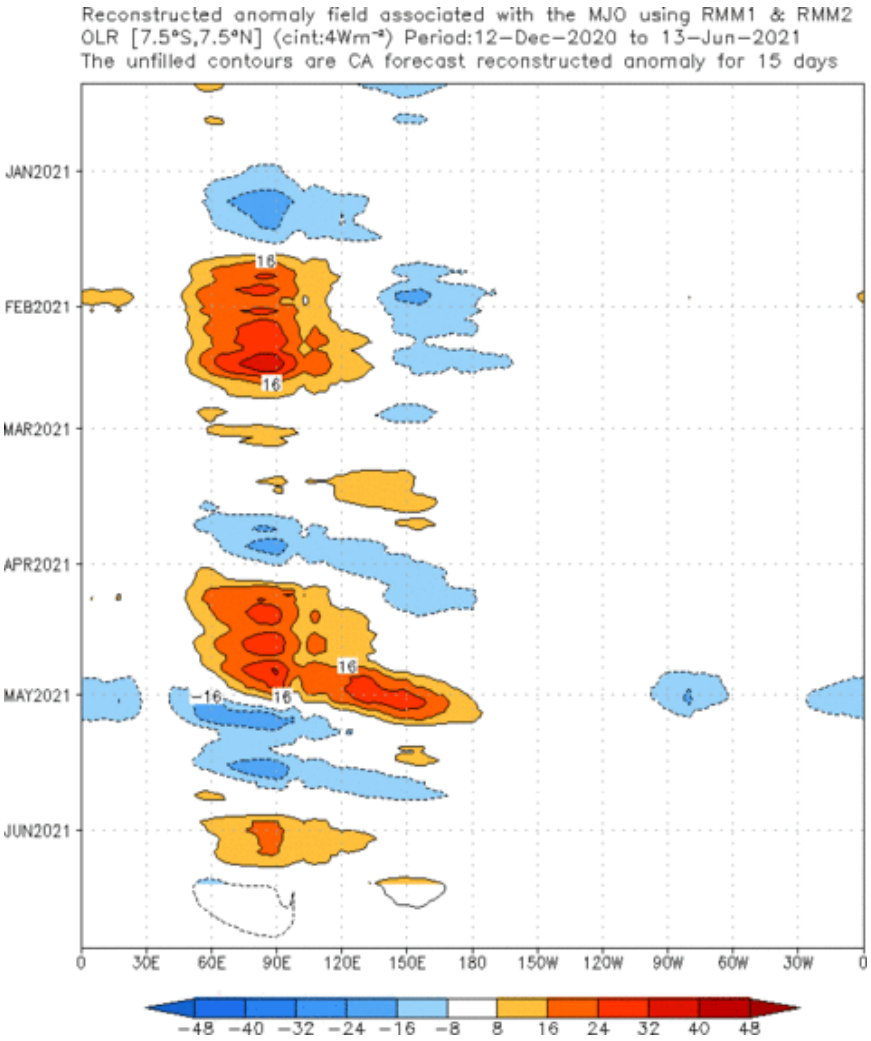


- The GEFS RMM-based OLR anomaly forecast shows a stationary pattern that generally decays in place, particularly any enhanced convection over the Indian Ocean.

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.)

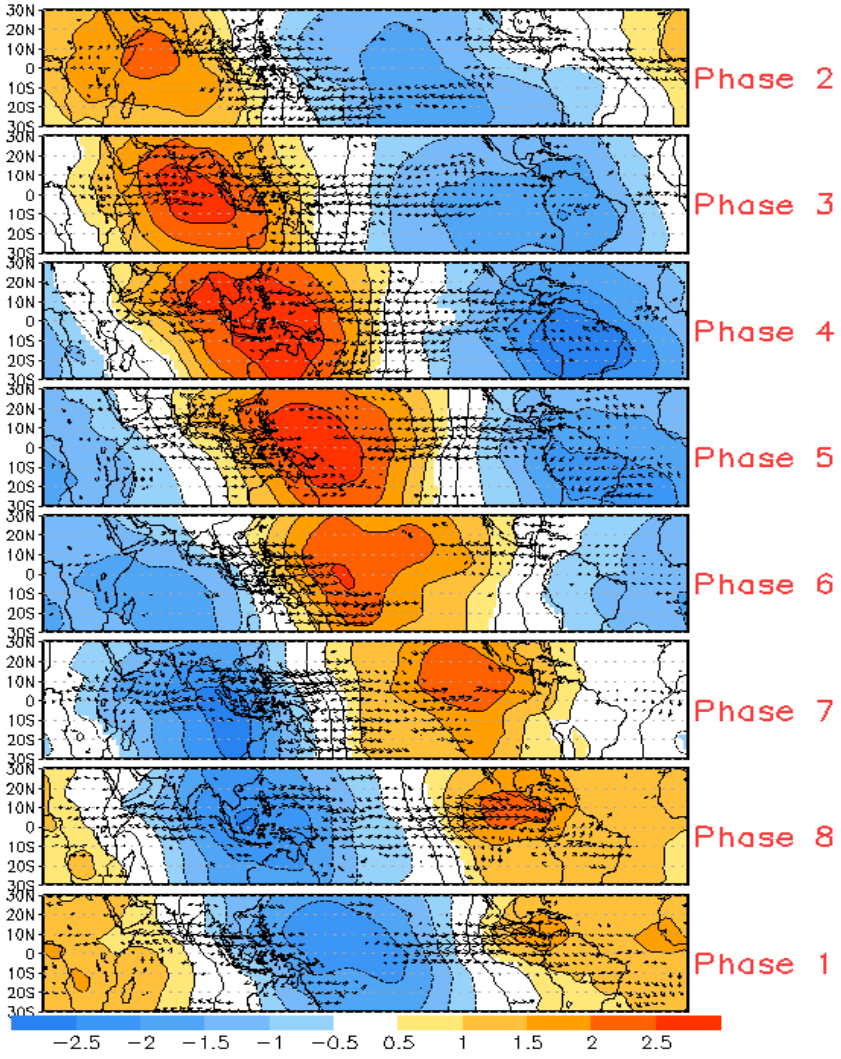




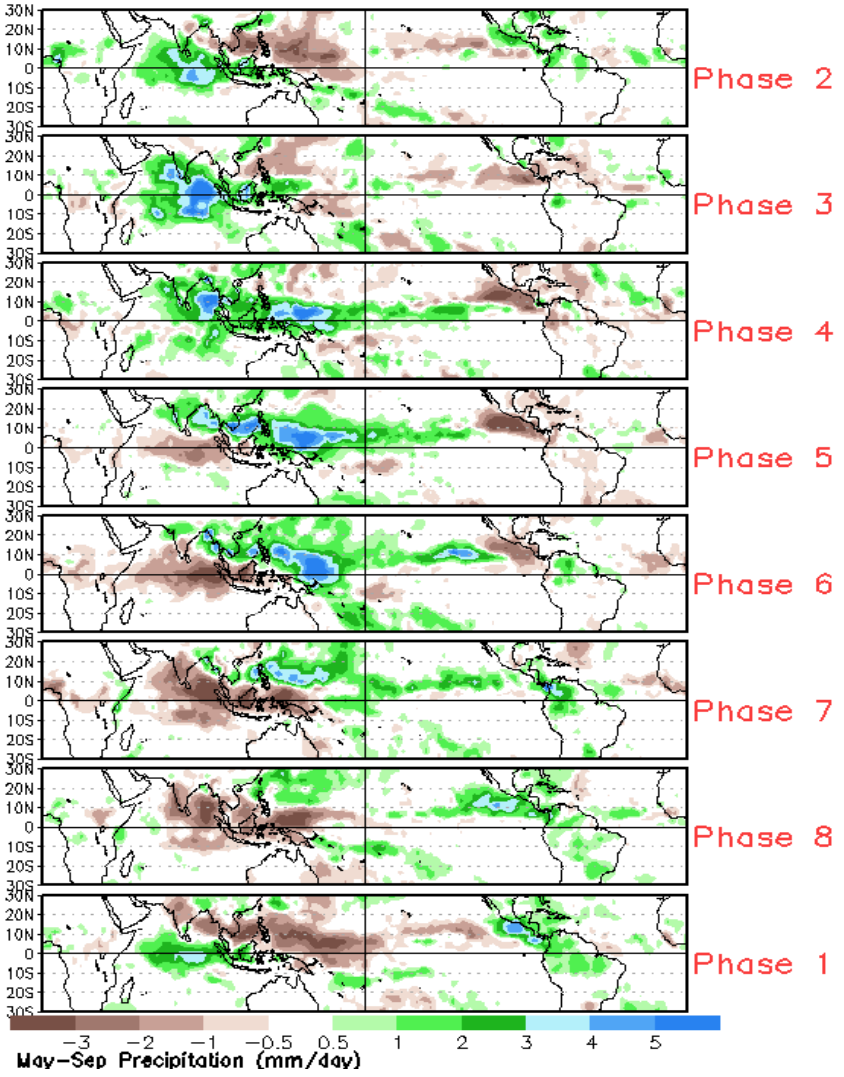
- The constructed analog forecast depicts a gradual eastward progression of the MJO, although the suppressed convection over the Pacific largely dissipates by 11-15 days.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



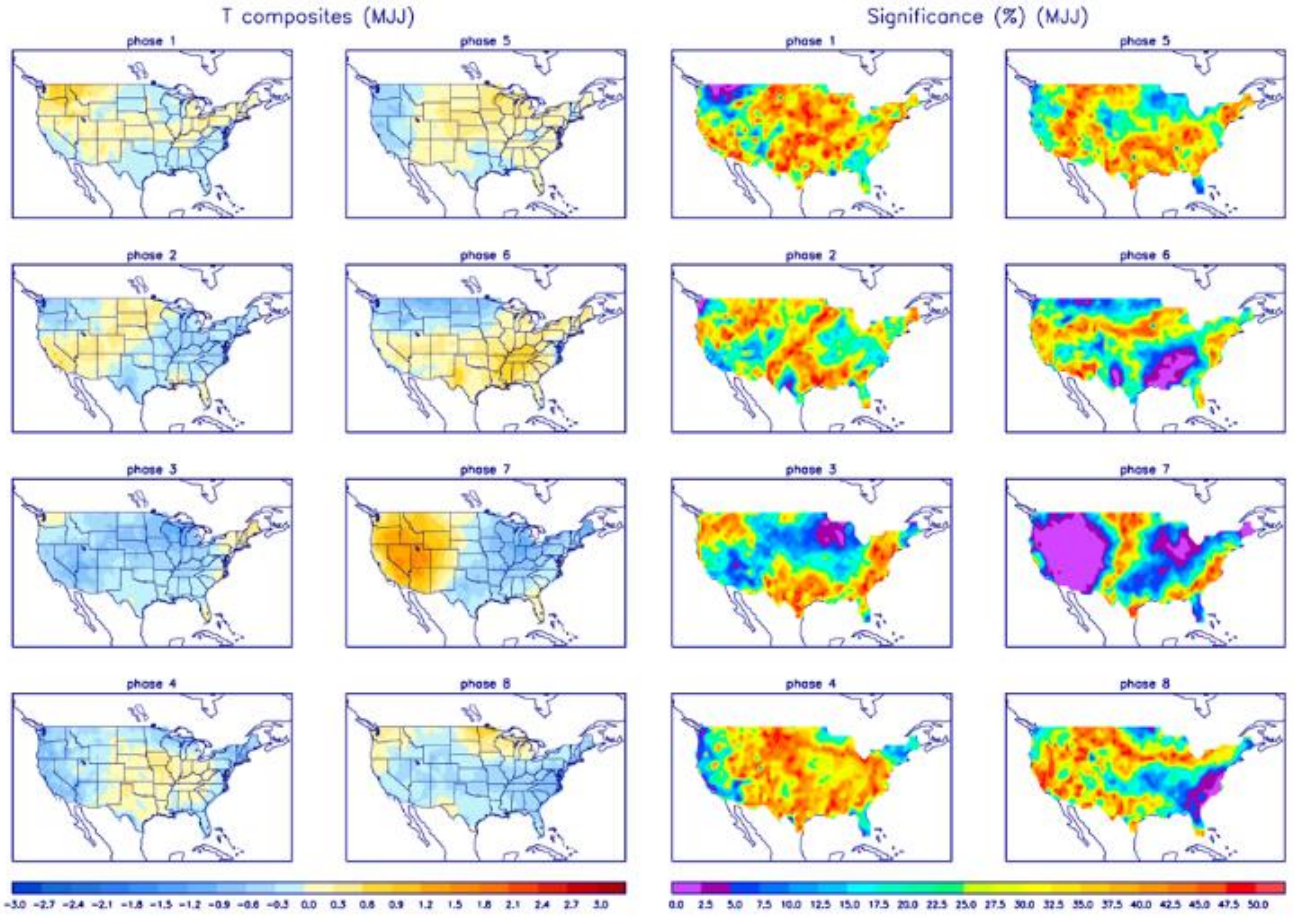
Precipitation Anomalies



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.

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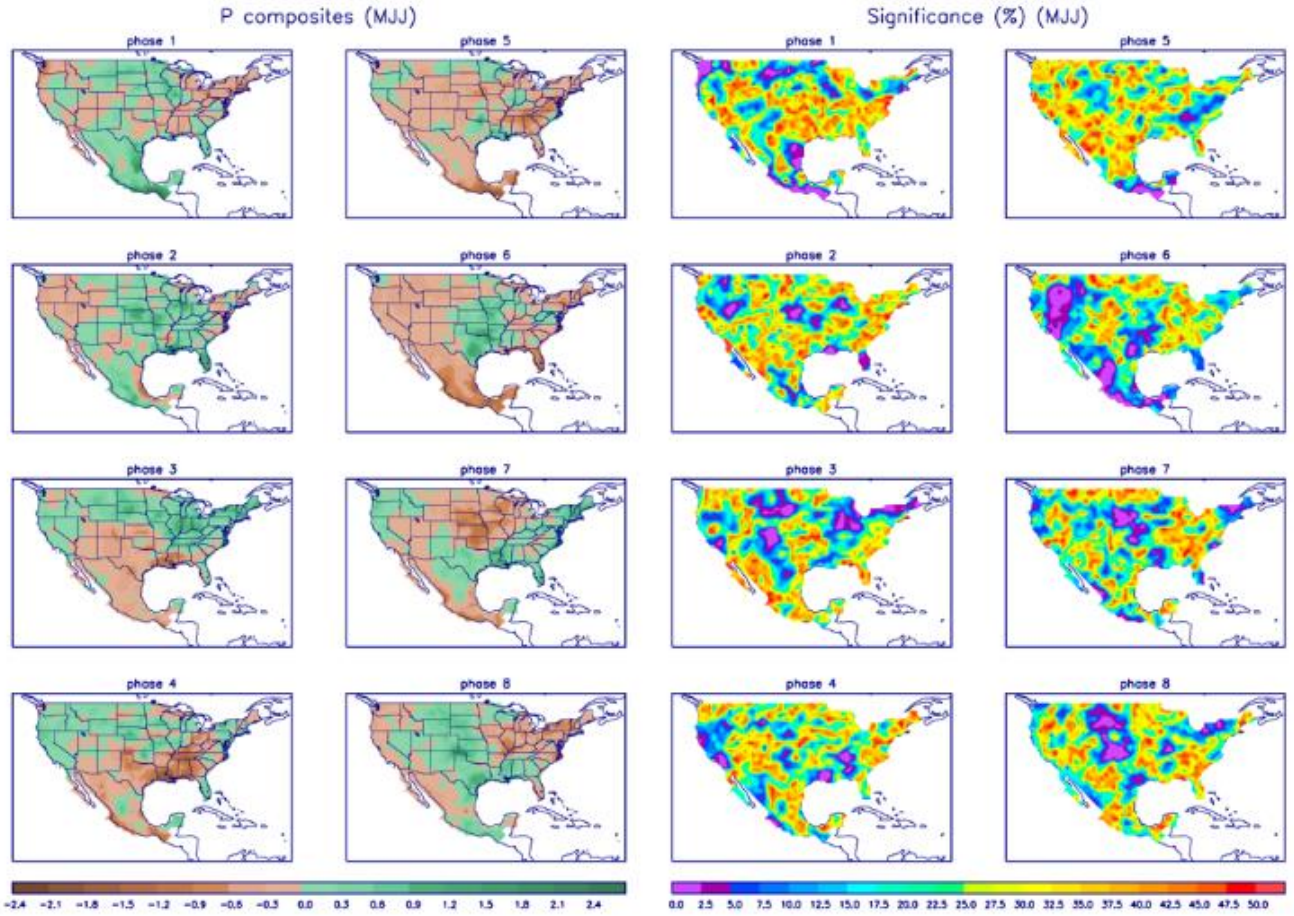

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