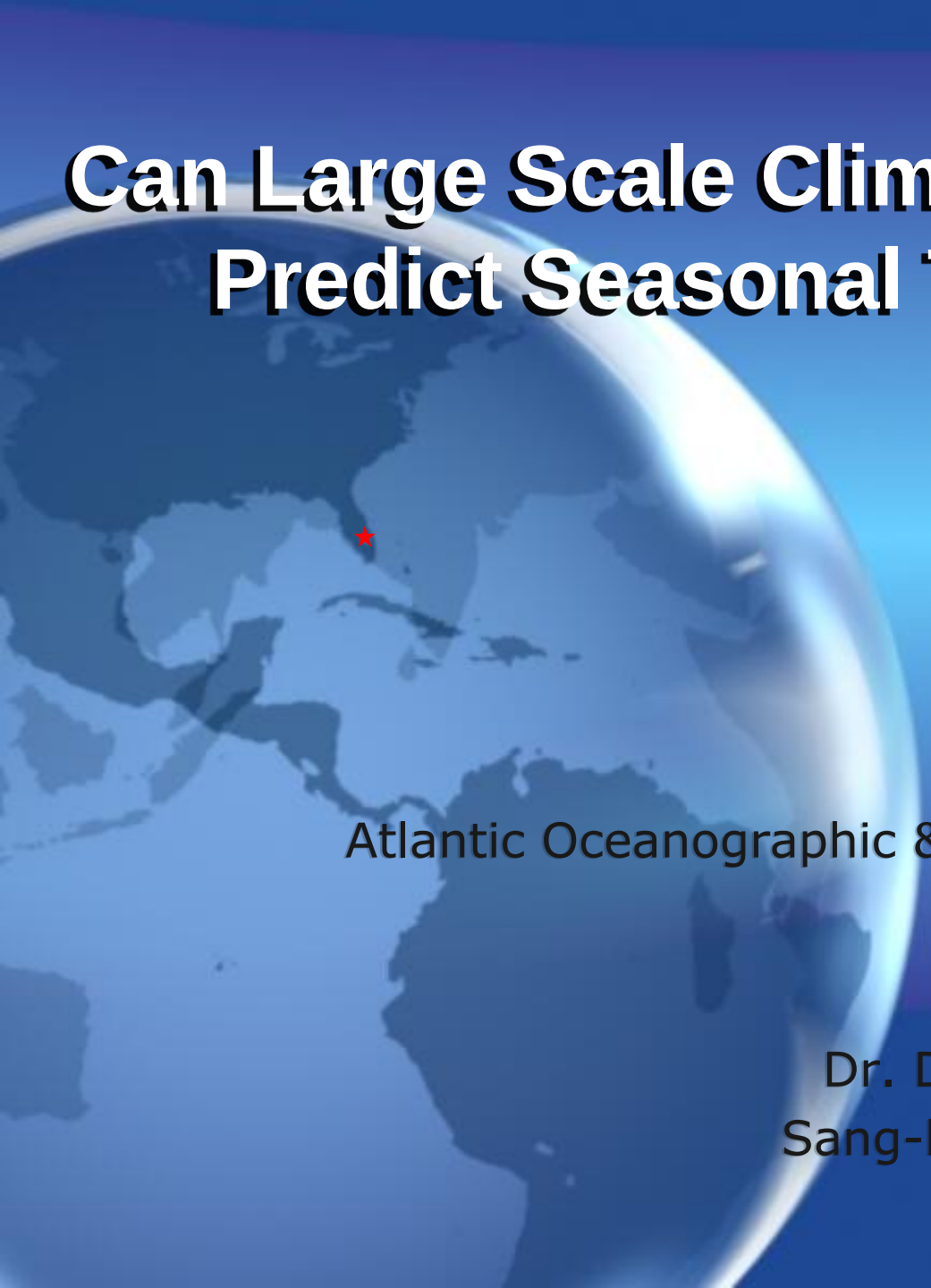
Can Large Scale Climate Controls Help Predict Seasonal Tornado Activity?



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Sang-ki Lee (University of Miami)

Outline

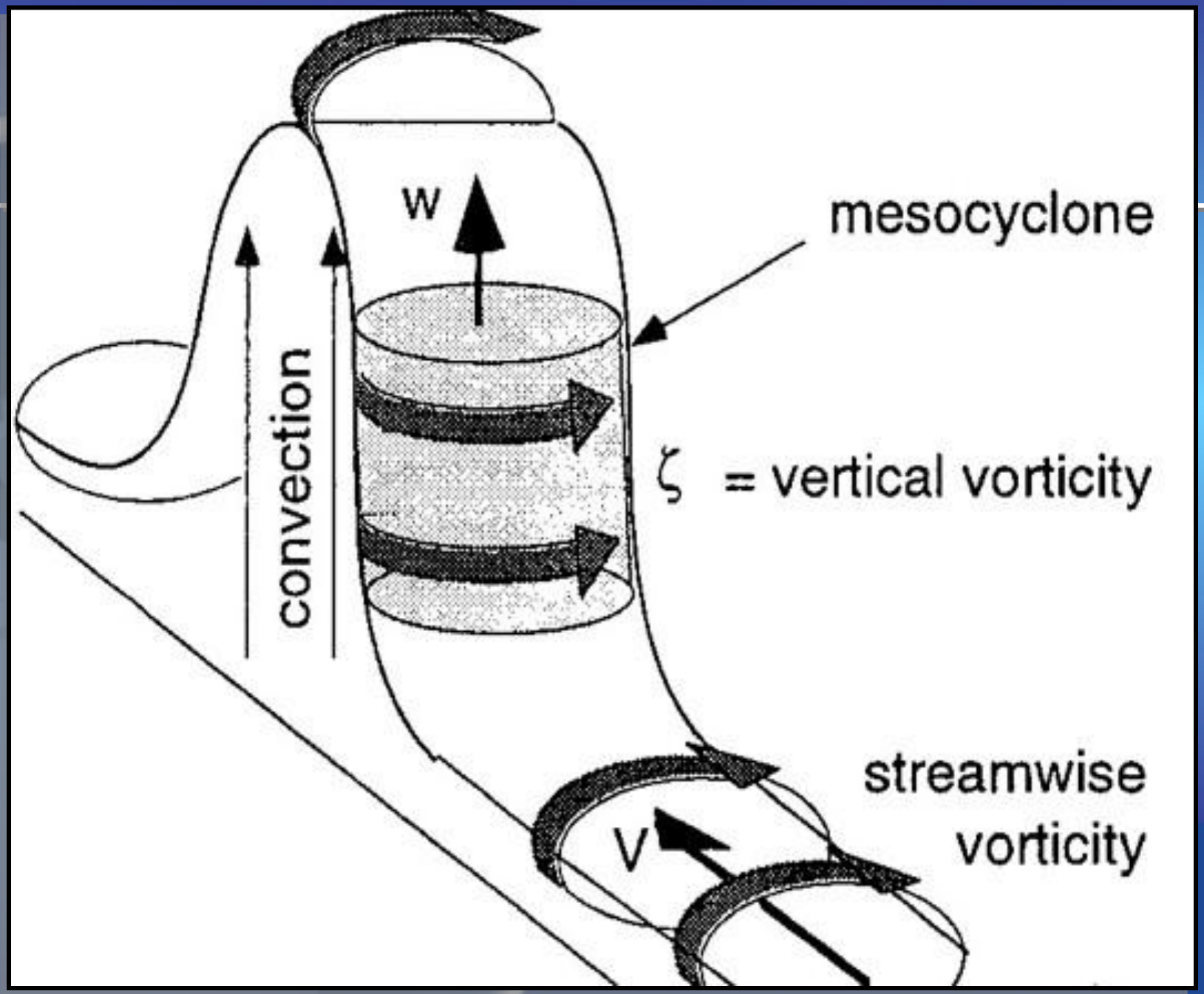
- Objectives- What I wanted to know
- Background- Things I needed to know
- Methodology- How I figured it out
- Results- What I found…
- Next Steps- Where to now?
- Summary
- Acknowledgements

Objective

- Identify large scale atmospheric patterns associated with high tornado activity
- Pursue the possibility of seasonal tornado prediction
- Develop and initiate a research project
- Learn Matlab computing environment

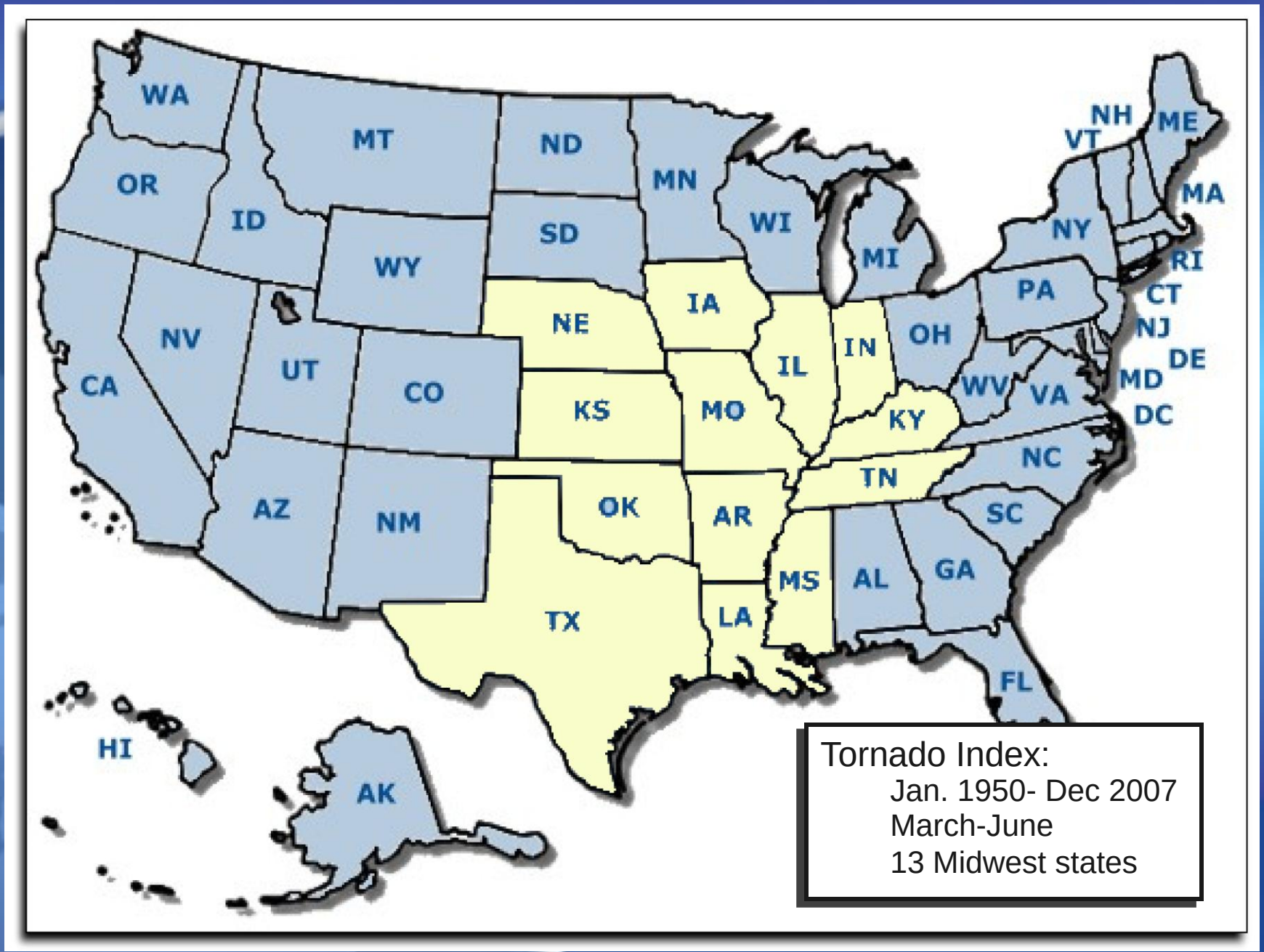
Background

- Tornado activity highly variable, valuable to foresee
- Common “ingredients” for Supercell thunderstorms and tornado formation can be related to large scale climate variables


w
mesocyclone
convection
ζ = vertical vorticity
streamwise
vorticity
v

Methodology

- Analysis approach
  - Rank years by seasonal tornado activity
  - Calculate trend and subtract to form index
  - Isolate years for Hi/Lo activity extremes
  - Average large-scale variables over data grid
  - Focus on selected variables
    - Moisture transport
    - Moisture convergence
    - Large-scale vertical wind shear
- NCEP-NCAR Global Reanalysis, Matlab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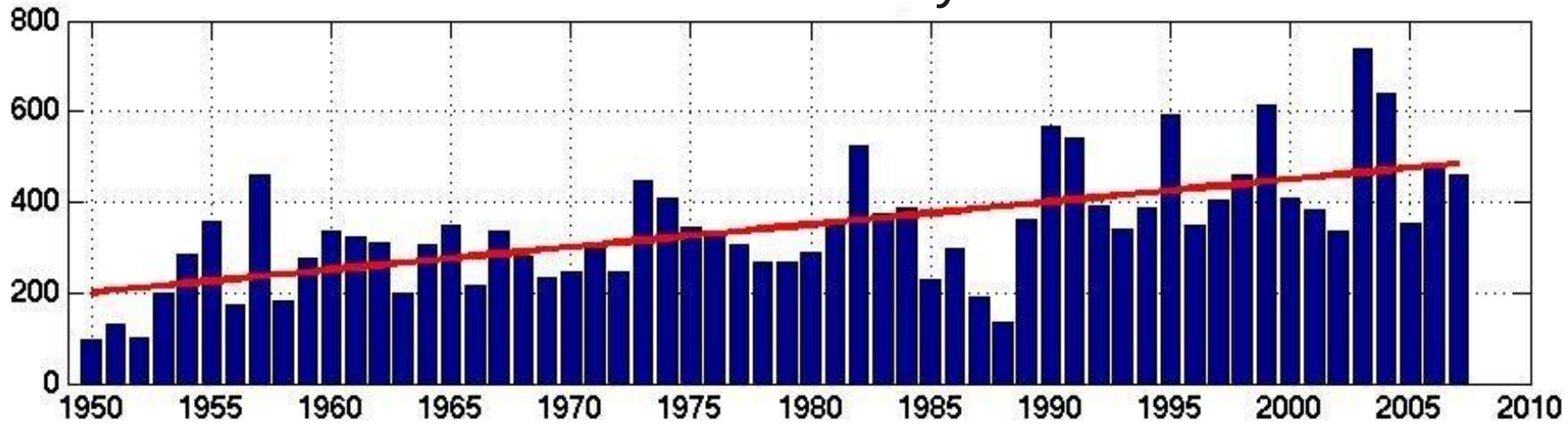
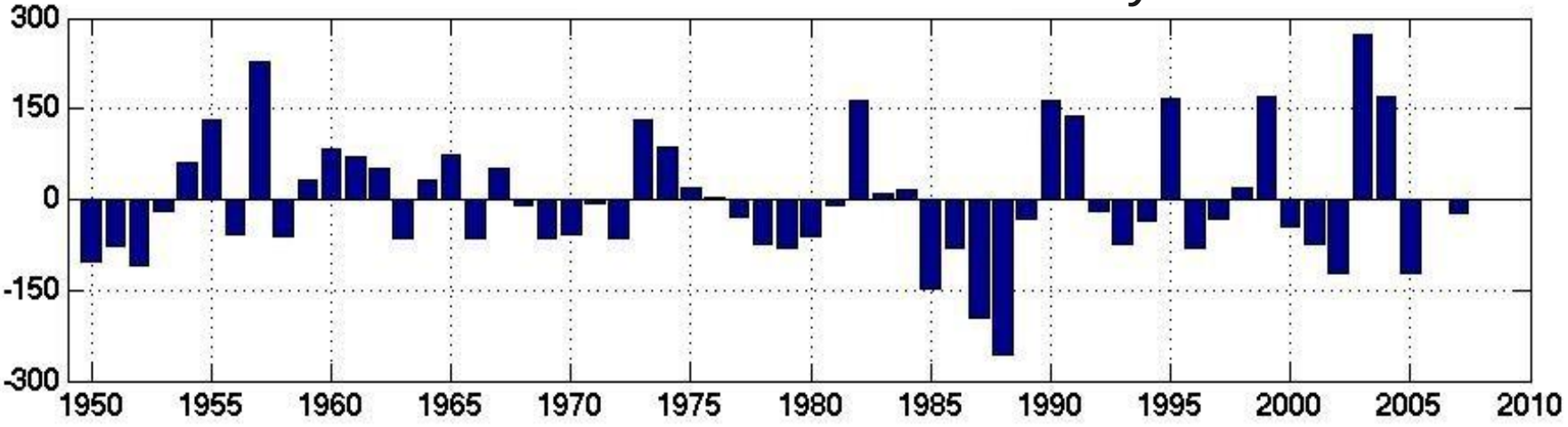
Tornado Index:
Jan. 1950- Dec 2007
March-June
13 Midwest states

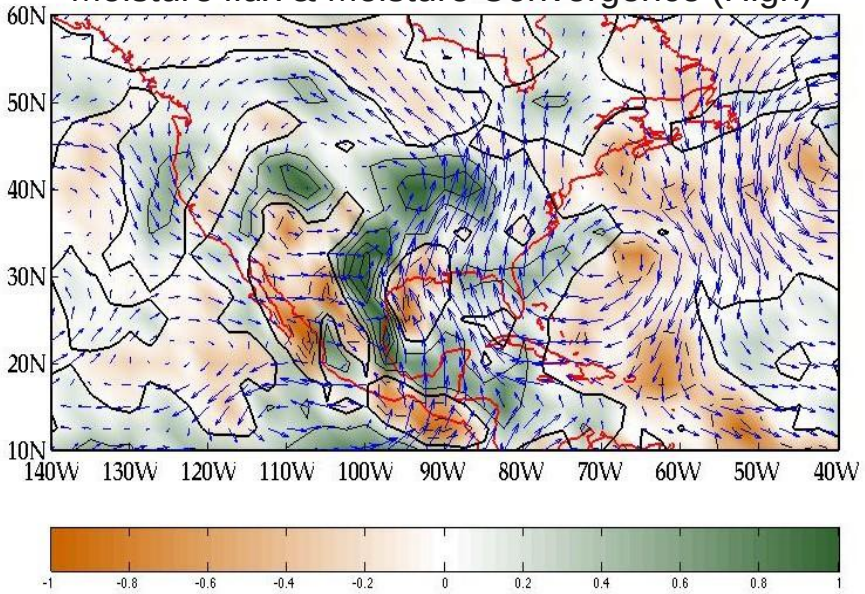
Tornado Activity



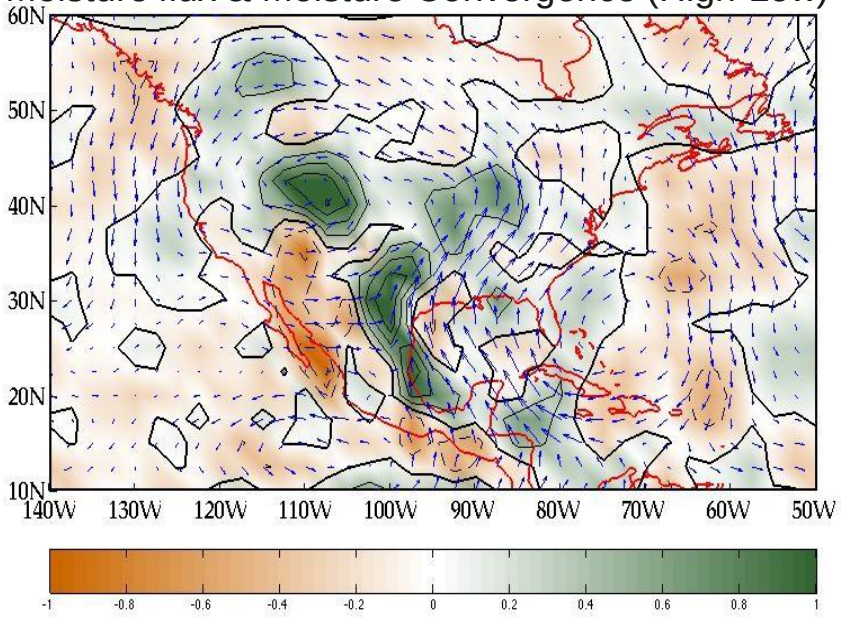
De-trended Tornado Activity



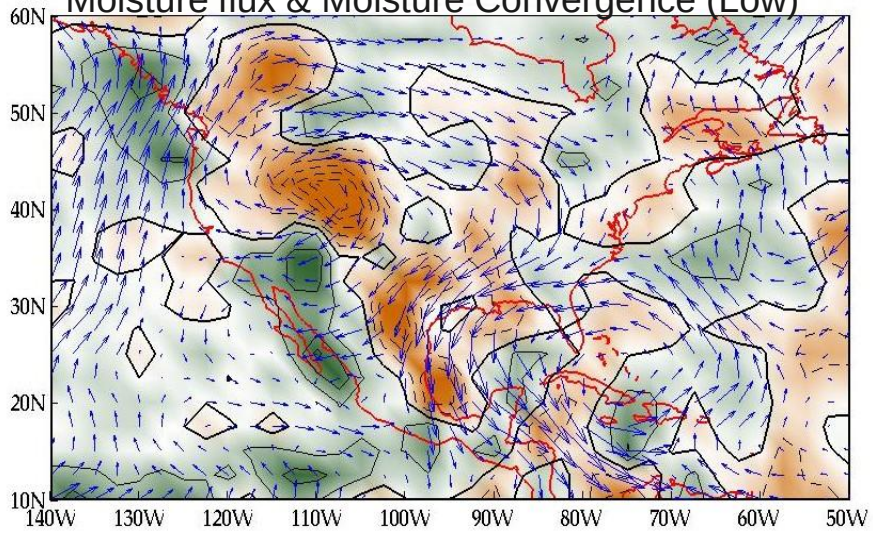
Moisture flux & Moisture Convergence (High)



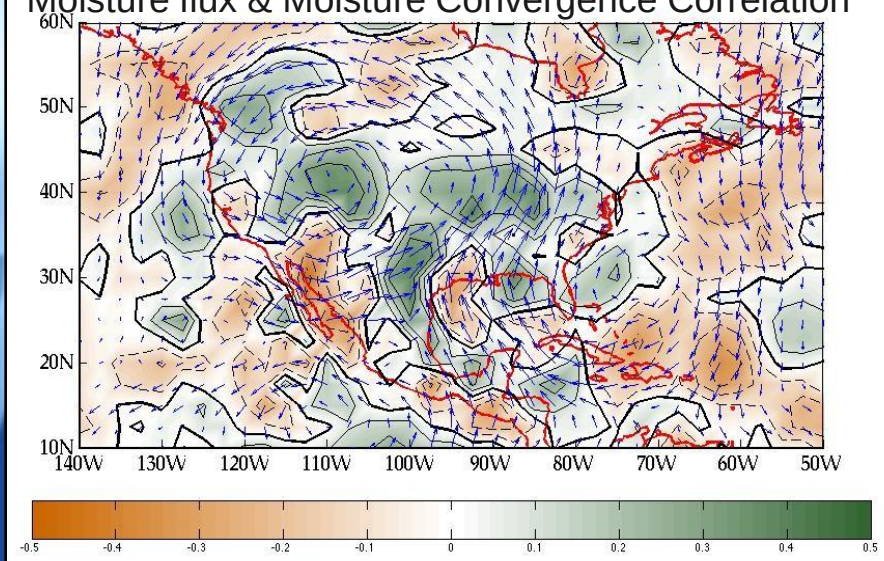
Moisture flux & Moisture Convergence (High-Low)



Moisture flux & Moisture Convergence (Low)



Moisture flux & Moisture Convergence Correlation



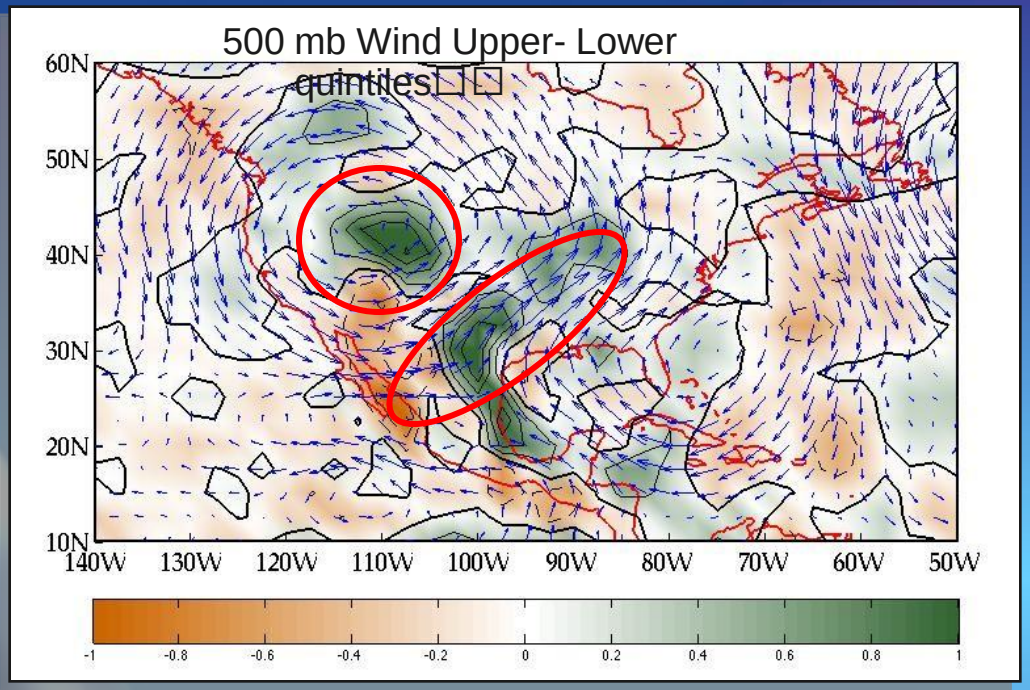
- Upper level wind profile

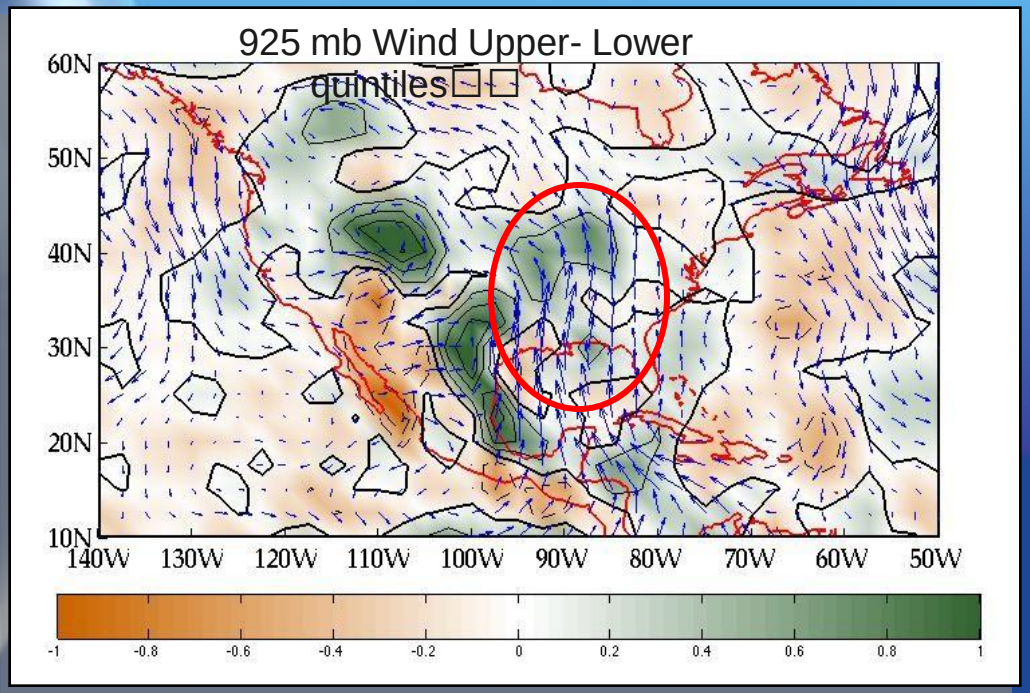
  -strong cyclonic rotation over the Rocky Mnts

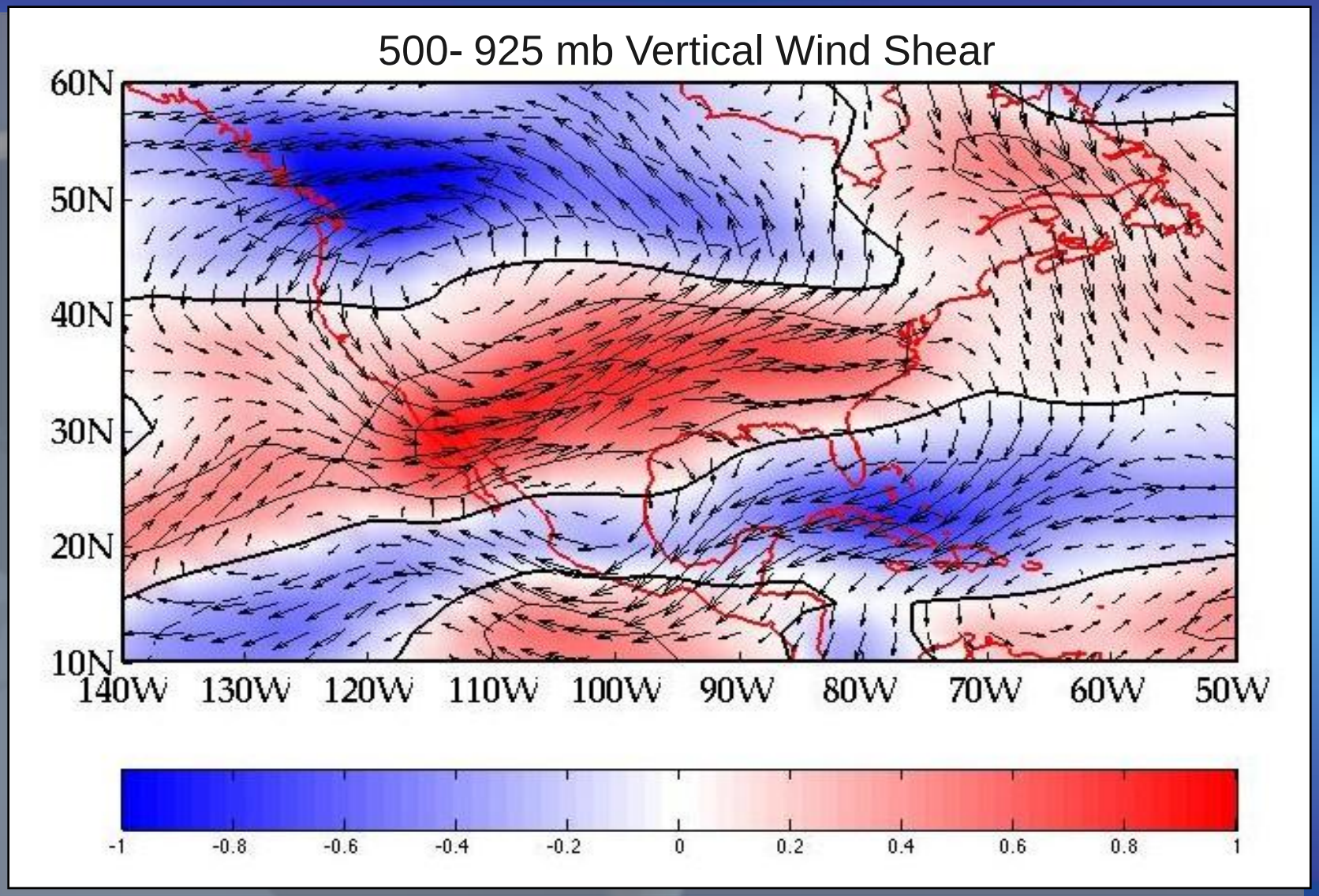
  -strong flow from the Southwest towards our region of interest

- Low level wind profile

  -strong onshore flow from the Gulf of Mexico.

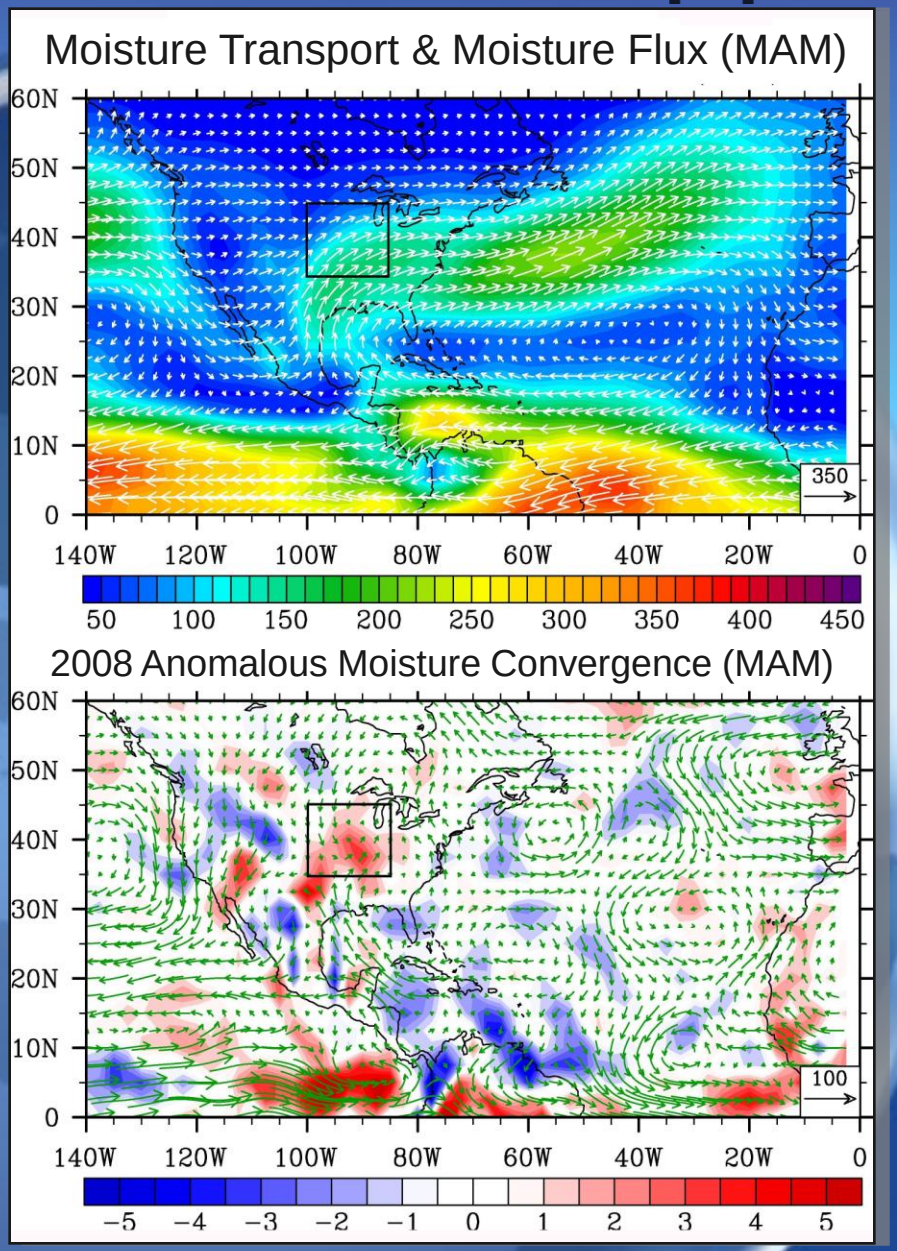






- Large swath of intense vertical wind shear from Arizona to the Midwest

What happened in 2008?



- Record setting floods and tornados this spring
- Composite average of moisture transport and moisture flux, using an index of recorded flooding
- Moisture convergence over our area of interest for March, April, and May this year.

Results

- The moisture transport from the Gulf Coast creates moisture convergence over the Midwest.
- This moisture is an indication of instability in the region of interest.
- Increasing large scale wind shear over the Midwest is positively correlated to increasing tornado activity.

Contributing to Science

- Research conducted relating climate variables to hurricane activity, but little research relating it to tornado activity
- Seasonal hurricane predictions but no such predictions for severe weather or tornados
- Adds to future AOML project:

Intra-American Studies of Climate Processes -- how are extreme events in US climate affected by Atlantic-Pacific variability?

Next Steps

- Several variables to continue researching:
  - Create similar indices to my tornado index for wind shear and moisture transport
  - Correlate these indices to SSTs around the globe
  - Investigate causes for high amounts of shear and onshore moisture transport
- Possible topic for a graduate school thesis

Summary

- Using Matlab, I analyzed climate variables and related them to Midwest tornado activity
- Discovered a positive correlation between a few variables
- Positive contribution to work being conducted at AOML
- A lot of room for further studies which I intend to pursue

Acknowledgements

- NSSL tornado activity index
- NCEP-NCAR Global Reanalysis
- AOML support staff:
  - Mentor: David Enfield
  - Collaborator: Sang-ki Lee
  - IT: Tom Heeb, Jon McKeever
  - Outreach: Erica Rule, Evan Forde