Improving Atlantic Hurricane Predictions with the Madden-Julian Oscillation

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CMMAP Intern
Advisor: Eric Maloney
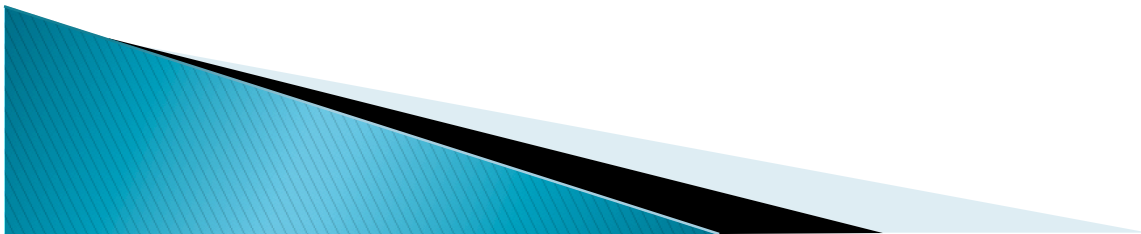
About Me

- Attend Millersville University
- Senior, Graduating Spring 2010
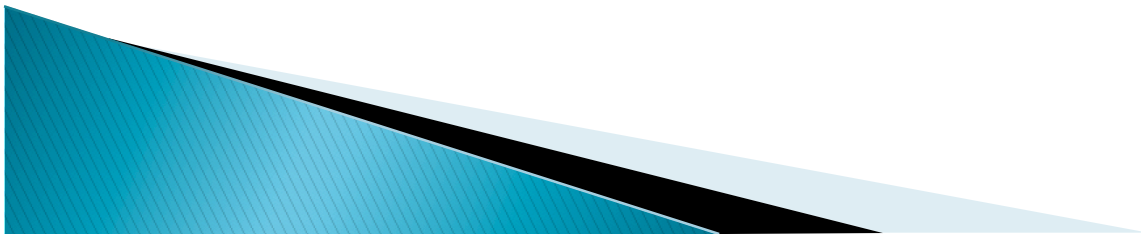- Major: Meteorology
- Minor: Mathematics

Importance…

• Better prediction of Atlantic Hurricanes will benefit the general public
- they can prepare better
- anticipate the strength of storm
- evacuate sooner

Introduction…

- The MJO is a pattern of tropical winds and precipitation that repeats on average every 30–60 days.
- This oscillation, that travels eastward from Asia to Africa, modulates Atlantic hurricanes.
- Information might be used to predict Atlantic hurricane activity a few weeks in advance.

The Beginning…

- Gathered HURDAT data of Atlantic Hurricanes from National Hurricane Center
- FORTRAN program to read in data
  - program came from example by Bill Thorson
- Used and modified a program by Eric Maloney to plot latitude and longitude points
- Next step was to plot the points on a map
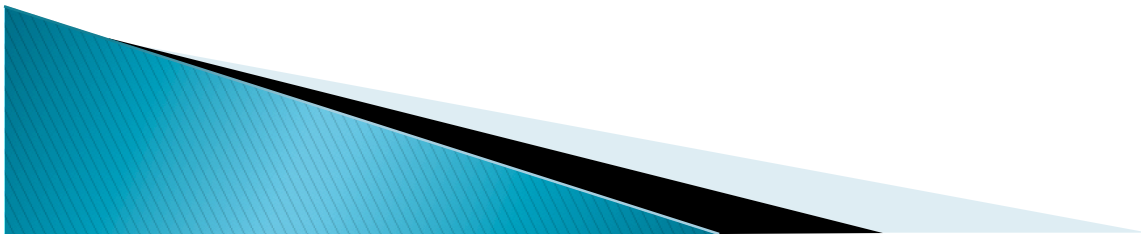
Mid-June…

- Learned NCL in 2 weeks
- Goal was to plot the hurricanes on maps that corresponded to their Madden-Julian Oscillation (MJO) phase
- Used MJO data from Matthew C. Wheeler's website
    - wrote a FORTRAN program to find like phases and group them together
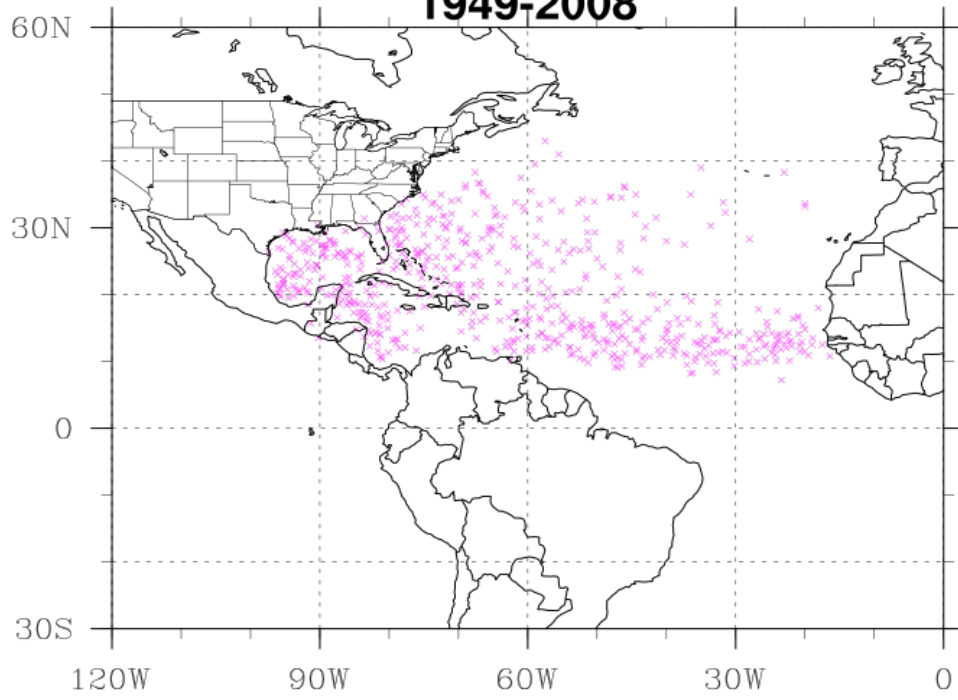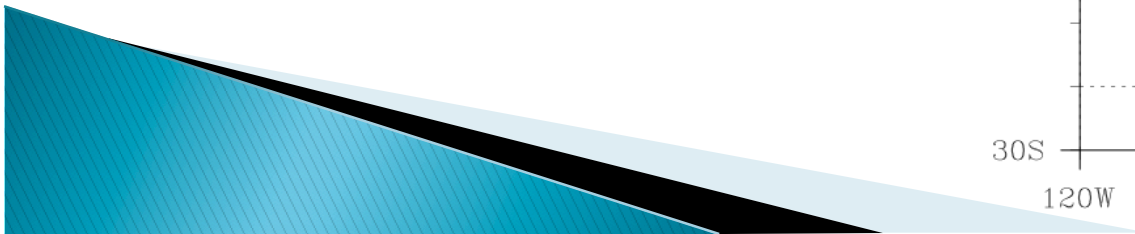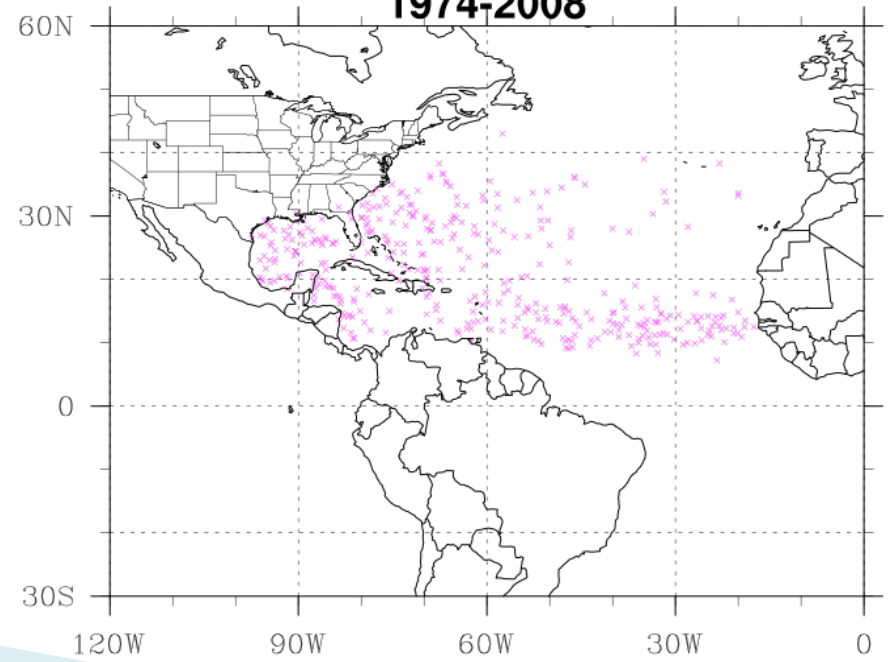- With help, I got the hurricanes to be plotted on the maps
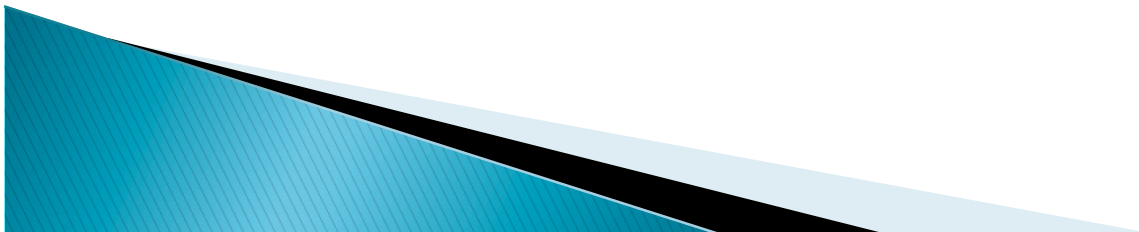
End of June…

- Started looking at Wheeler and Hendon's article
- Took their figures and made my own to match my data
- Made a phase plot with RMM1 and RMM2 data
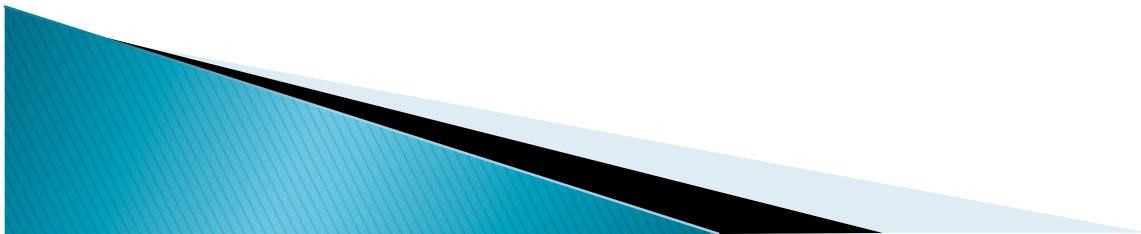
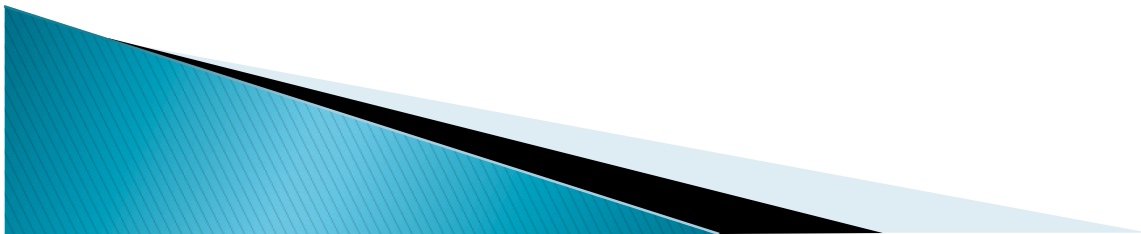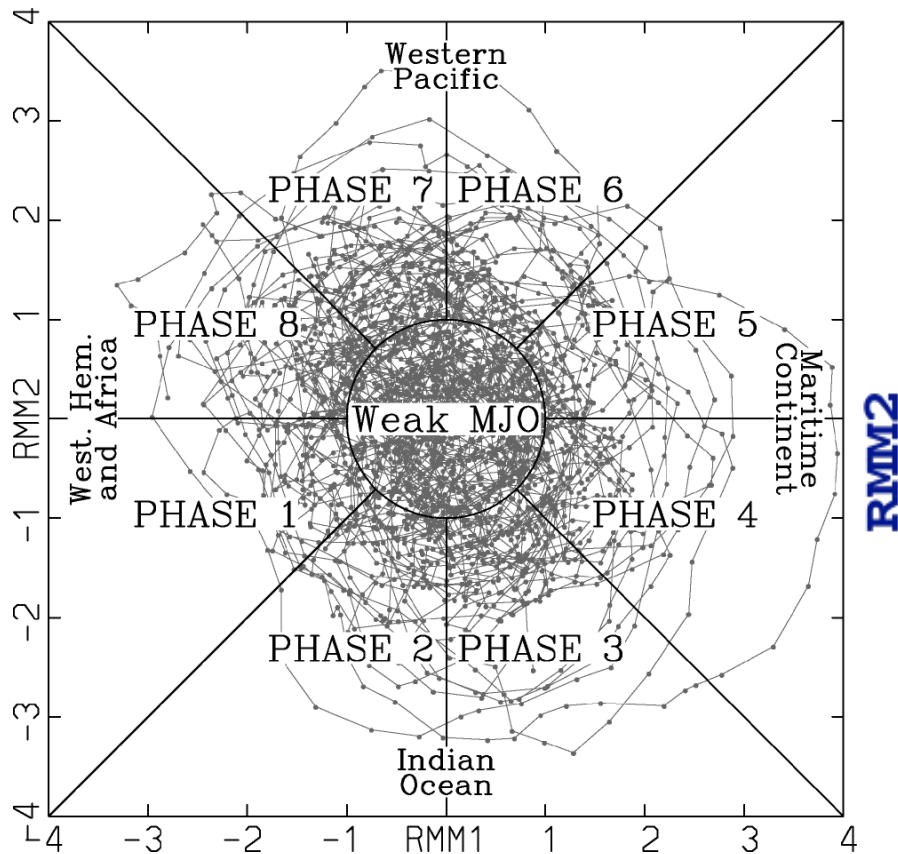## Positions of Hurricanes
1949-2008

## Positions of Hurricanes
1974-2008

RMM1 and RMM2...

- RMM1 and RMM2 are times series that when combined give the strength and sign of the MJO.
- In addition, they are derived from empirical orthogonal function analysis on equatorial winds in the upper and lower troposphere and tropical convection.

Phase Diagram of the MJO
1974-2008

This figure is from Wheeler and Hendon's journal. It plots all available days in Dec, Jan, and Feb from 1974-2003
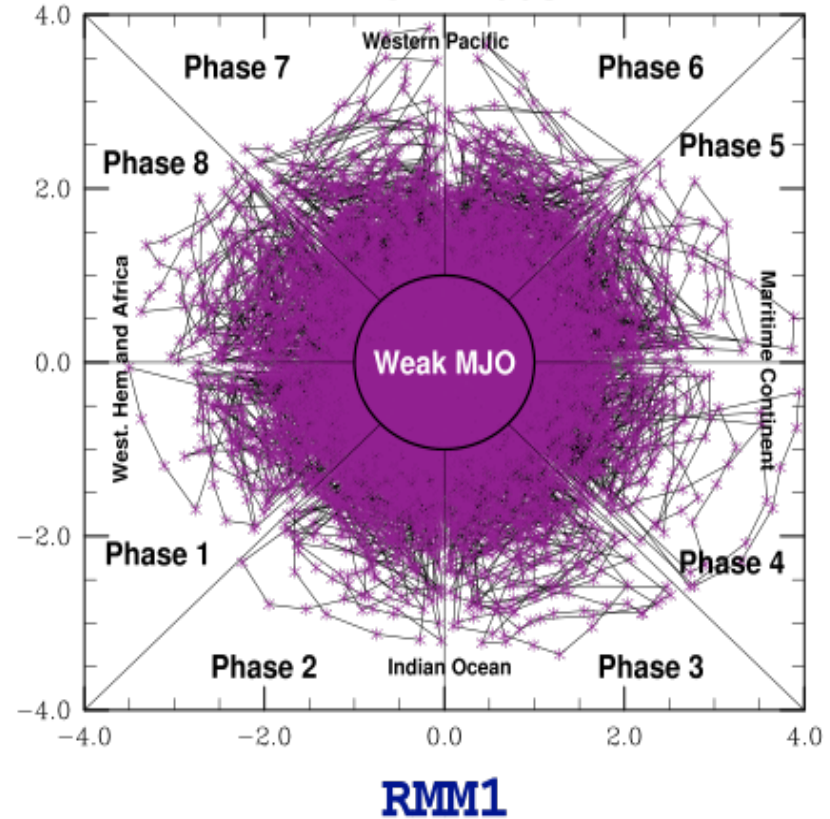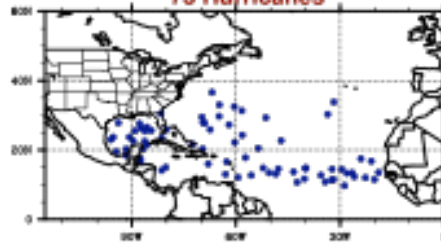
This figure is the one I created in NCL will all available data from 1974-2008
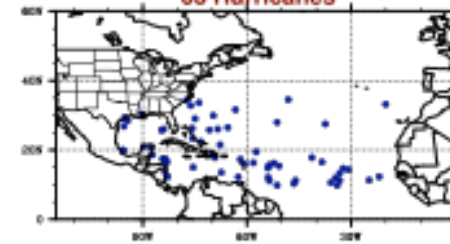
Phases of the MJO

Phase 1
73 Hurricanes

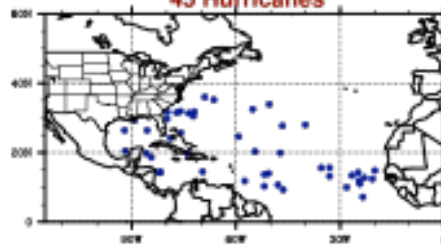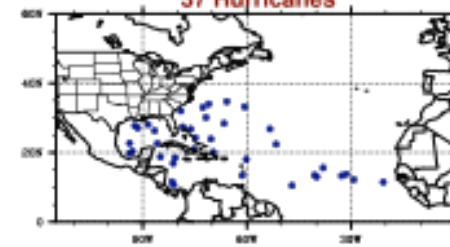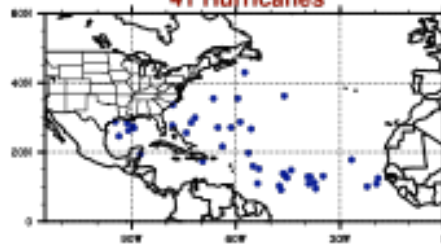**Phase 2**
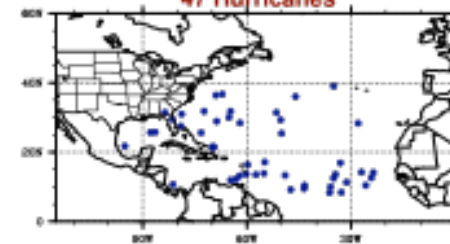63 Hurricanes

Phase 3
45 Hurricanes

Phase 4
37 Hurricanes

Conclusion:
- Phase 7 had the least number of Atlantic Hurricanes
- Phase 1 had the most number of Atlantic Hurricanes
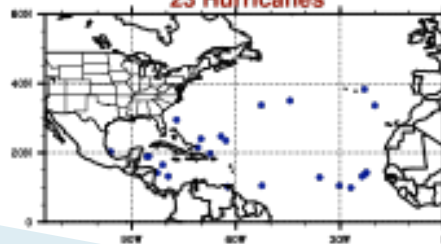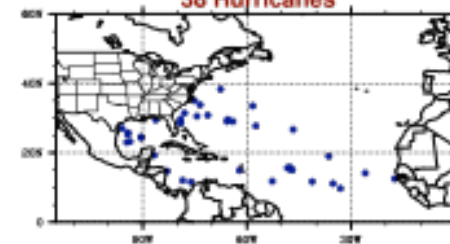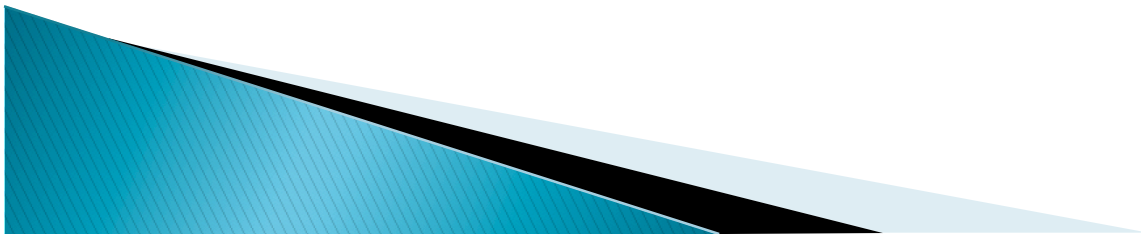
Phase 5
41 Hurricanes

Phase 6
47 Hurricanes

Phase 7
23 Hurricanes

Phase 8
38 Hurricanes

Recent work...

- started look at the relationship between retired hurricanes and their corresponding MJO phase
- looked at Saffir-Simpson scale for all 1974-2008 hurricanes and their corresponding MJO phase
    - separated them by East and West Atlantic Ocean
    - East is 15-57W and West is 58W-100W

Saffir-Simpson Scale Versus Phase

- Category 1
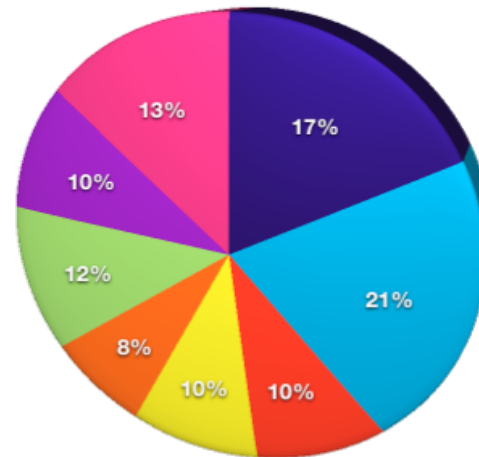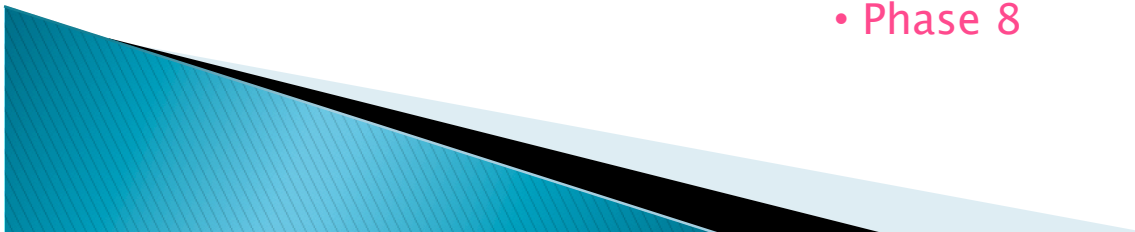- Category 2
- Category 3+
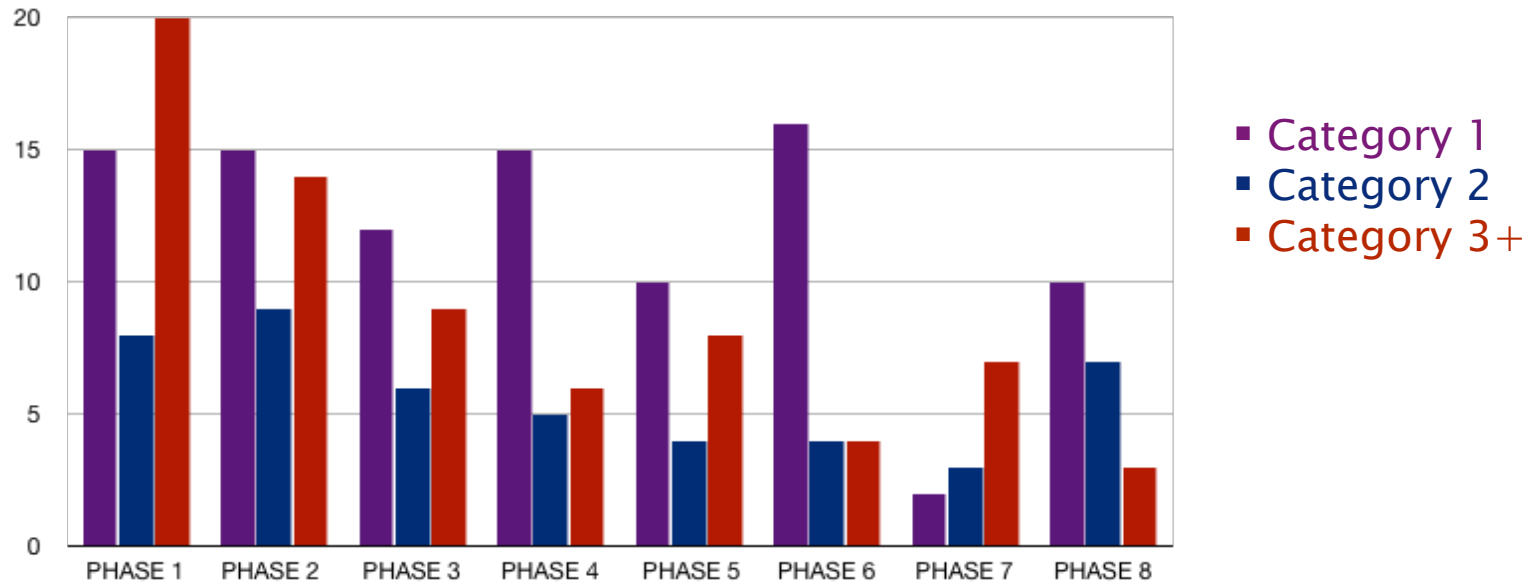
• Conclusion
  • Category 3+ decrease through MJO phase
  • Phase 1 & 2 are more active than 7 & 8
  • Pie chart gave no real conclusion due to small sample size

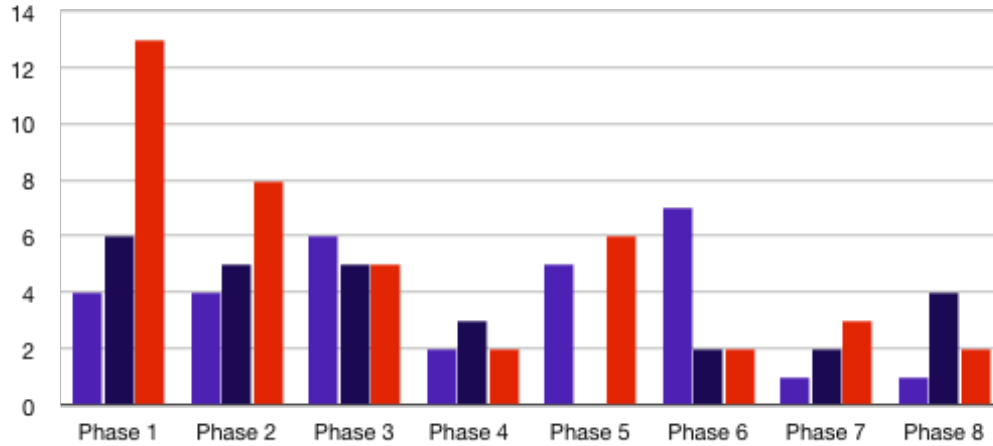## Number of Retired Hurricanes per MJO Phase

- Phase 1
- Phase 2
- Phase 3
- Phase 4
- Phase 5
- Phase 6
- Phase 7
- Phase 8

Pie chart only contains 52 hurricanes

Saffir-Simpson Scale versus Phase (East)

- Category 1
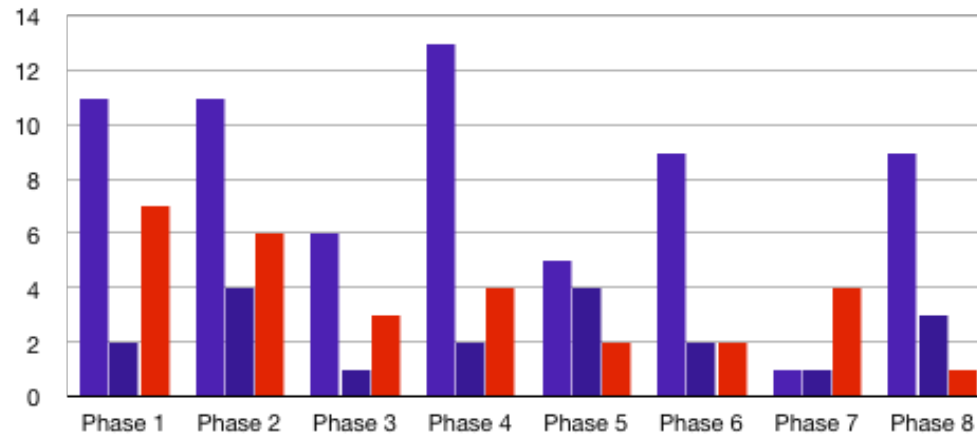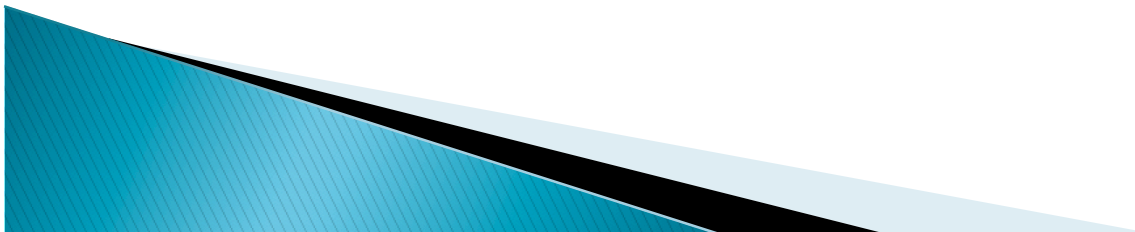- Category 2
- Category 3+

Saffir-Simpson Scale versus Phase (West)

- Category 1
- Category 2
- Category 3+
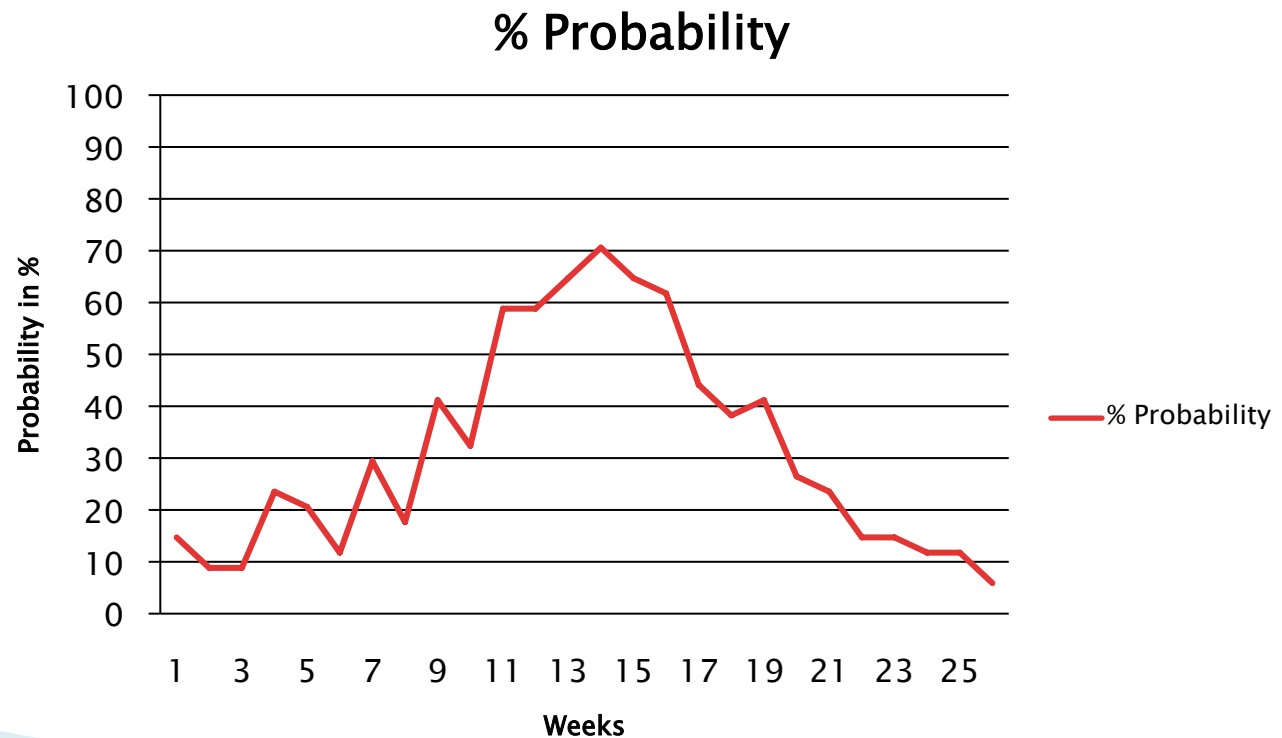
- Conclusion
    - East had more Category 3+
    - West had a significant amount of Category 1

Future Work...

• Use knowledge of the MJO, El Niño and seasonal cycle of hurricane activity to make hurricane activity forecast.

% Probability

References

- Leroy, Anne, and Matthew C. Wheeler, 2008 Statistical Prediction of Weekly Tropical Cyclone Activity in the Southern Hemisphere. *Mon. Wea. Rev.*, **136**, 3637–3654
- [1]Wheeler, Matthew C., and Harry H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development and Index for Monitoring and Prediction. *Mon. Wea. Rev.,* **132**, 1917–1932
- Maloney, Eric D. and Dennis L. Hartmann, 2000: Modulation of Hurricane Activity in the Gulf of Mexico by the Madden–Julian Oscillation. *Science*, **287**, 2002–2004.