Spatial Redistribution of Tornadoes in a Warming Climate

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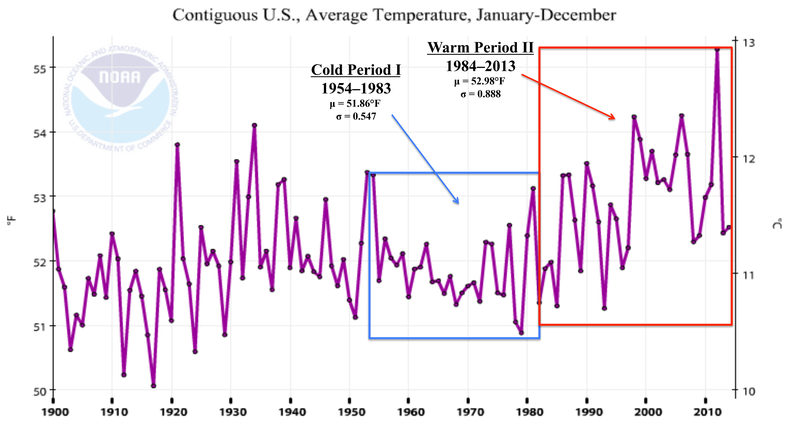
MOTIVATION AND GOAL

- Climate change impacts on the occurrence, frequency, and intensity of many extreme weather and climate phenomena, such as heat waves, droughts, and floods, have been the subject of much research in recent years. However, less analysis has been performed with USA tornado statistics, yielding insufficient and inconclusive results.
- Tornadoes pose many risks for destruction and personal harm, so any evidence for spatial shifts in their occurrence in a warming climate can help the public be more prepared and alert, and allow climate scientists to focus their efforts in enhanced risk areas.
- This work showcases an initial step in a larger Master's thesis which aims to refine and analyze cold-season tornado climatology, including any spatial and intensity trends as well as assessing societal impacts and communication of cold-season tornadoes.
- Warming temperatures used to define two consecutive 30-year periods, which are then used in assessing a changing tornado spatial distribution.



Mean annual temperature for CONUS, taken from NOAA/NCDC. Period I (1954-1983) is characterized by colder temperatures and less variability relative to Period II (1984-2013)

METHODOLOGY

TORNADO DATA

- Storm Prediction Center's *Storm Data* archive is used to extract tornado counts, intensity, and starting/ending location.
- (E)F1-(E)F5 tornadoes from 1954-2013 are analyzed, consistent with recent studies (*Agee and Childs 2014, Elsner et al. 2014, Verbout et al. 2006, etc.).*

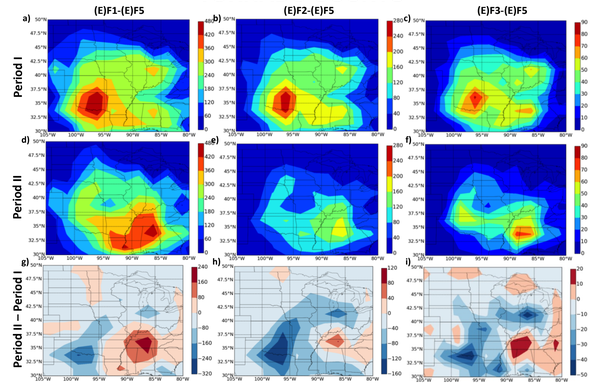
GRIDDED DOMAIN

- Grid of 2.5° x 2.5°, encompassing (30-50°N, 80-105°W).
- Each grid box receives a count of 1 tornado for the following conditions:
  - tornado is entirely contained within the grid box
  - tornado starts in grid box but ends elsewhere
  - tornado starts elsewhere but ends in grid box
  - tornado starts and ends elsewhere but straight-line path traverses grid box

TORNADO SPATIAL DISTRIBUTION

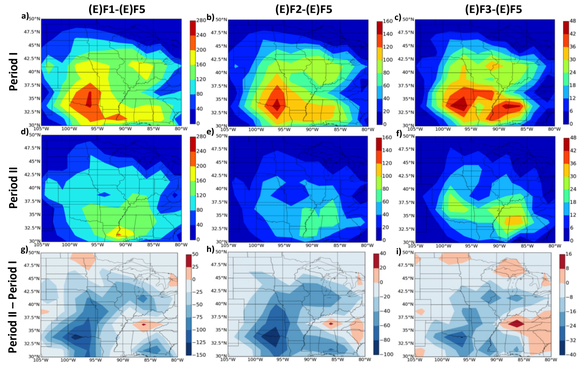
How has the spatial distribution of all tornadoes, significant tornadoes, and strong and violent tornadoes changed from the Cold Period I to the Warm Period II?

TORNADO COUNTS



AGEE ET AL, 2016, J. Appl. Meteor. Climat., under review

TORNADO DAYS

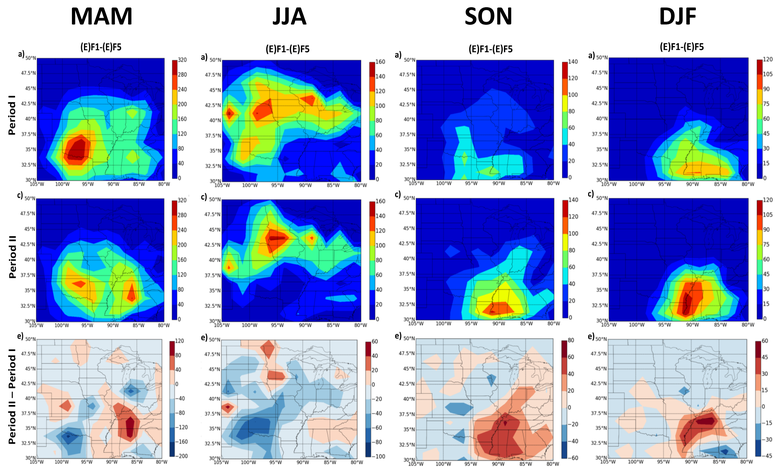


AGEE ET AL, 2016, J. Appl. Meteor. Climat., under review

- Tornado count maximum has shifted from OK/TX southeastward to TN/AL/MS/LA in the warmer Period II.
- Significant and strong/violent tornadoes have decreased in occurrence from Period I to Period II but show similar spatial shifts to the all-tornado case.
- Tornado days have decreased from Period I to Period II (except in TN) with maximum in tornado days shifted from OK/TX towards the Mississippi Valley (*Brooks et al. 2015*).
- Bootstrapping approach(not shown) reveals a significant difference in the mean counts from Period I to Period II in several grid boxes across the southern Great Plains (decrease) and Mississippi Valley (increase) regions.

SEASONAL ANALYSIS

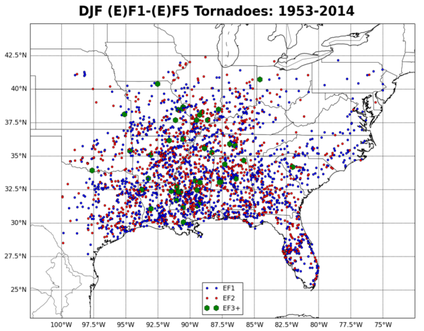
Which seasons are contributing to the respective increase and decrease in tornado frequency across Mississippi Valley and southern Great Plains?



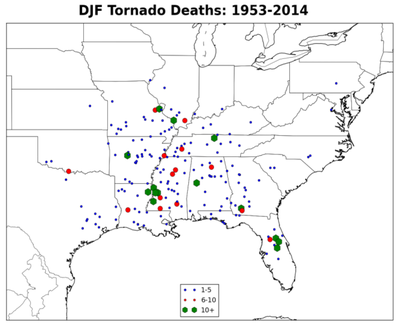
AGEE ET AL, 2016 (under review).

- Spring (MAM) tornadoes show a strong shift in occurrence from TX/OK toward AL/TN.
- A large decrease in summertime (JJA) tornadoes is noted across much of the Great Plains and Midwest, with greatest counts in both periods further north.
- Autumn (SON) and winter (DJF) tornadoes are becoming more frequent across the Mississippi Valley with very marginal decreases elsewhere.

CURRENT FOCUS: COLD SEASON ANALYSIS



Total DJF Tornado Counts = 2734



Total DJF Tornado Deaths = 688

ACKNOWLEDGMENTS

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CONCLUSIONS

- Tornado counts and days are increasing across the Mississippi Valley region and decreasing across the southern Great Plains in the more recent 30-year warm period.
- Seasonal analysis shows Spring and Summer months contributing most to the decreasing counts across the Great Plains , while Spring, Autumn, and Winter months are contributing to increasing counts in the Mississippi Valley.