A Comparison of Significant Tornadoes in the Central and Southeastern United States

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Motivation

- Tornadoes are more common in the Central Plains than they in the Southeast U.S. (332 vs. 276 per 10,000km)
- Relative frequency of significant (≥ EF2) tornadoes is higher in the Southeast U.S. except from May-July.
Motivation

• Dixon et al. (2011) found that there were regions of higher tornado occurrence
  – Statistically significant differences separating these regions did not exist
• This study’s objective is to determine whether tornadic storms in the Plains and the Southeast U.S. exhibit different storm structures and characteristics

Density calculations of average annual tornado days within 25 miles of any point

From Dixon et al. (2011)
Methods

- Matched 360 significant (> EF2) tornadoes between 2007-2010 with parent storms using Gibson-Ridge Level II radar software package.

- Omitted duplicate reports, tornadoes spawned by tropical cyclones, and storms whose tornadoes could not be matched with radar data.
Storm Structure Climatology

**Type I**
Supercell

CL, HP, LP, MINI

**Type II**
QLCS/MCS

TS, LS, PS, TL-AS, QLCS
What is a Supercell?

• Severe thunderstorm featuring a rotating updraft (mesocyclone)

From Ahrens (2008)
Supercell Structures

High Precipitation (HP)

Date: 4/24/2010
Time: 20:38Z
Storm: LA-14

Low Precipitation (LP)

Date: 4/10/2009
Time: 1:02Z
Storm: OK-21

MINI

Date: 1/21/2010
Time: 23:15Z
Storm: AL-26

MINI Cross Section

30,000 ft.
What is a QLCS/MCS?

- Linear system of thunderstorms that extend 100km in at least one direction (QLCS) or both directions (MCS).

From Ahrens (2008)
MCS/QLCS Structures

Leading Stratiform (LS)

Date: 4/10/2009
Time: 20:02Z
Storm: TN-16

Parallel Stratiform (PS)

Date: 1/20/2010
Time: 6:50Z
Storm: MS-20

Training Line Adjoining Stratiform (TL-AS)

Date: 5/11/2008
Time: 5:37Z
Storm: AL-18

Quasi-Linear Convective System (QLCS)

Date: 5/23/2010
Time: 2:30Z
Storm: NE-16
Storm Structure Climatology

Type I
Supercell

CL, HP, LP, MINI

A: Discrete
B: Merger

Type II
QLCS/MCS

TS, LS, PS, TL-AS,QLCS

A: Discrete
B: Merger
Supercell to Supercell Mergers: Type I-B

Date: 5/5/2007
Time: 2:33Z
Storm: KS-5
Supercell to Supercell Mergers: Type I-B
Supercell to Supercell Mergers: Type I-B
Supercell to Supercell Mergers: Type I-B

Date: 5/5/2007
Time: 3:14Z
Storm: KS-5
Supercell to QLCS Mergers: Type II-B

Date: 12/31/2010
Time: 22:01Z
Storm: MS-32
Supercell to QLCS Mergers: Type II-B
Supercell to QLCS Mergers: Type II-B
Supercell to QLCS Mergers: Type II-B
Supercell to QLCS Mergers: Type II-B
Supercell to QLCS Mergers: Type II-B
Supercell to QLCS Mergers: Type II-B
Supercell to QLCS Mergers: Type II-B
Supercell to QLCS Mergers: Type II-B
Supercell to QLCS Mergers: Type II-B

Date: 12/31/2010
Time: 22:44Z
Storm: MS-32
Supercell to QLCS Mergers: Type II-B

Date: 12/31/2010
Time: 22:44Z
Storm: MS-32
• Discrete supercells produced 3 times more significant tornadoes than QLCS/MCSs.
  • Cell mergers occurred in 19% of these cases.
• Compared to the Plains, QLCS or MCS tornadoes are 2-3 times more likely in the Southeast.

Results: Storm Type Distribution

<table>
<thead>
<tr>
<th>TYPE</th>
<th>ALL STORMS</th>
<th>PLAINS STORMS</th>
<th>SOUTHEAST STORMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-A</td>
<td>232 (64%)</td>
<td>98 (67%)</td>
<td>134 (62%)</td>
</tr>
<tr>
<td>I-B</td>
<td>42 (12%)</td>
<td>29 (20%)</td>
<td>13 (6%)</td>
</tr>
<tr>
<td>II-A</td>
<td>58 (16%)</td>
<td>14 (10%)</td>
<td>44 (21%)</td>
</tr>
<tr>
<td>II-B</td>
<td>24 (7%)</td>
<td>3 (2%)</td>
<td>21 (10%)</td>
</tr>
<tr>
<td>III</td>
<td>4 (1%)</td>
<td>1 (1%)</td>
<td>3 (1%)</td>
</tr>
<tr>
<td>Total</td>
<td>360 (100%)</td>
<td>145 (100%)</td>
<td>215 (100%)</td>
</tr>
</tbody>
</table>
Compared to the Plains, QLCS or MCS tornadoes are 4 times more likely in Mississippi, Alabama, and Georgia.
85% of Southeastern Type I tornadoes are associated with HP supercells, whereas half are caused by CL cases in the Plains.
Trailing-stratiform MCSs produce the most Type II tornadoes in both regions, but Southeast tornadoes arise from a wider variety of storm modes.
Results: Diurnal Characteristics By Region

- Significant tornadoes are most common during early evening (6-8 p.m.) in both regions in agreement with Trapp et al. (2005)
- QLCSs and MCSs also exhibit nocturnal maxima between 4-6 a.m. in both regions.
- Southeast tornadoes display a less amplified bimodal diurnal cycle due to having more QLCS/MCS tornadoes.
Conclusions & Future Work

- The majority of significant tornadoes in both regions are associated with discrete supercells. However, half of the significant tornadoes in Mississippi, Alabama, and Georgia are not, suggesting different storm structures.
- Nearly one-fifth of tornadoes occurred after a merger took place.
- Diurnal features of both regions depicted the peak tornado risk for supercells between 6-8pm and QLCS/MCSs between 4-6am.
- Future work includes investigating how tornadogenesis in mergers differ from discrete cases, as well as statistical analyses including data from the Midwest and/or more years.
References and Acknowledgements

