

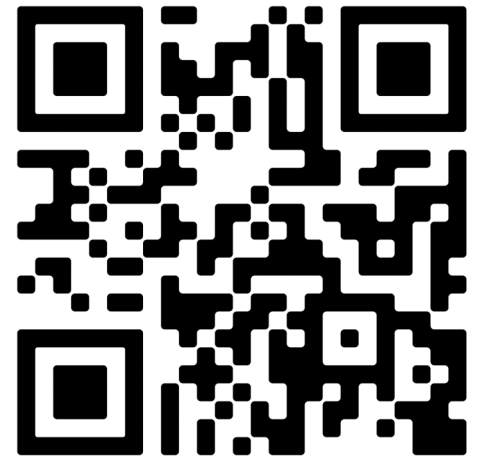
# Tropical Cyclone Outer Size Impacts the Number and Location of Tornadoes

Marco Paredes(FIU) [mpare054@fiu.edu](mailto:mpare054@fiu.edu)

Benjamin A. Schenkel(NSSL), Roger Edwards(SPC), Michael Congilo(NSSL)

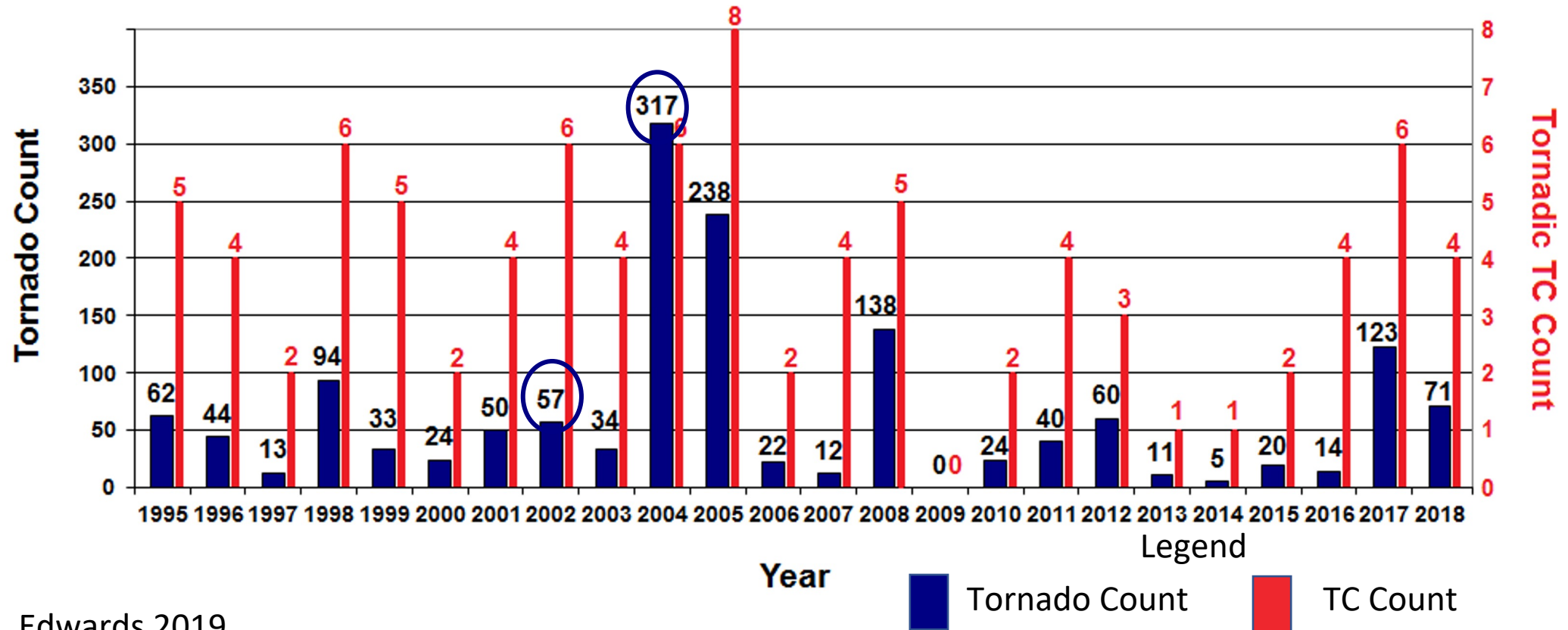


NSF Grant No. AGS-1560419. and the National Weather Center REU



# Large Variability in Tornado Production among TCs

## TC Tornadoes and Tornadoic TCs by Year

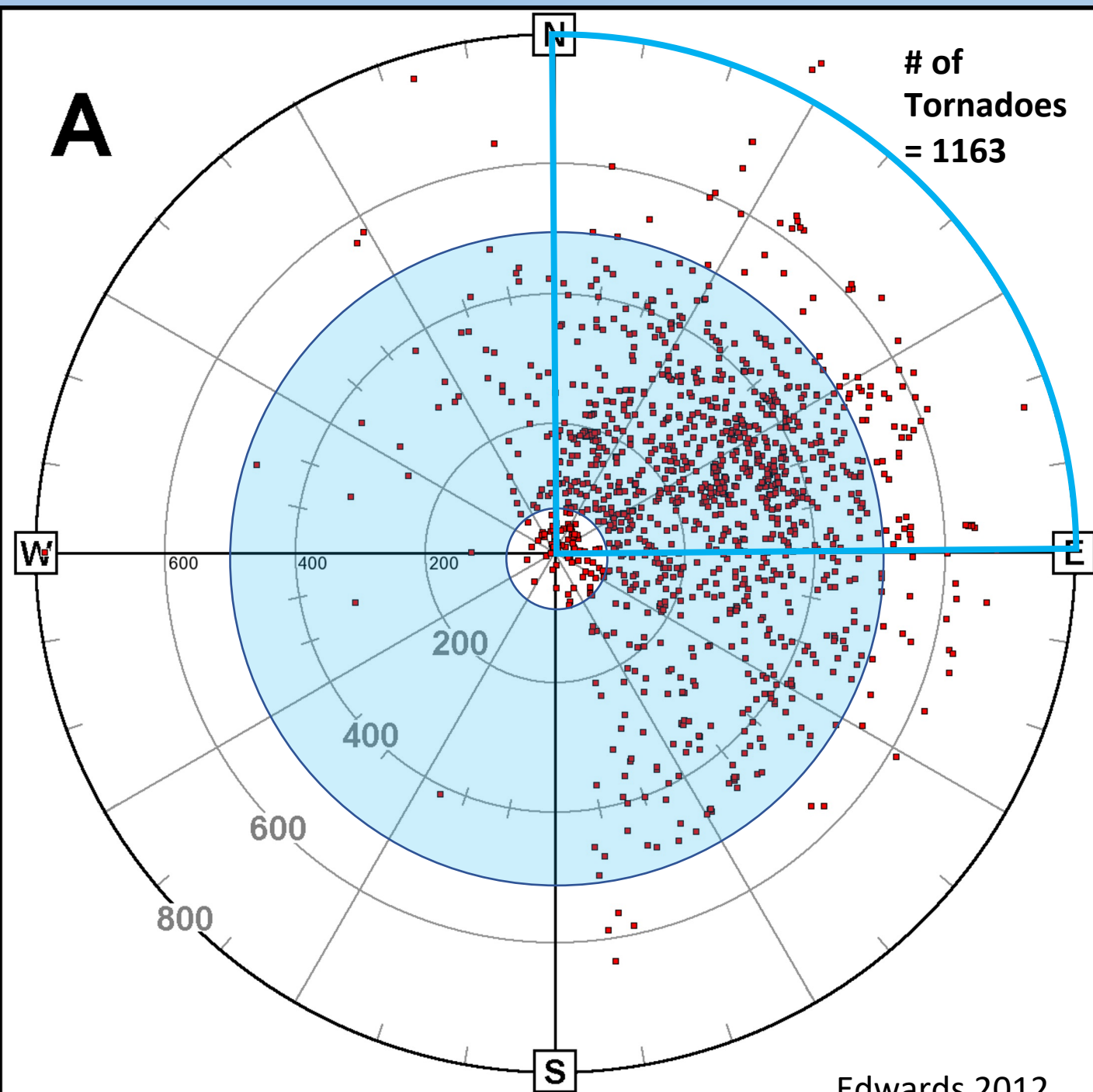


Edwards 2019

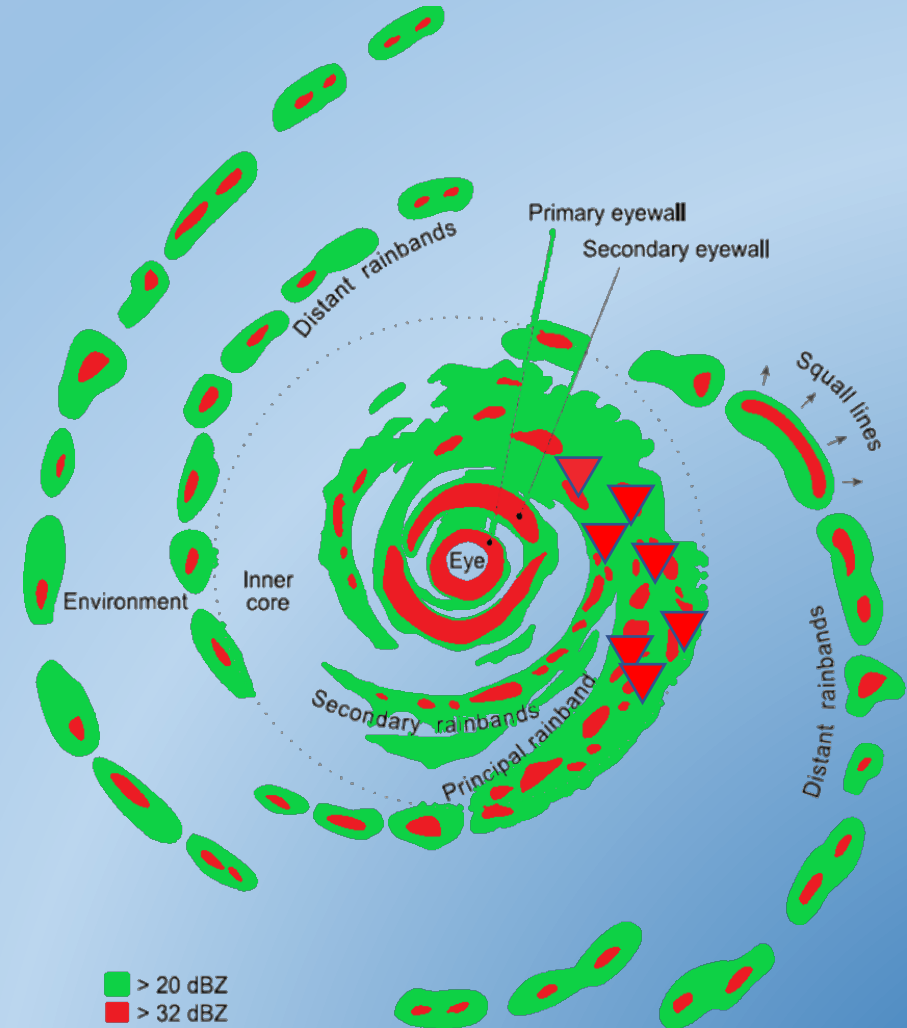
- Both years had the same number of tornado producing TCs (6)
- Both years had different number of tornadoes 2002:(57) vs 2004:(317)

# TC Relative Location of Tornadoes

- Tornadoes most often occur within the outer rainbands; 100-500 km away from TC center (Novlan & Gray 1974).
- Tornadoes form in the northeast quadrant of TCs (Schultz & Cecil 2009)



# Relationship Between TC Outer Size and Tornadoes?



1. Do tornadoes occur further from the center of large TCs?
2. Are larger TCs associated with a larger number of tornadoes?

# Data and Methods

- **Hypothesis:** Larger TCs spawn more tornadoes further from the cyclone center
- **TC tornado Data:** Storm Prediction Center TC Tornado dataset (Edwards 2010) from 1995-2019 (1304 tornadoes, 92 TCs)
- **TC Data:** National Hurricane Center 6-hr North Atlantic Best Track (Landsea & Franklin 2013)

# Data and Methods

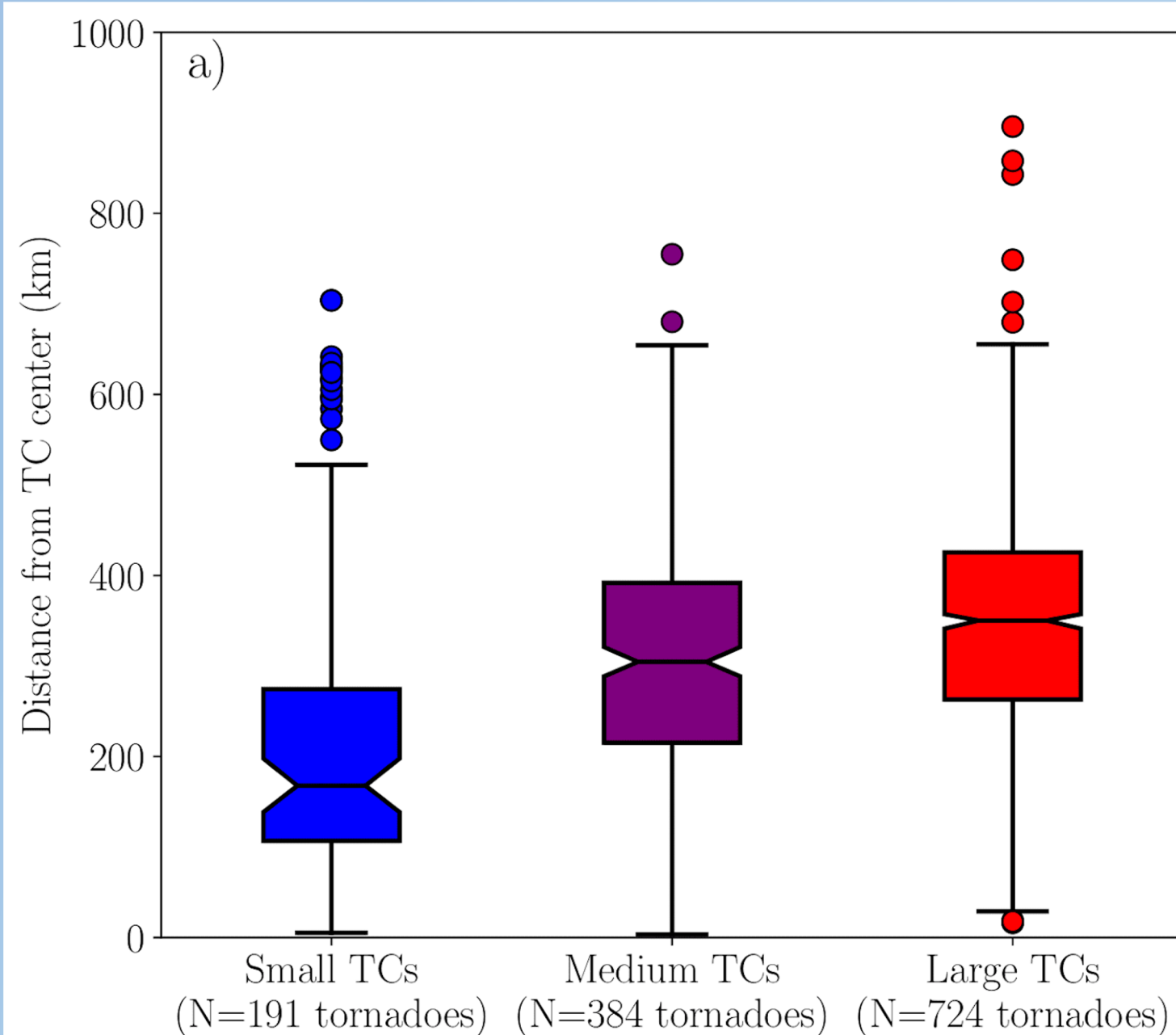
**TC Outer Size Metric:** Radius at which azimuthal mean 925 mb azimuthal winds equal 6 m/s derived from ERA5 reanalysis (Schenkel et al. 2017) (**r6**).

- **TC Outer Size Categories:** Based on terciles of r6 distribution for all recorded TCs:
  - Small TCs: < 461km
  - Medium TCs: 461km – 668 km
  - Large TCs: > 668km



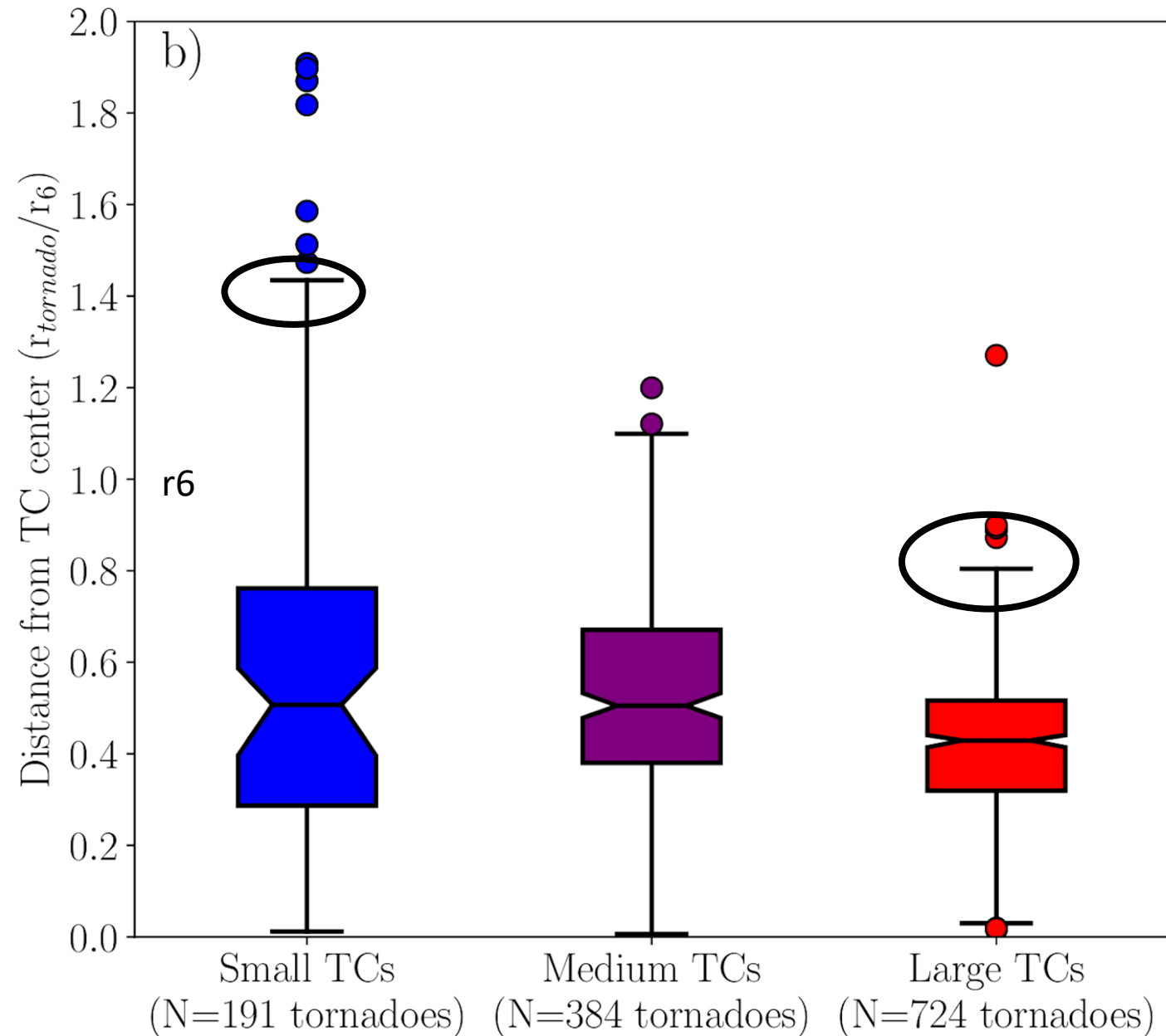
# Relationship Between TC Outer Size and Tornado Location

- Tornadoes are located further from the center in large TCs
- Large TCs are affiliated with greater number of tornadoes.
- Are changes in tornado distance from the center comparable to changes in TC outer size?



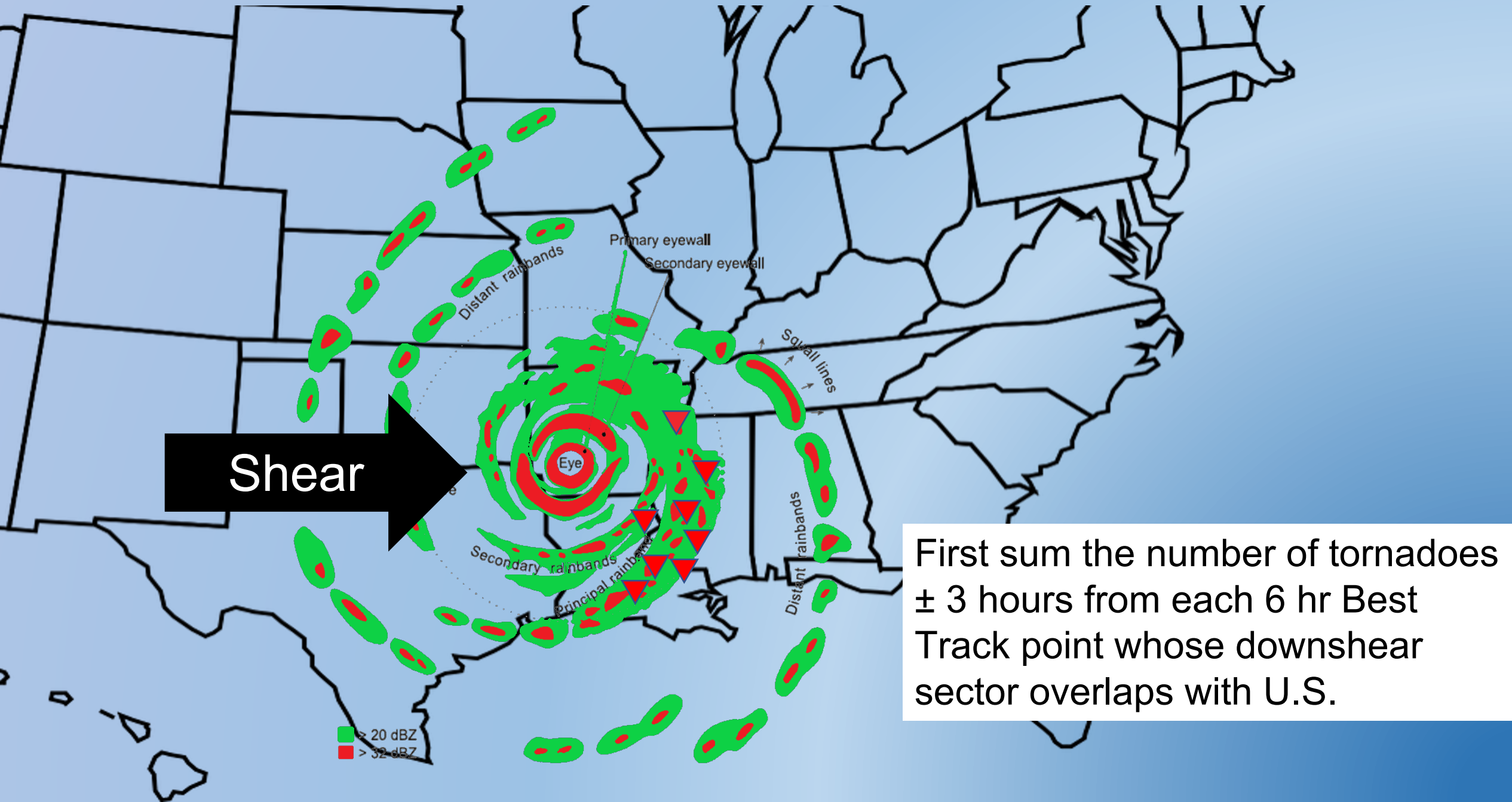
# Relationship Between TC Outer Size and Tornado Location

- Normalize tornado distance from TC center by outer size ( $r_6$ )
- Median tornado distance from center is similar between small, medium, large TCs
- Tornado distance from TC center does not scale completely with outer size



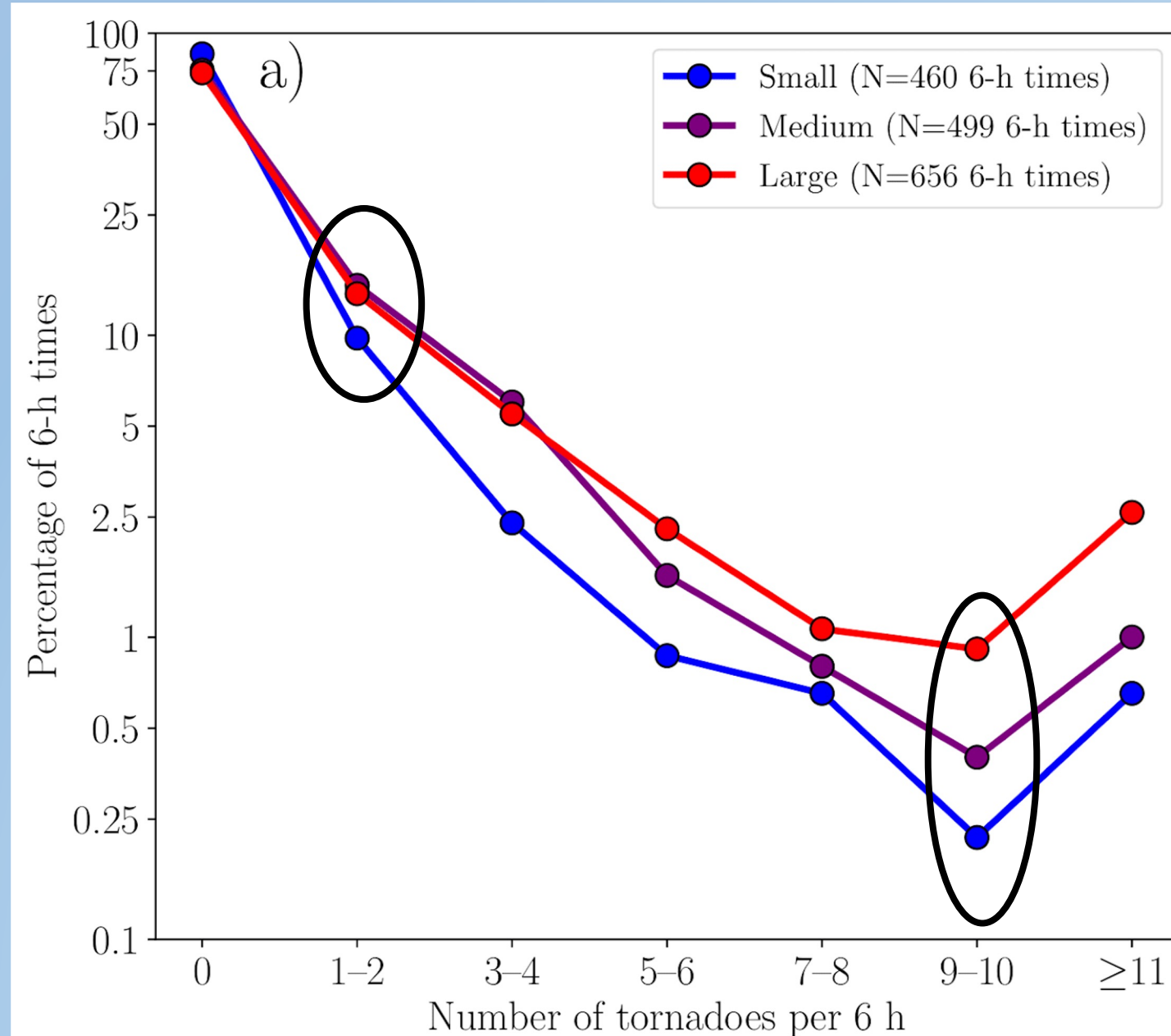


# Relationship Between TC Outer Size and Number of Tornadoes

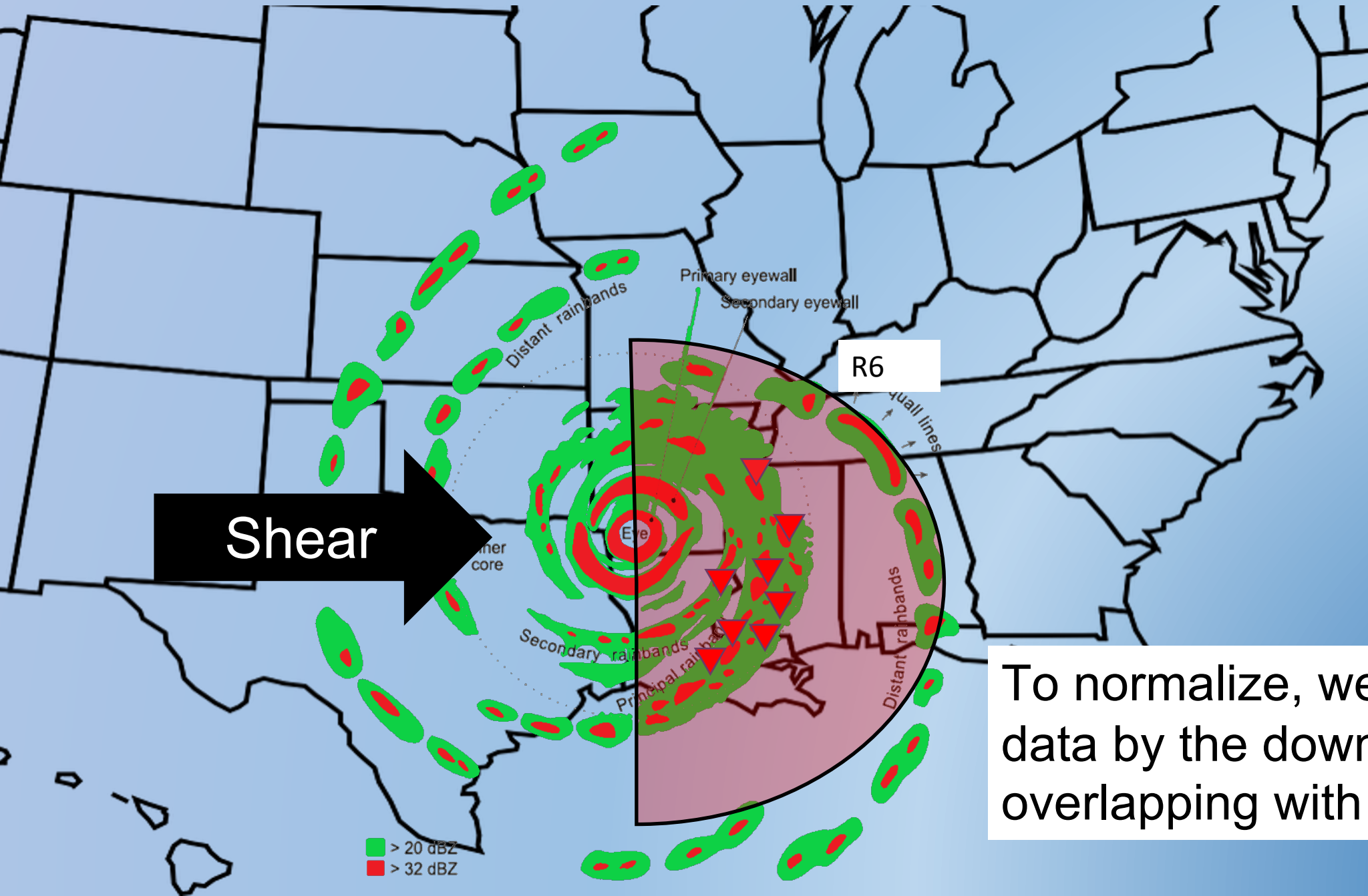


# Relationship Between TC Outer Size and Number of Tornadoes

- Large TCs are more likely to produce 1+ tornadoes
- Large TCs are up to 4 times more likely to produce large number of tornadoes
- Do large TCs produce more tornadoes per unit area?



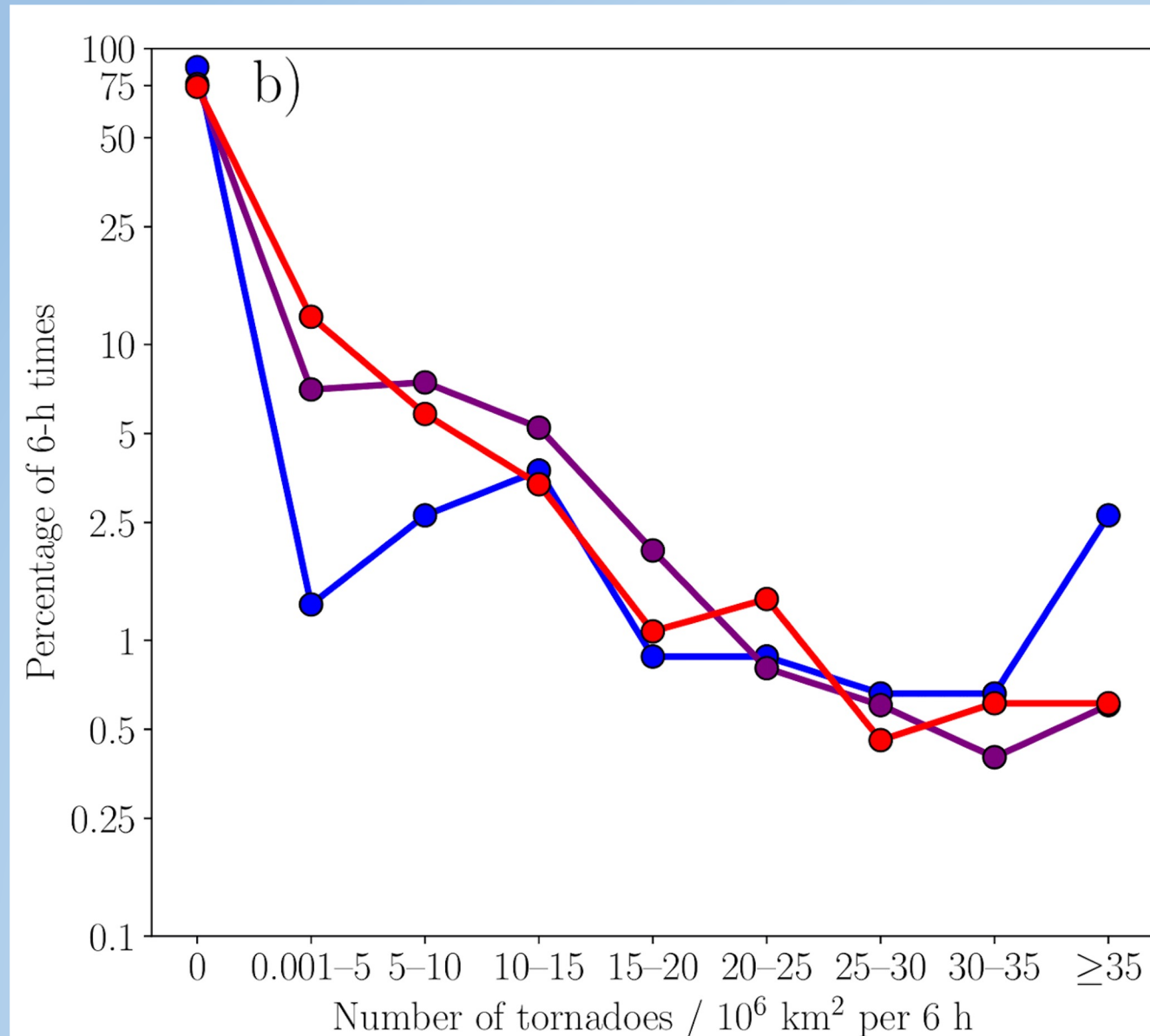
# Relationship Between TC Outer Size and Number of Tornadoes



To normalize, we divide the data by the downshear area overlapping with the U.S.

# Relationship Between TC Outer Size and Number of Tornadoes

- No systemic differences among TC outer size categories
- Large TCs do not produce more tornadoes per unit area.



# Summary

- Used multidecadal tornado reports and reanalysis-derived TC-outer size metric to investigate the sensitivity of tornado number and location to TC outer size.
- Our study concluded that:
  1. Larger TCs produce typically produce tornadoes further from the center over a broader region, although the scaling isn't one to one
  2. More tornadoes are produced in large TCs strictly due to a broader favorable area
  3. Large TCs don't produce more tornadoes per unit area

**For more information:** Paredes, M., Schenkel, B. A., Edwards, R., & Coniglio, M. (2021). Tropical cyclone outer size impacts the number and location of tornadoes. *Geophysical Research Letters*, 48, e2021GL095922. <https://doi.org/10.1029/2021GL095922>

