Severe Weather Within The Context of Climate Change

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Sources of information for thunderstorms and climate

- Severe thunderstorm/tornado reports/observations
- Proxy observations (hail)

- Environmental conditions (ingredients)
  - Relationships between environments and events
  - Look locally at what conditions are

- Pattern analysis
  - Large-scale background for events
  - Probably better simulated/predicted by models
Use of environments

- Meteorological covariates for things we care about
  - Relationships biased to where we have reports
  - Initiation, mode?

- Soundings (proximity studies)

- Reanalysis (process into forecast model)
  - More complete coverage
  - Errors compared to observed?
Regional Temperature Impacts on Tornadoes

- Warmer than normal (up)
  - Fewer tornado days in summer, especially in west
  - More tornado days in winter, especially in east

Running Three-Month Tornado Days

- Positively Correlated (p<0.05)
- Positively Correlated (p<0.01)
- Negatively Correlated (p<0.05)
- Negatively Correlated (p<0.01)
Days Per Year with at Least 1 (E)F1 Tornado
>15 (E)F1 Tornadoes

US Tornado Data
Updated from Brooks et al. (2014)
Date of 50th [E]F1+ Tornado (*Red=10% earliest/latest*)

- 1 May
- 1 April
- 1 March
- 1 Feb

Year

Timing of tornadoes (TX-NE)

- Long and Stoy (2014)
- Liu et al. (2015)
Changes in tornado occurrence (1979-2016)
Reports (left) Favorable Environments (right)

Gensini and Brooks (2018)
Environmental changes

- Naïve mean changes with warming
  - CAPE increase
  - Tropospheric wind shear decreases (thermal wind)
  - Initiation? (CIN, convective precip)
  - Other parameters????

- Care about combinations
ERA5 (1979–“present”)

Taszarek et al (2021)
Climate models look ahead

- Climate models
  - Environments
  - Severe storm proxies from convection-allowing models
Favorable Severe Storm Environments

Black dots:
Ensemble S/N > 1

White dots:
Ensemble S/N > 2
Convective Parameter Climate Model Changes Spring

- CAPE > 2000
- CAPE*Shear > 20,000

Gensini and Mote (2015)
Annual accumulated model severe storm occurrences (downscaled)

Gensini and Mote (2015)
Patterns

- Find typical “weather maps” and relationship to storms
Favorable for Tornadoes  Unfavorable for Tornadoes
Bottom line

- North America
  - Likely increase in non-tornadic severe storm occurrence in future
  - Increase in variability

- Challenge-
  - Environment-event relationships
  - Pattern-event relationships
  - Will those relationships change?