The Impact of the Madden-Julian Oscillation (MJO) on Temperature and Precipitation in the Americas

Michael Natoli[1], E. Hugo Berbery[1], Emily Becker[2]

1. Earth System Science Interdisciplinary Center (ESSIC)/Cooperative Institute for Climate and Satellites-Maryland (CICS-MD) - University of Maryland
2. Climate Prediction Center – NOAA

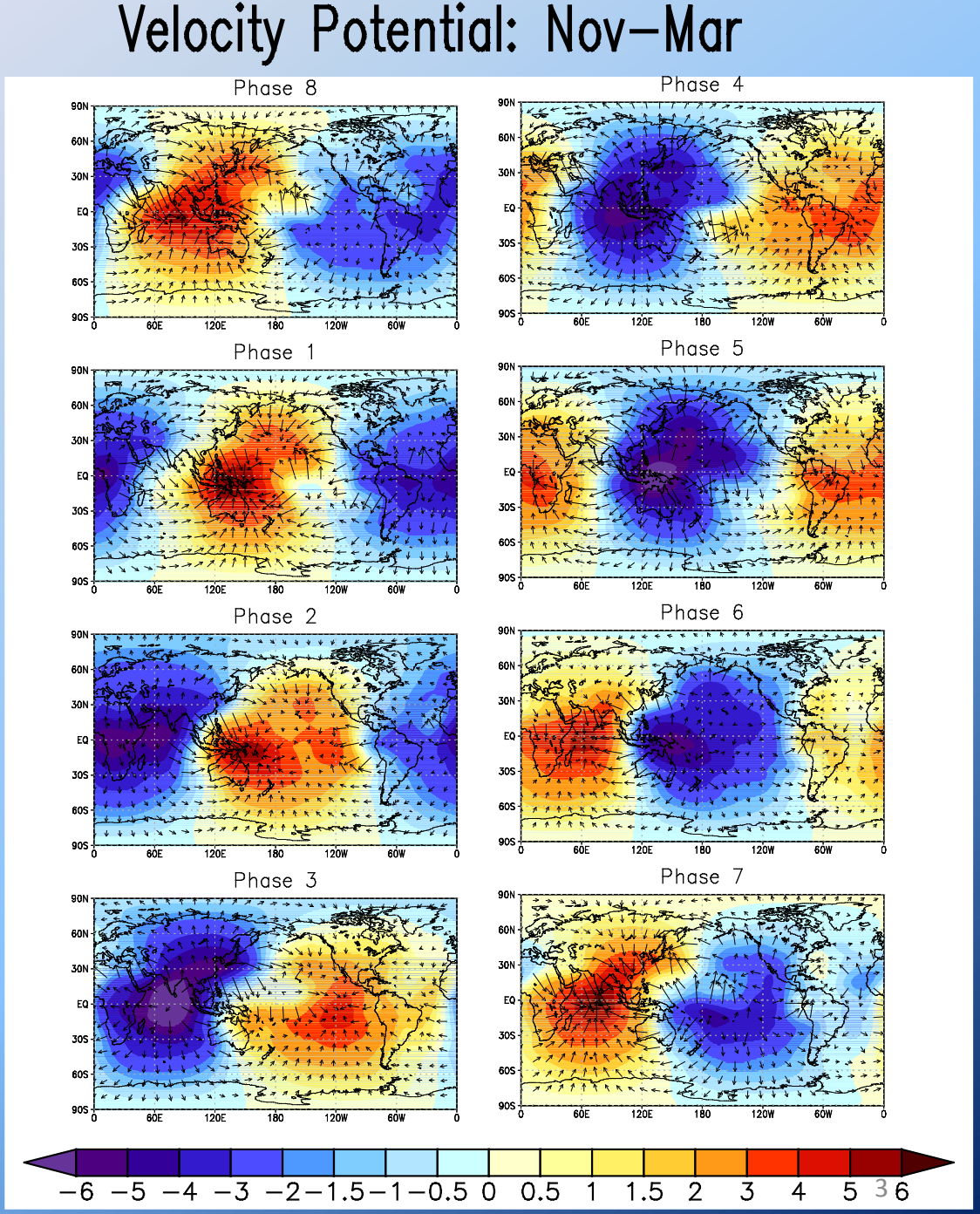
Objectives

- Identify the Madden-Julian Oscillation (MJO) effects on the temperature and precipitation patterns over the Americas

- Understand the corresponding large scale mechanisms by which those alterations take place.

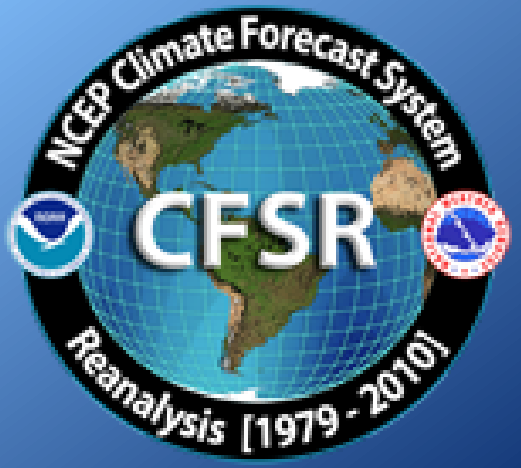
What is the MJO?

- Area of eastward-propagating enhanced tropical convection
- Wheeler-Hendon Index (2004)



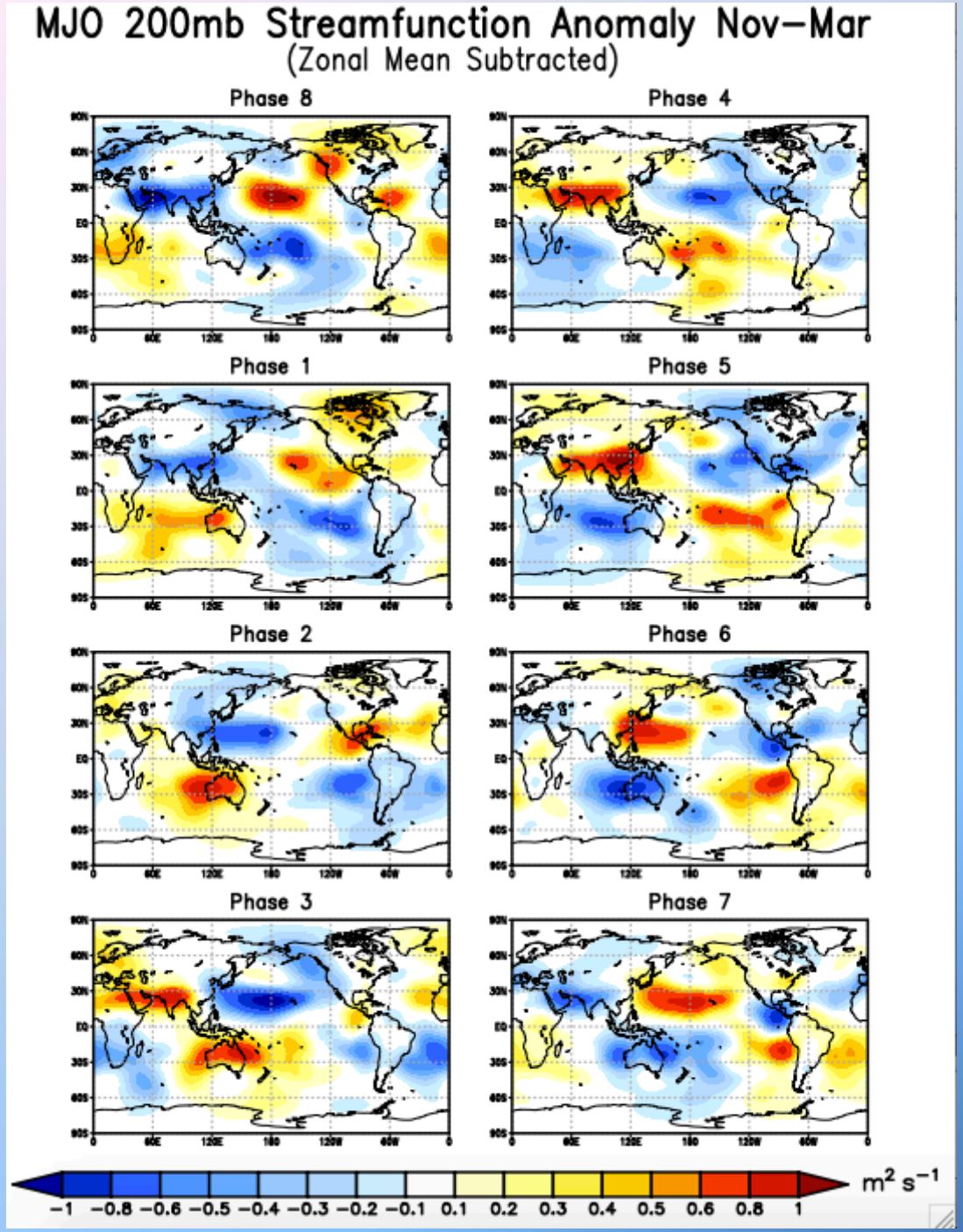
Data: NCEP's Climate Forecast System Reanalysis

- Variables studied
  - 200mb zonal and meridional wind (m/s)
  - 200mb Velocity Potential (m^2/s)
  - 200mb Streamfunction (m^2/s)
  - 2m Temperature (K)
  - Average Precipitation Rate (mm/day)
- Period Analyzed: 1979- 2010
- MJO data using WH Index from the Climate Prediction Center



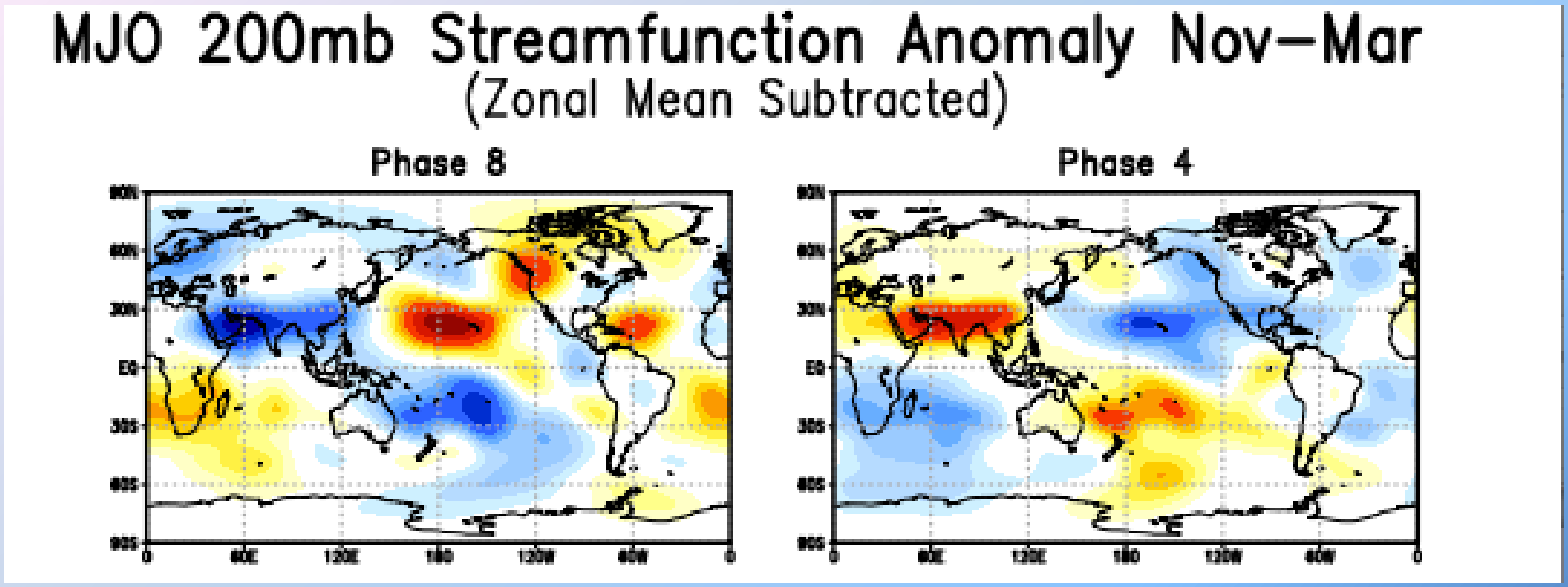
Method

- Identified phases of MJO using the WH index
- Composite data sets created for each of the eight phases in two seasons, Nov-Mar and May-Sep
  - An average of daily anomalies (departure from monthly mean) for all days in that season and phase



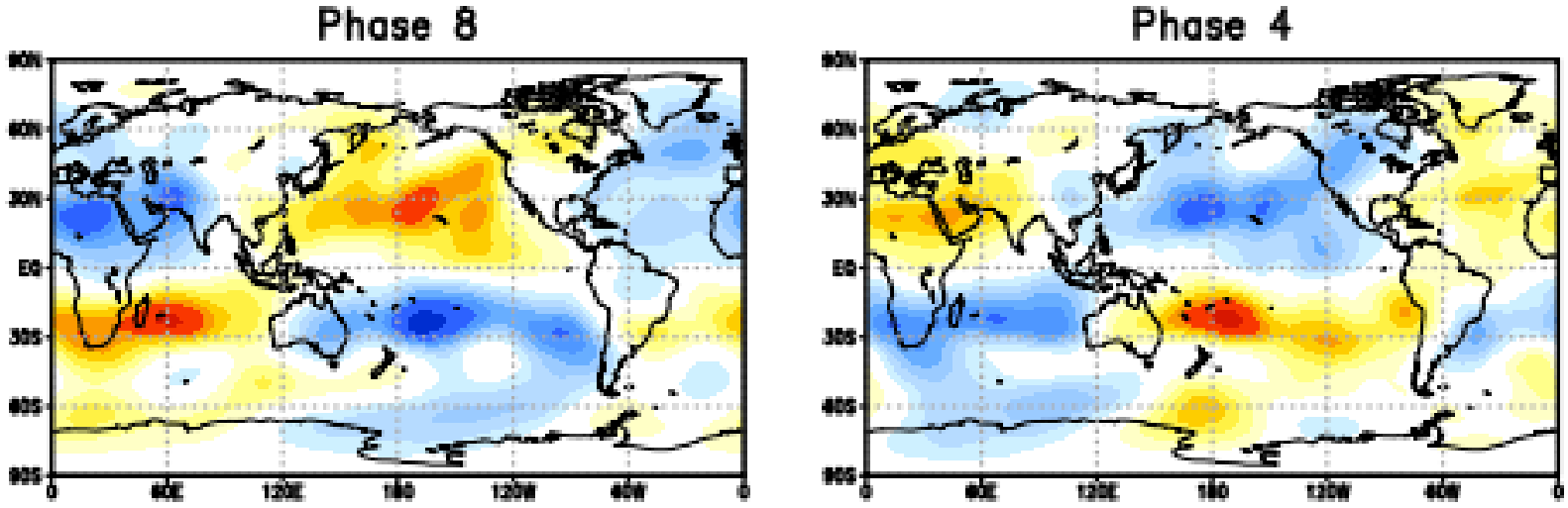
Streamfunction

- Red=Positive Anomaly
  - Anti-cyclone in NH, cyclone in SH
- Blue=Negative Anomaly
  - Cyclone in NH, anti-cyclone in SH

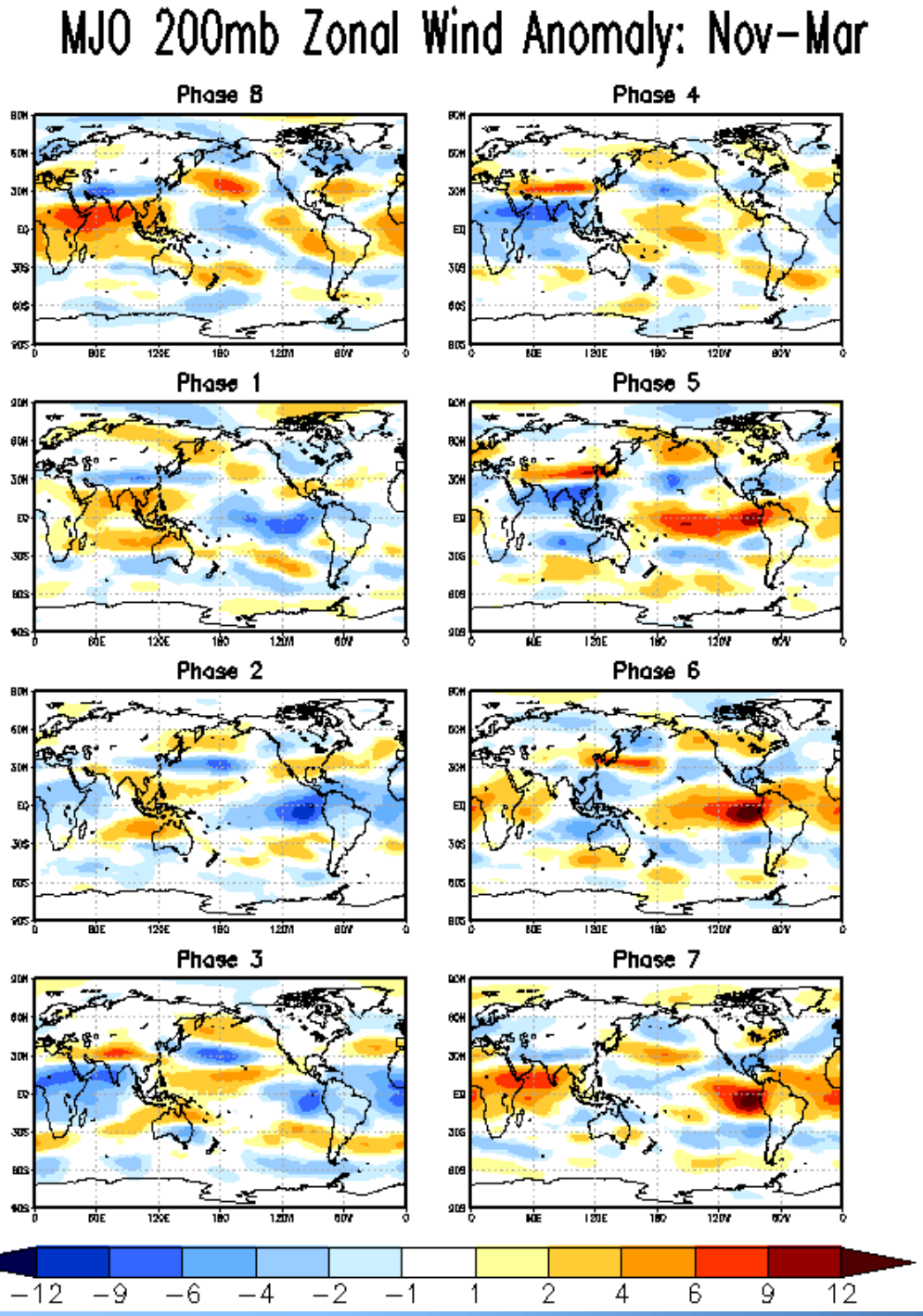


- Cyclonic anomaly leading MJO convection
  - Stronger in the winter hemisphere
- Anti-cyclonic anomaly trailing convection
- Excitation of wave-trains into the extra-tropics
  - Can have effects on other climate modes, i.e. NAO, AO, PNA, etc.

MJO 200mb Streamfunction Anomaly May–Sep
(Zonal Mean Subtracted)



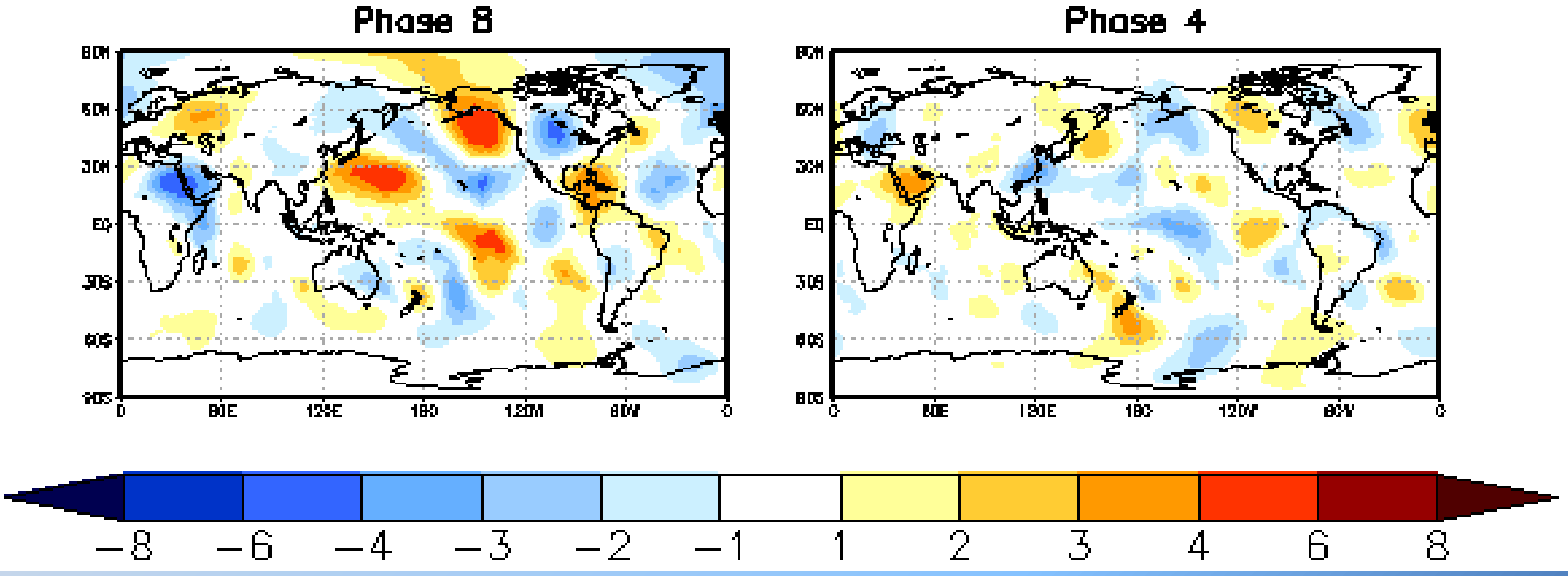
- Austral Winter Pattern
- Wave train prevalent in Southern Hemisphere, non-coherent signal in Northern Hemisphere



Zonal Wind Anomalies

- Follow the streamfunctions
- Red=westerly anomaly
- Blue=easterly anomaly
- Relation to jet streams

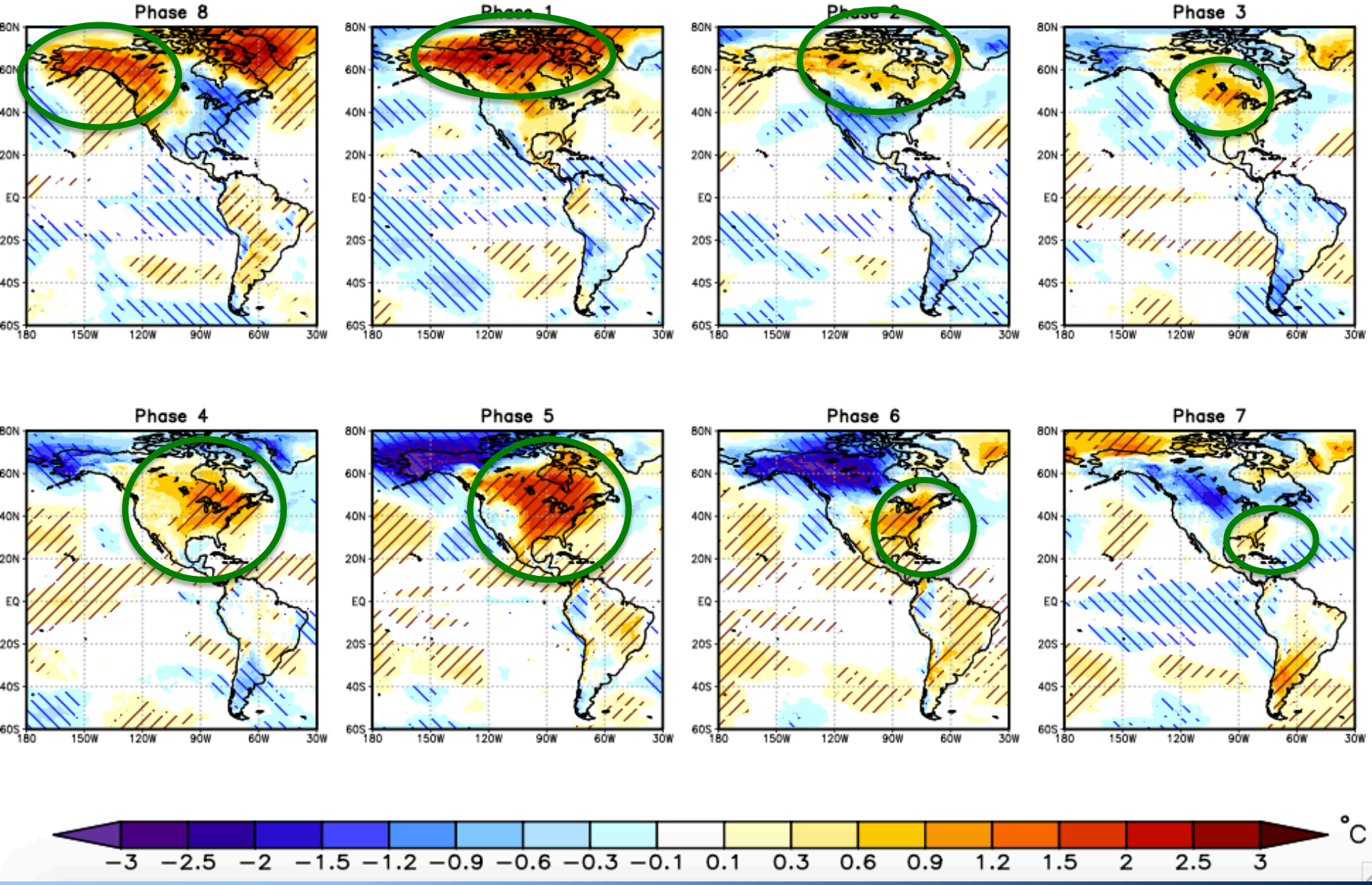
MJO 200mb Meridional Wind Anomaly: Nov-Mar



- Red=southerly anomaly, blue=northerly anomaly
  - Again follows streamfunctions
- Opposite pattern on west side of suppressed convection
- Strongest when pattern is over Pacific Ocean

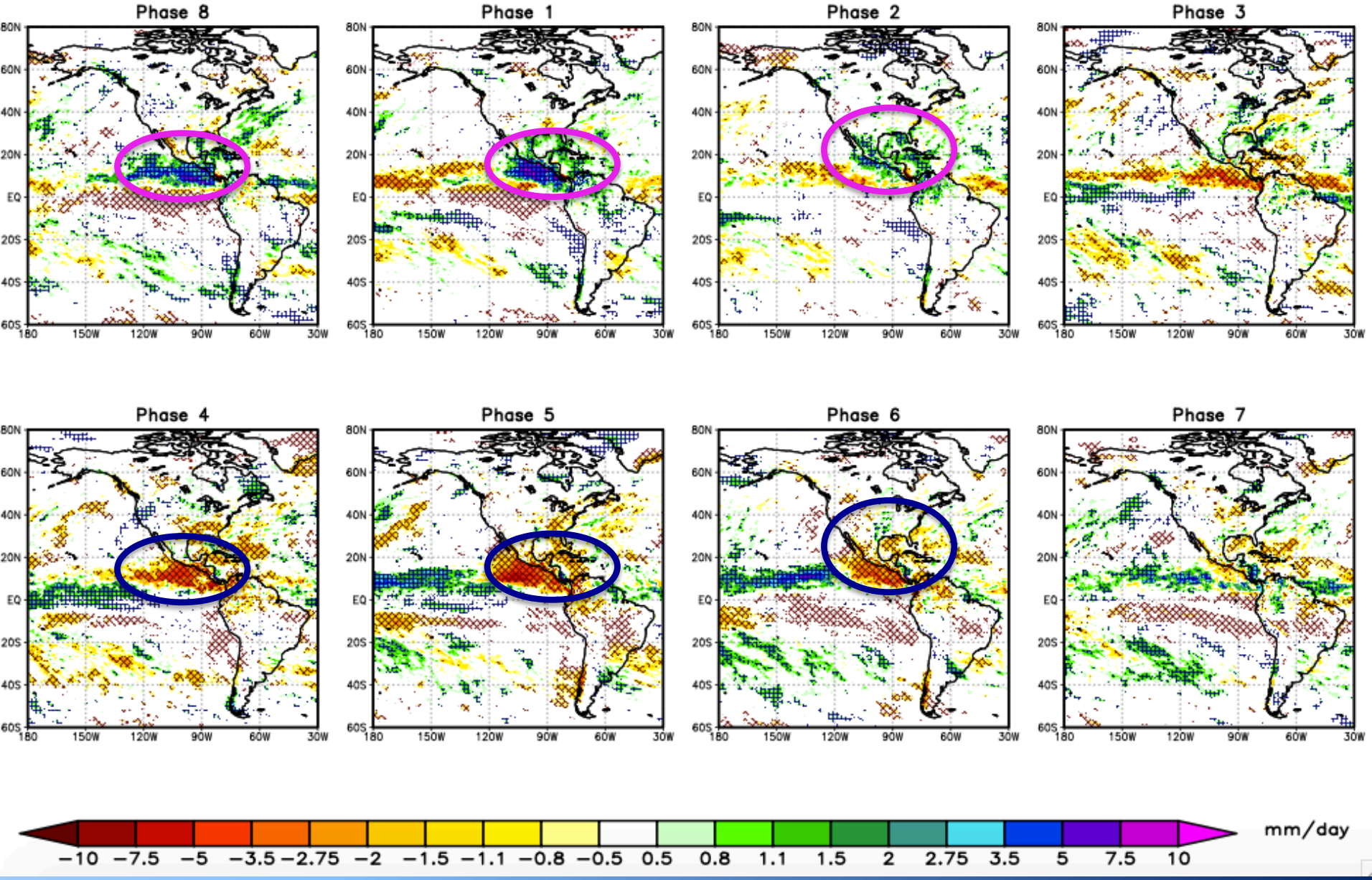
MJO Temperature Anomaly Nov–Mar

Hatching at 5% Significance Level



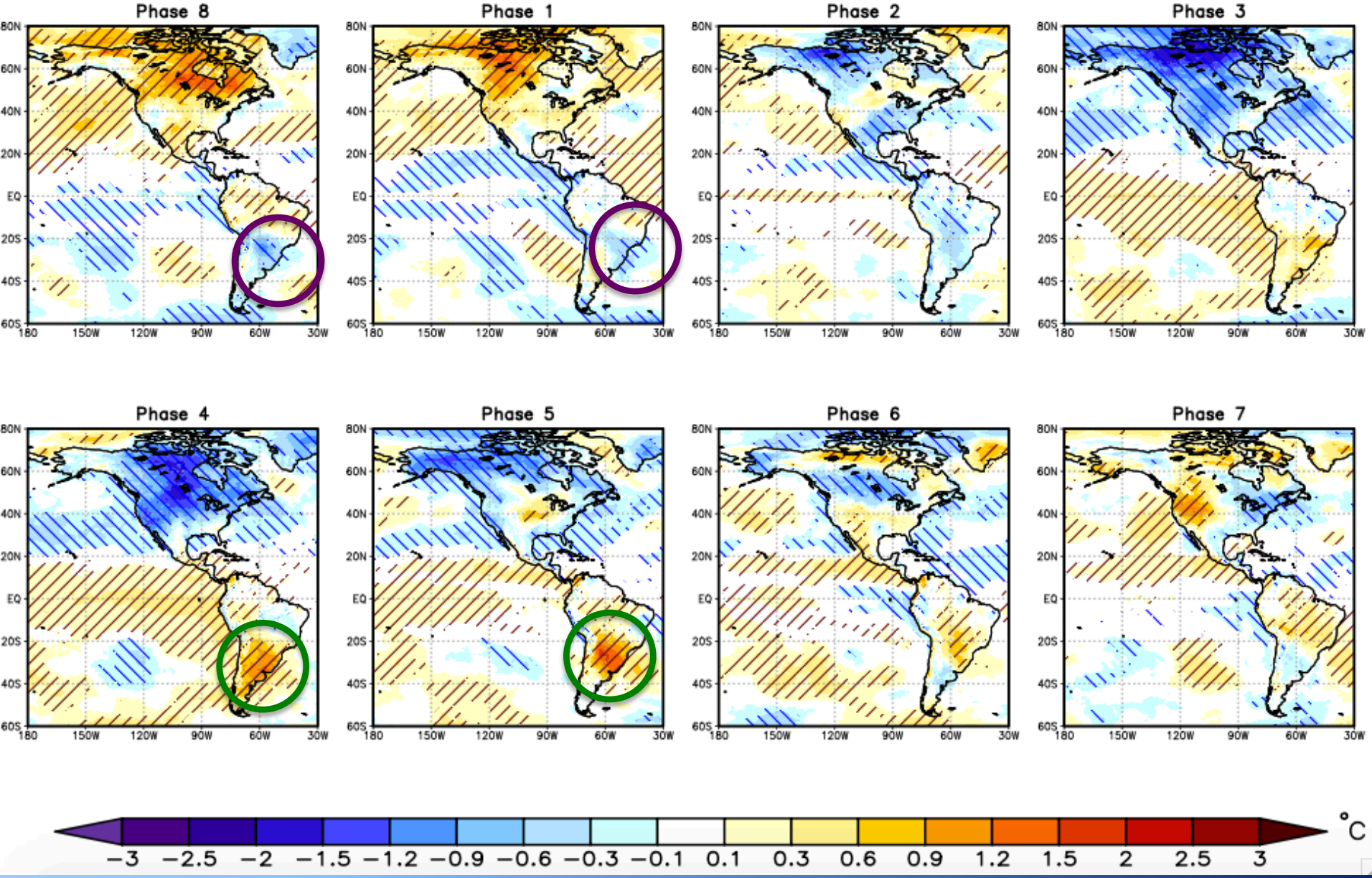
MJO Precip Rate Anomaly May–Sep

Hatching at 5% Significance Level



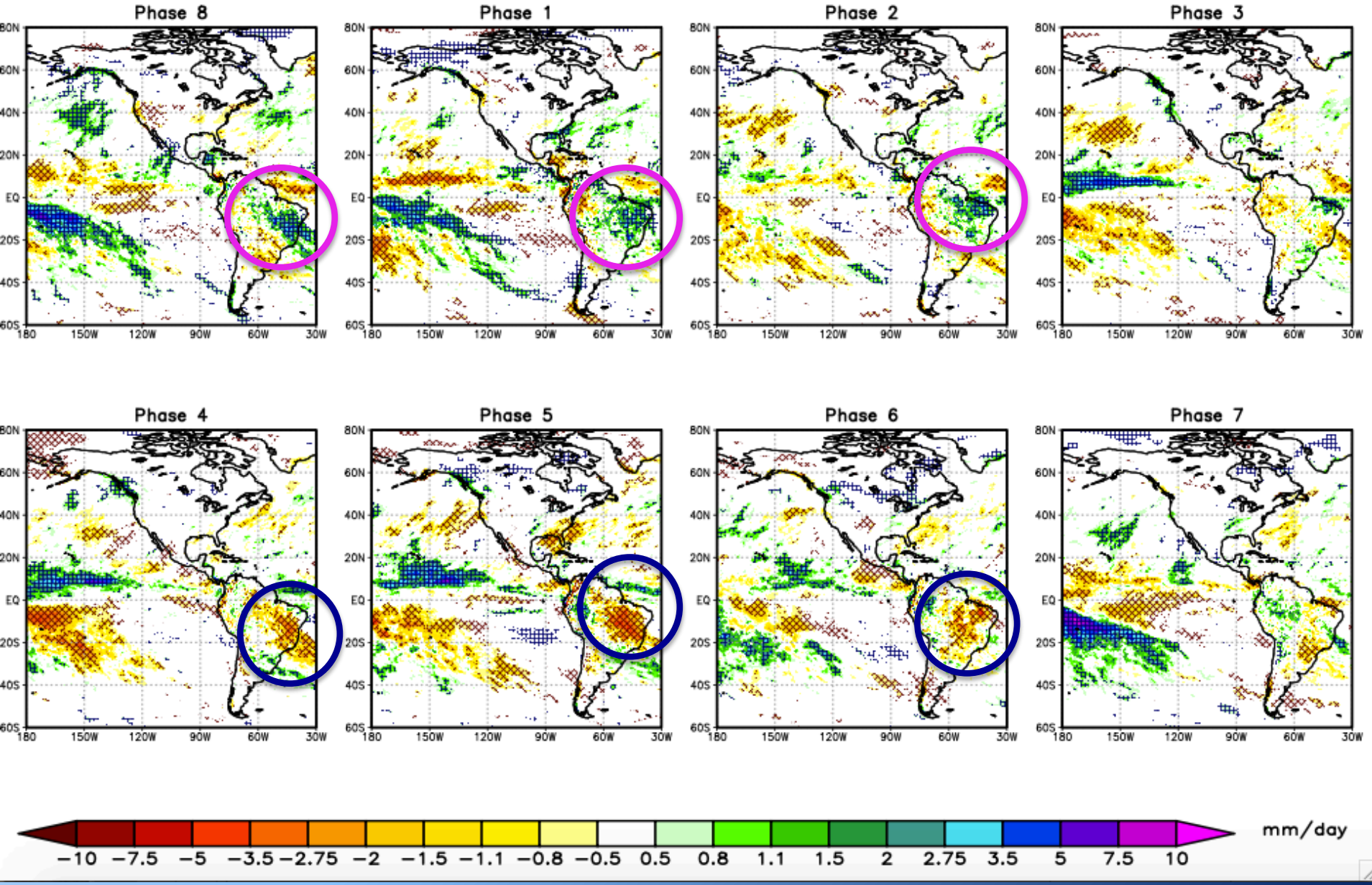
MJO Temperature Anomaly May–Sep

Hatching at 5% Significance Level



MJO Precip Rate Anomaly Nov–Mar

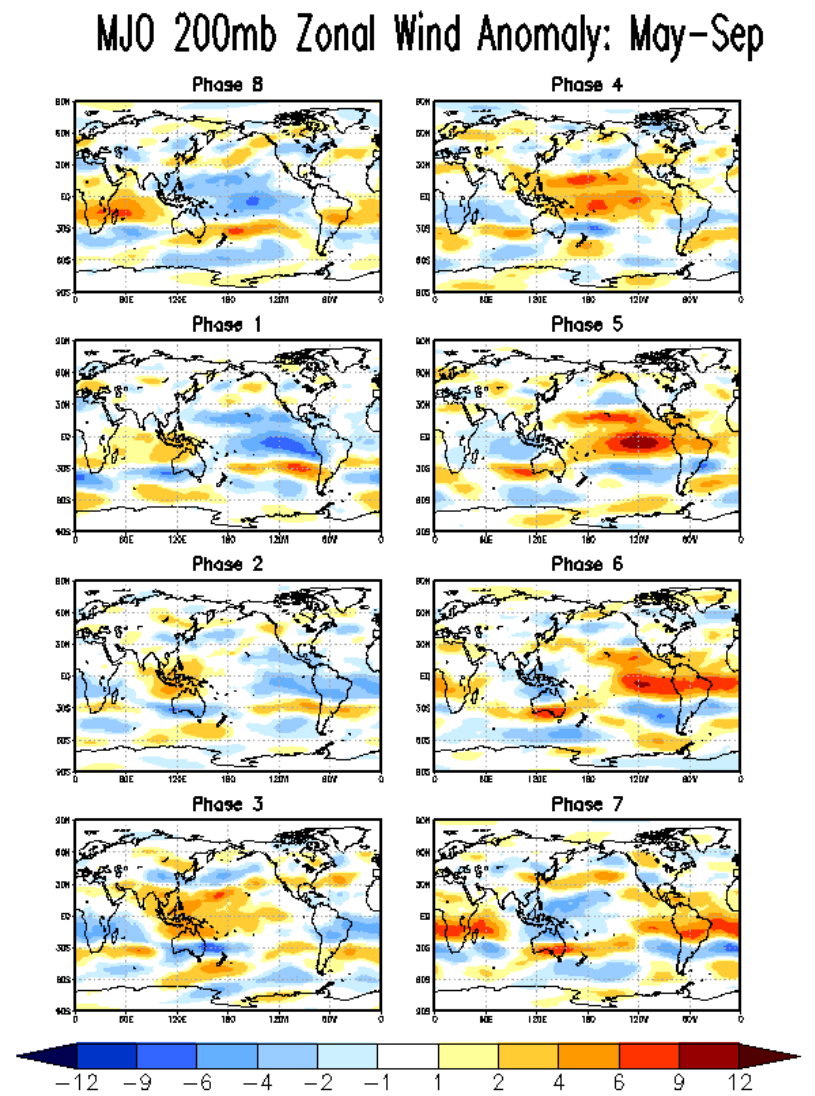
Hatching at 5% Significance Level



Summary and Conclusions

- The MJO signal is stronger in precipitation in the summer hemisphere
- The MJO signal in temperature is more prevalent in the winter hemisphere
- Upper level wind patterns can be connected to the alterations in divergence and convergence corresponding to the enhanced convection of the MJO

MAY-SEP
200-hPa Zonal Wind Anomalies



- Much stronger signal in the winter hemisphere
- Same pattern with 30°S easterly (westerly) anomalies just SW of the area of suppressed (enhanced) convection
  - In the southern Hemisphere for May-Sep