An Analysis of Crashes, Fatalities, and Injuries Caused by Thunderstorm and Tornado Winds While Traveling

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Introduction

- Vehicles - of all types - have been a large part of our society for decades now, and since they have become more prominent here in the United States, there has always been a debate around what should be done to keep safe, or how a person should take shelter during an extreme weather event.
- An issue that follows this idea comes from how prepared are people, and how does that preparedness – or lack thereof – influence and affect the well being of vehicle occupants?
- When discussing the overall impact, a weather event (in this case, convective winds) has on people, it is common for indirect injuries and fatalities to be often overlooked when thinking about damages and omitted from official statistics.

Research Questions

1. How many crashes, injuries, and fatalities that are related to thunderstorm and tornado winds occur while traveling in a vehicle?
2. Are there areas within the contiguous United States where vehicular crashes, injuries, and fatalities occur more often?
3. How do these events compare to the climatology of thunderstorm and tornado occurrence?

Research Objective and Study Area

- The aim for this project is to not only to raise awareness for both direct and indirect vehicular crashes, injuries, and fatalities to help in fully understanding the risk posed by these weather events, but also to update outdated information on the weather induced incidents that affect people who are traveling.
- The contiguous United States is the chosen location for this study as the wide range in climate types provides for a greater investigation of CONUS' many regions.
- This area allows for broader view of locations concerning crash, fatalities, and injury occurrence, and it creates opportunity for a considerable amount comparison between regions, as well as a wider range of observable behaviors between people living in the different regions.

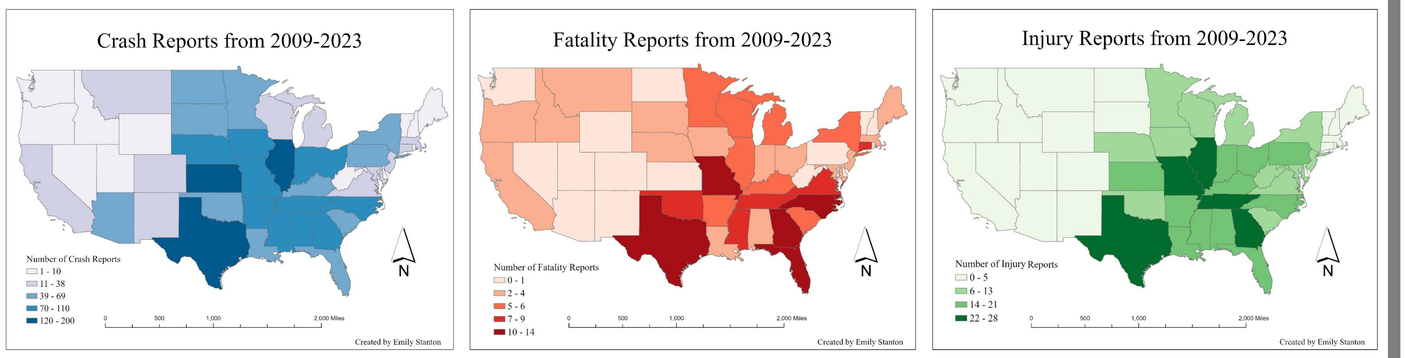


Figure 1. The maps above display crash, fatality, and injury report occurrence by state. Only the 2,476 reports taking places in the states (and D.C.) are included in these maps. The other 38 boating-related reports occurred off the coasts or within the Great Lakes.

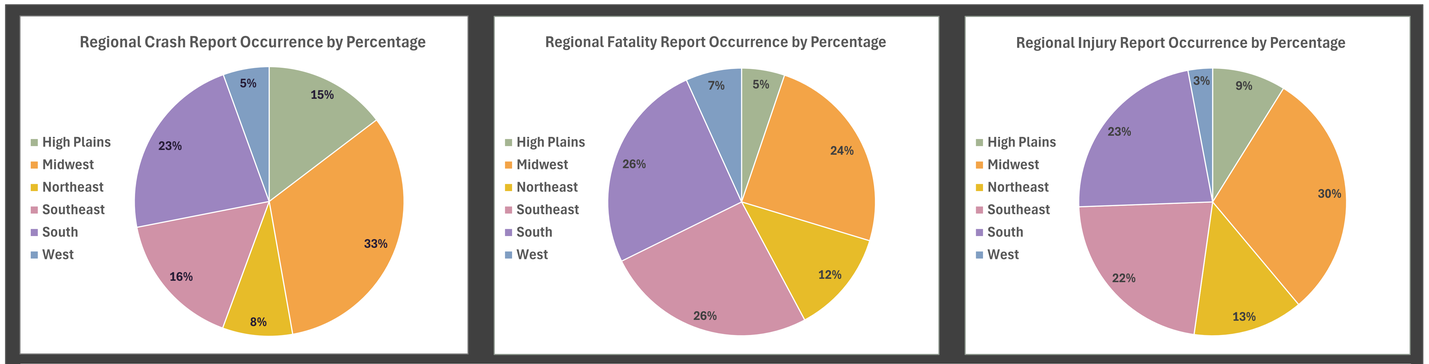


Figure 2. The charts above display the percentages of crash, fatality, and injury report percentages for regions in the contiguous United States that are covered by NCEI's Regional Climate Centers.

Years	Confirmed Crashes	Non-numeric Crashes	Overall
2009	202	15	217
2010	236	16	252
2011	300	20	320
2012	189	5	194
2013	180	8	188
2014	169	10	179
2015	135	2	137
2016	159	7	166
2017	219	22	241
2018	89	4	93
2019	204	13	217
2020	138	8	146
2021	171	11	182
2022	160	13	173
2023	216	18	234
All Years	**2767**	**172**	**2939**

Table 1. Confirmed crashes added to a non-numeric value of crashes (marked as 1) to total number of overall potential crashes.

Years	Confirmed Fatalities	Non-numeric Fatalities	Overall
2009	21	0	21
2010	16	0	16
2011	31	1	32
2012	18	0	18
2013	18	0	18
2014	14	0	14
2015	32	0	32
2016	10	0	10
2017	16	0	16
2018	32	0	32
2019	17	0	17
2020	10	0	10
2021	29	0	29
2022	25	0	25
2023	13	0	13
All Years	**302**	**1**	**303**

Table 2. Confirmed fatalities added to a non-numeric value of fatalities (marked as 1) to total number of overall potential fatalities.

Years	Confirmed Injuries	Non-numeric Injuries	Overall
2009	75	1	76
2010	80	1	81
2011	65	2	67
2012	67	2	69
2013	37	1	38
2014	35	1	36
2015	29	1	30
2016	27	1	28
2017	40	2	42
2018	29	3	32
2019	48	3	51
2020	11	0	11
2021	35	0	35
2022	32	3	35
2023	64	1	65
All Years	**674**	**22**	**696**

Table 3. Confirmed injuries added to a non-numeric value of injuries (marked as 1) to total number of overall potential injuries.

Methods

- *Storm Data* was collected from the NOAA Storm Events Database for the years 2009-2023 and filtered using R to identify episodes and events containing key words relating to travel.
- The narratives identified by program were read and categorized based on the confidence that a vehicle was involved: definite (absolutely sure), possible (not enough information given), or no vehicle involved which were removed.
- Events and episodes categorized as definite were then analyzed by report type (crash, fatality, and/or injury) and the confirmed number of crashes, fatalities, and/or injuries.
- The data includes a wide range of vehicles that are not always thought of or are labeled as an 'outside death'. The idea is that if the person is traveling, be it on a boat or in a car, the incident was included in the analysis.

Results

- The years of 2009-2023 had an estimated, overall total of 2939 crashes, 303 fatalities, and 696 injuries (including those off the coasts). **Table 1, Table 2**, and **Table 3** display the estimation method used.
- Any incident that was reported under words such as: some, several, many, few, etc. are marked as a non-numeric incident, so those incidents are not ignored.
- The tables are used to show that the non-numeric values only take up a small portion of the actual confirmed incidents with only 5.85% of crashes, 0.33% of fatalities, and 3.16% of injuries being classified as non-numeric values.
- The overall report total was 2,505 crash, 209 fatality, and 479 injury reports. For the contiguous United States, the total was 2,476 crash, 194 fatality, and 473 injury reports.
- In **Figure 1**, it is clear that the eastern half of the United States is more affected than the western half of the country, and this is expected because of where the majority of thunderstorms and tornadoes occur. The regions affected can also be easily observed in **Figure 2**, where regional report occurrence by percentage can be found.

Results Continued

- The results from **Figure 1** and **Figure 2** display the trends by region and location within the contiguous United States, but trends vary between months and time of day.
- The number of events spike right around April through August with June and July, alone accounting for 38.76% of reports for the year, and April through August with 75.8%. This is consistent with the climatology of thunderstorm occurrence.

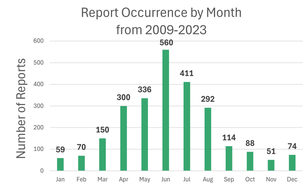


Figure 3. Overall reports per month, showing report occurrence throughout the year.

- Along with location and time of year, the time of day is incredibly important in understanding the relationship between crash risk and climatology. **Figure 4** and **Figure 5** represent the times in which a report took place. Peak hours for both start and end times extends from 2PM to 7PM with 58.0% (start) and 58.2% (end) of all reports occurring in that period.



Figure 4. Reports organized by start time. The graph is organized by 24hr time (horizontal) and number of reports (vertical).

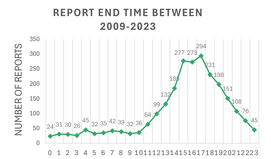


Figure 5. Reports organized by end time. The graph is organized by 24hr time (horizontal) and number of reports (vertical).

Conclusion

- The Midwestern region of the United States holds the highest percentage of crash and injury reports with 33% of crash and 30% of injury reports. The Southern and Southeastern regions both have 26% of the fatality reports, a total of 52% of across the two regions.
- Late spring through late summer hold the highest percentage of reports with 75.8%, and June has the most out of all the months with 22.4% of total reports.
- As expected, 14:00 through 19:00 were determined to be peak report hours due to rush hour traffic and generalized thunderstorm climatology.
- The last point does raise a question about whether the main cause comes from one or the other, or both – which I suspect is the case – however, it would be an interesting question to look at.

Acknowledgements and Contact

Partial support for this work was provided by the SIUE Undergraduate Research and Creative Activities program and the National Science Foundation (Award 1911512). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

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