

## A New High-Quality Lightning Fatality Database for Lightning Safety Education

William P. Roeder\*  
Private Meteorologist  
Patrick AFB, FL

and John Jensenius  
National Weather Service  
Gray, ME

### 1. Introduction

Lightning is one of the top storm-related killers in the U.S. and inflicts life-long debilitating injuries on many more people than it kills. Until recently, lightning was the second leading source of storm deaths in the U.S. (Holle, 2011a) (Curran et al., 2000). However, the lightning fatality rate has been decreasing over several decades (Lopez and Holle, 1998, Jensenius, 2011). More recent data shows that lightning is now the third leading source of storm deaths, behind tornadoes (Roeder, 2012; Jensenius, 2011). Part of the most recent decrease in lightning fatalities is attributed to increased public education. The scientific understanding of the lightning threat has improved considerably in the past few decades and a consensus has emerged on what constitutes safe lightning behavior (Roeder et al., 2011). In the early 1990s, a small cadre began a new lightning safety initiative. In 2001, NOAA began a national Lightning Safety Awareness Week (Jensenius and Franklin 2012; 2006). More information on the NOAA Lightning Safety Awareness Week and other lightning safety materials is available at the NOAA website ([www.lightningsafety.noaa.gov](http://www.lightningsafety.noaa.gov)).

### 2. New Lightning Fatality Database

A new database of recent lightning fatalities in the U.S. has been created by one of the authors (Jensenius). This database currently covers 2006 to 2011 and contains information for 210 lightning fatalities. An example of the information in the database is in Figure-1. The new database provides information that is more accurate and timely than previous lightning

fatality data, and is available to the public ([www.lightningsafety.noaa.gov/statistics.htm](http://www.lightningsafety.noaa.gov/statistics.htm)).

Lightning fatality reports are typically posted in the database within a few days of a reported event. NOAA uses media sources, local National Weather Service offices, and local officials to keep the database accurate and up-to-date. Prior to 2006, NOAA's *Storm Data* publication was the primary source for information on lightning fatalities in the U.S. However, *Storm Data* is typically available two to three months after an event, and studies have shown inaccuracies and omissions in the *Storm Data* information (Ashley and Gilson, 2009). For the past few years, the new database has been used to quality control the reports entered into *Storm Data*.

### 3. Lightning Safety Applications of the New Database

NOAA's new lightning database provides several opportunities to improve lightning safety education. For the media, it provides a source of up-to-date fatality information that can be used in news stories about recent lightning incidents. For lightning safety speakers, the database provides a source of timely information on recent lightning incidents that can make the talk more topical, interesting, and memorable. The database can also be used to determine patterns among lightning victims that can be used to tailor safety messages to specific audiences. For example, one of the authors (Roeder) taught lightning safety to 150 teachers in Alabama at the 2011 annual meeting of the National Weather Association; this database was used to note that that state appeared to have more lightning fatalities from fishing than average.

---

\* Corresponding Author: William P. Roeder,  
e-mail: [wroeder@cfl.rr.com](mailto:wroeder@cfl.rr.com)



# National Weather Service

## Lightning Safety

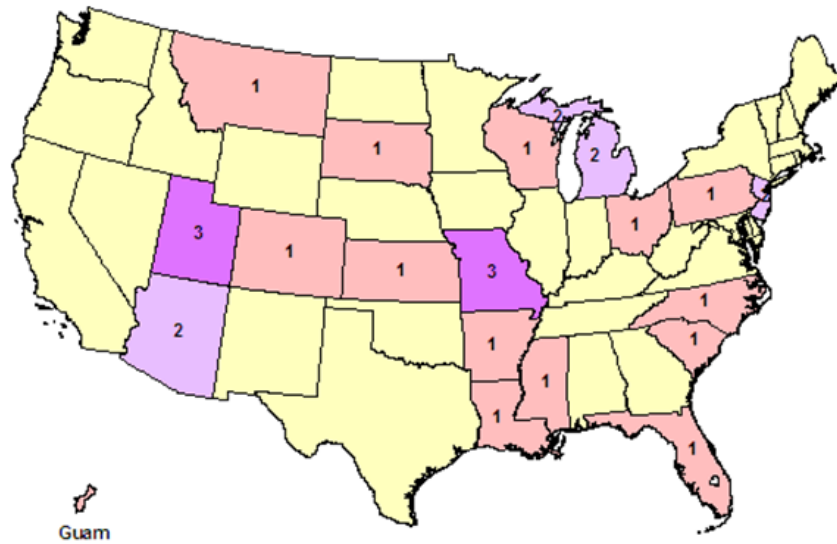
[Home](#)[News](#)[Organ](#)[Home](#)[Espanol](#)[Safety Tips](#)[Overview](#)[Indoor](#)[Outdoors](#)[Science](#)[Facts](#)[History](#)[Truths and Myths](#)[Health](#)[Medical](#)[Survivor stories](#)[Learn More](#)[Kids Corner](#)[Teacher Tools](#)[Statistics](#)[Toolkits](#)[Resources](#)[Photos](#)[Multimedia](#)[Brochures](#)[Posters](#)[News](#)[Media Resources](#)[In the News](#)[Links](#)[Contact NWS](#)

### To date, there has been 26 fatalities in 2011 in 18 States and Guam Missouri and Utah tragically have 3 deaths

No.	Date	Day	ST	City	Age	Sex	Location	Activity	Victim
1	5/23	Mon	MO	Joplin	31	M	Outside open	Tornado rescue	Officer Jeff Taylor
2	6/7	Tue	LA	Shreveport	49	M	Golf course	Golfing	Jay Greenleaf
3	6/9	Thu	PA	Sadsbury	13	M	Open field	Baling hay	Levi Lantz
4	6/10	Fri	NC	Durham Cnt	45	M	Field	Feeding livestock	Steven Taylor
5	6/11	Sat	MT	Bridger	54	M	In open, on horse	Herding cattle	Gary Devries
6	6/21	Tue	SC	Ruby	26	M	Open field	Playing baseball	Michael Gulledge
7	7/1	Fri	WI	Burnett Cnty	11	F	Under Tree	Camping	McKenzie Klar
8	7/3	Sun	NJ	Hammonton	54	M	Near Tree	Family picnic	Stephen M. Rooney
9	7/11	Mon	UT	Emery Cnty	56	M	Open Desert	Camping	Joseph L. Geiser
10	7/12	Tue	AZ	Big Lake	46	M	Camping	Camping	Rob Christopher
11	7/13	Wed	UT	Carbon Cnty	12	M	Open area	Camping, Scouts	David Rayborn
12	7/23	Sat	MI	Oscoda Cnty	54	F	River bank	Tubing	Lisa Mann
13	7/23	Sat	MI	Oscoda Cnty	54	F	River bank	Tubing	Cheryl Nickert-Keyser
14	7/30	Sat	MO	Polaski Cnty	20	F	River bank	Canoeing	Lindsey Smith
15	7/31	Sun	MS	Pacagula	41	M	Pier	Fishing	Bobby Broadus
16	8/3	Wed	SD	Wasta	57	M	On Interstate	Riding motorcycle	Kurt Stolba
17	8/4	Thu	AZ	Fredonia	64	F	Grand Canyon	Tourism	German tourist
18	8/5	Fri	MO	Warsaw	78	F	Boat Ramp	Pulling out boat	Peggy Louise White
19	8/8	Mon	AR	Rector	71	M	Open Field	Chopping cotton	William "Neil" Arnol
20	8/18	Thu	UT	Bryce Canyon	51	M	Under tree	Tourism	Volker Kunz
21	8/31	Wed	CO	Westcliffe	59	M	Open area near mountain	Camping	Kirk Snyder
22	9/4	Sun	OH	Westchester	40	M	On Lake	Camping	Donnell Russell
23	9/11	Sat	FL	Tampa	21	M	Water Park	In water evacuating pool	Justin Savers Inversso
24	9/10	Sat	KS	New strawn	48	F	Reservoir dam	Bicycling	Patty Gilliam
25	9/15	Thu	NJ	Atlantic City	40	M	Building under construction	Finishing concrete	Bryan Bradley
26	10/14	Fri	GU	Hagåtña	59	M	In water on reef	Fishing	Edward Cruz San Nicolas

a) First of two pages from NOAA's new lightning fatality database for 2011.

### Lightning Fatalities for 2011 by State



### 2011 Lightning Fatality Demographics

State	Gender		Age		Day Of Week		By Month								
AZ	2	Mal	19 (73%)	0- 9	0 (0%)	Sun	3 (12%)		11	10	09	08	07	06	Norm*
AR	1	Fem	7 (27%)	10-19	3 (12%)	Mon	3 (12%)	Jan	0	0	0	1	0	1	0
CO	1			20-29	3 (12%)	Tue	3 (12%)	Feb	0	0	0	1	0	0	0
FL	1			30-39	1 (4%)	Wed	3 (12%)	Mar	0	0	1	0	1	0	1
GU	1			40-49	7 (27%)	Thu	4 (15%)	Apr	0	0	1	0	1	3	2
KS	1			50-59	9 (35%)	Fri	4 (15%)	May	1	4	2	2	5	5	6
LA	1			60-69	1 (4%)	Sat	6 (23%)	Jun	5	7	12	9	12	10	12
MI	2			70-79	2 (8%)			Jul	9	11	10	14	10	16	16
MO	3			80-89	0 (0%)			Aug	6	4	3	0	9	7	12
MS	1			Unknown	0 (0%)			Sep	4	2	4	1	5	4	5
MT	1							Oct	1	1	1	0	2	2	1
NC	1							Nov	0	0	0	0	0	0	0
NJ	2							Dec	0	0	0	0	0	0	0
OH	1							Year	26	29	34	28	45	48	55
PA	1														
SC	1														
SD	1														
UT	3														
WI	1														

Percentages may not add up to 100% due to rounding.

\* - Known Fatalities to date

b) Second of two pages from NOAA's new lightning fatality database for 2011.

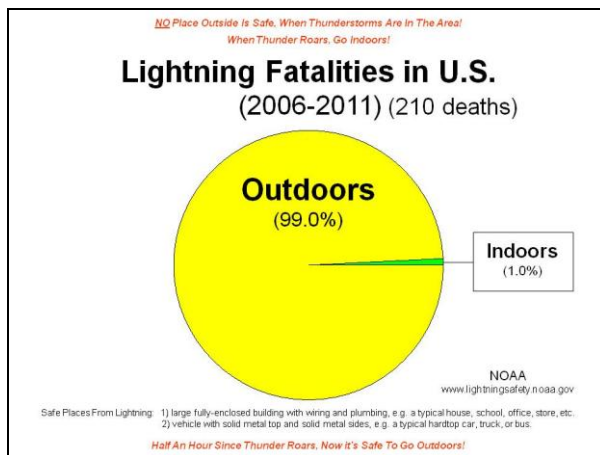
**Figure-1.** Example of the information in the NOAA's new lightning fatality database. This example is from 2011.

Finally, a new set of visual aids was developed by one of the authors (Roeder) from the database. These new visual aids should improve lightning safety education in the U.S. by offering consistent information from this high-quality database and in a top-quality consistent graphic style. The new visual aids are listed in Table-1 and shown in

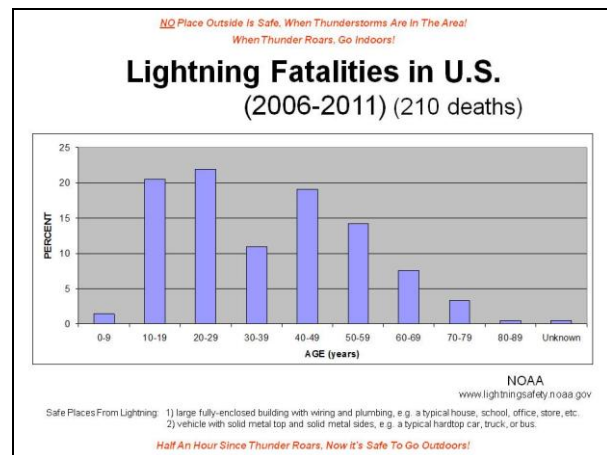
Figure-2 through Figure-16. Each new visual aid contains the three most useful lightning safety slogans, and lists the most frequently available locations that provide safety from lightning. This supplemental information is always in the same location in each visual aid for easy use.

**Table-1.**  
Visual aids for lightning safety education developed from the new NOAA database.

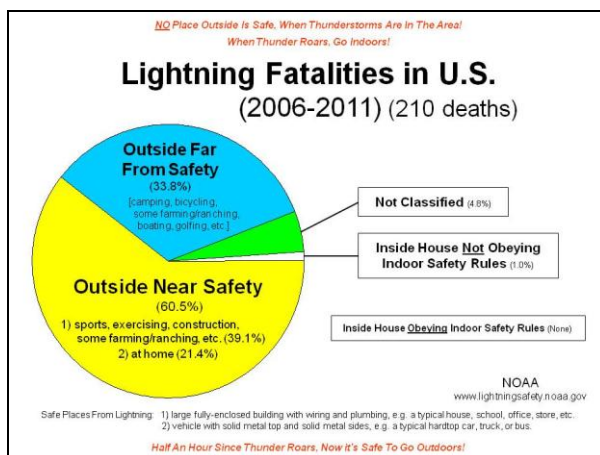
Figure Number	Description (distribution of lightning fatalities by . . .)	Comments
2	Outdoor and indoor	First-ever explicit visual aid showing this distribution
3	Activity and location	'Outdoors Near Safety' and 'Outdoors Far from Safety' are categories not used previously. Classification of events into these two categories is very subjective. When in doubt, the decision was made conservatively to favor the 'Outdoors Far From Safety' category and so that category may be overestimated.
4	Gender	Consistent with previous studies
5	Age ( <u>not</u> normalized by population in each age brackets)	The large jump between the number of lightning fatalities in children (ages 0-9 years) and youths (10-19 years) suggests that one focus of lightning safety education should be children
6	Age ( <u>normalized</u> by population in each age brackets)	
7	Month	Consistent with lightning climatology (Holle, 2010)
8	Day of week	More lightning fatalities on weekends, presumably due to more outdoor recreation
9	Weekday and weekend ( <u>not</u> normalized by number of days in each period)	Weekend has more <u>per diem</u> lightning fatalities than weekday, presumably due to more outdoor recreation on weekends
10	Weekday and weekend ( <u>normalized</u> by number of days in each period)	
11	Number of fatalities per lightning flash	Consistent with previous studies
12	State – number of fatalities	None
13	State – percent of fatalities	None
14	State – rank	None
15	State – per capita rank	State populations are interpolated between 2000 and 2010 to the middle of 2008, the middle of the 2006-2011 database. State populations are from the U.S. Census (2012).
16	State – per capita annual rate	



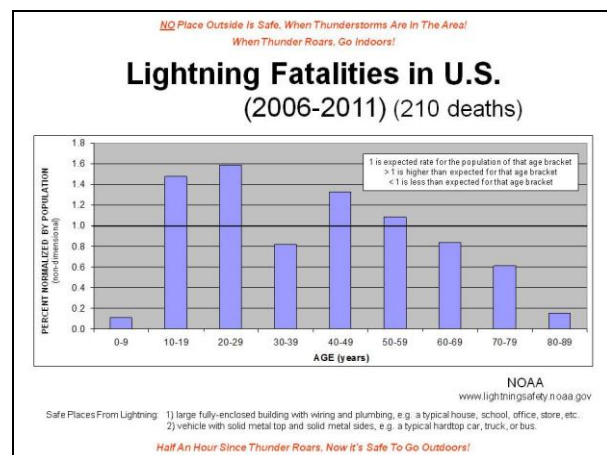
**Figure 2.** Distribution of U.S. lightning fatalities by outdoor/indoor location, based on the new 2006-2011 lightning fatality database.



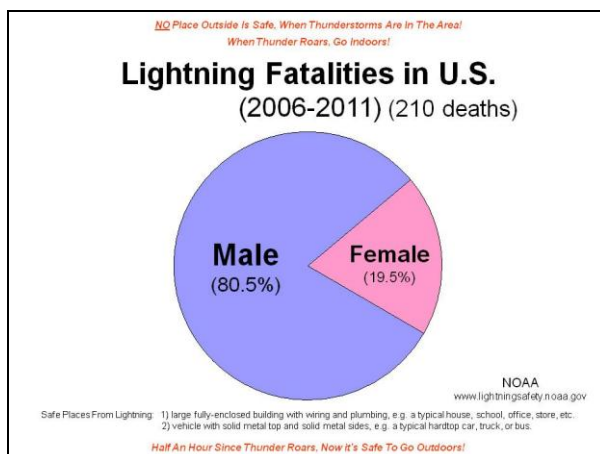
**Figure 5.** Distribution of U.S. lightning fatalities by age, not normalized for population, based on the new 2006-2011 lightning fatality database.



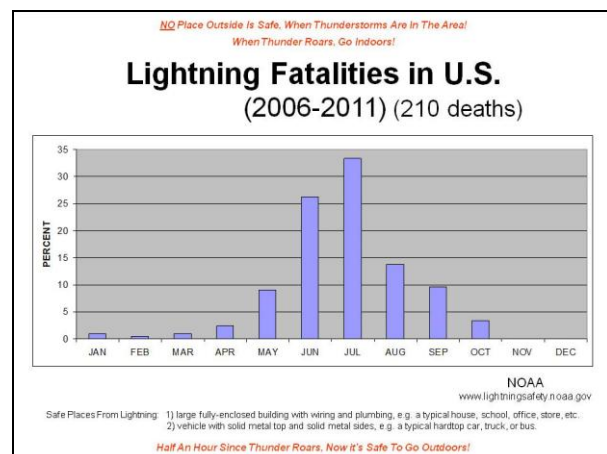
**Figure 3.** Distribution of U.S. lightning fatalities by activities/locations, based on the new 2006-2011 lightning fatality database. As noted in Table-1, 'Outside Far From Safety' may be overestimated.



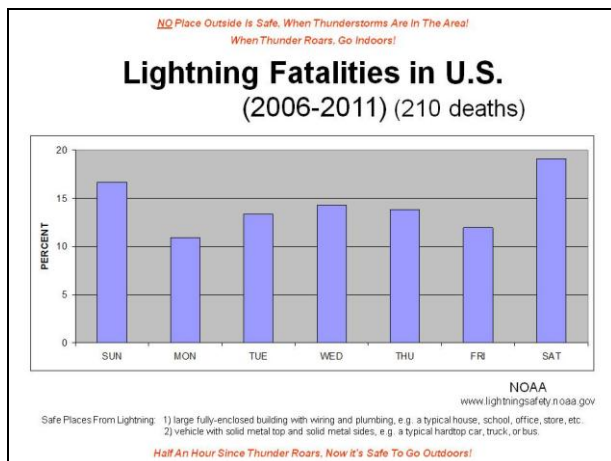
**Figure 6.** Distribution of U.S. lightning fatalities by age, normalized for population, based on the new 2006-2011 lightning fatality database.



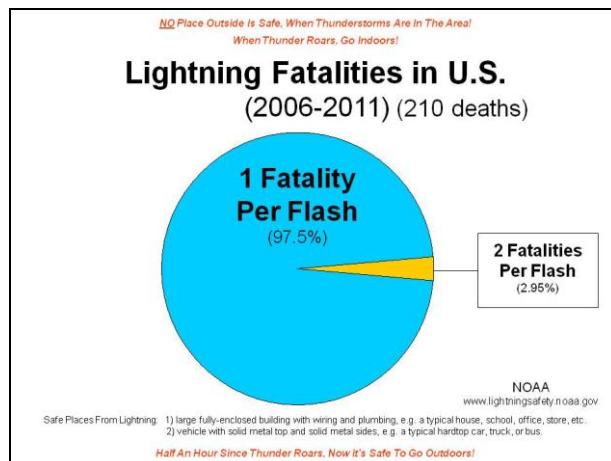
**Figure 4.** Distribution of U.S. lightning fatalities by gender, based on the new 2006-2011 lightning fatality database.



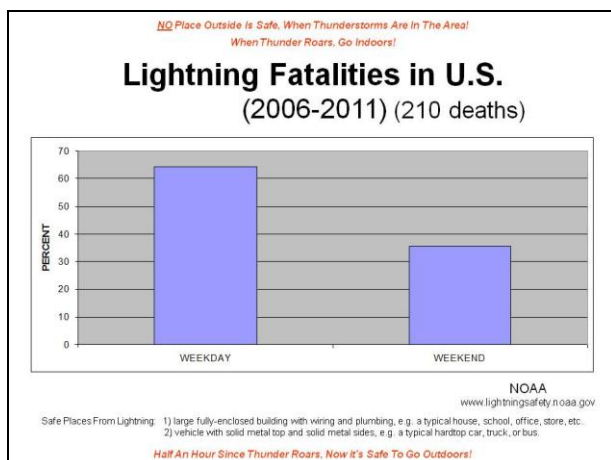
**Figure 7.** Distribution of U.S. lightning fatalities by month, based on the new 2006-2011 lightning fatality database.



**Figure 8.** Distribution of U.S. lightning fatalities by day of week, based on the new 2006-2011 lightning fatality database.



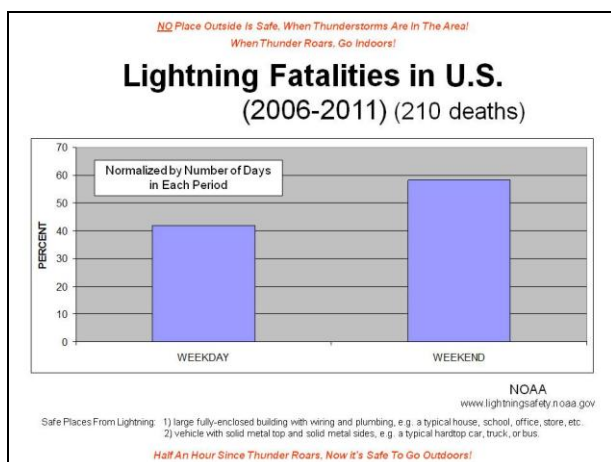
**Figure 11.** Distribution of U.S. lightning fatalities by number of fatalities in each event based on the new 2006-2011 lightning fatality database.



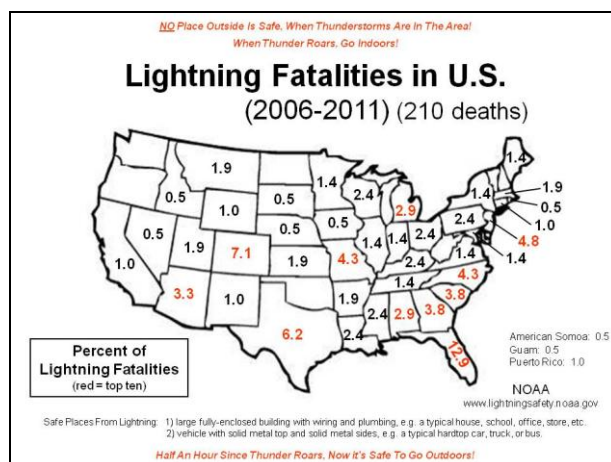
**Figure 9.** Distribution of U.S. lightning fatalities by weekday/weekend, not normalized by number of days in each period, based on the new 2006-2011 lightning fatality database.



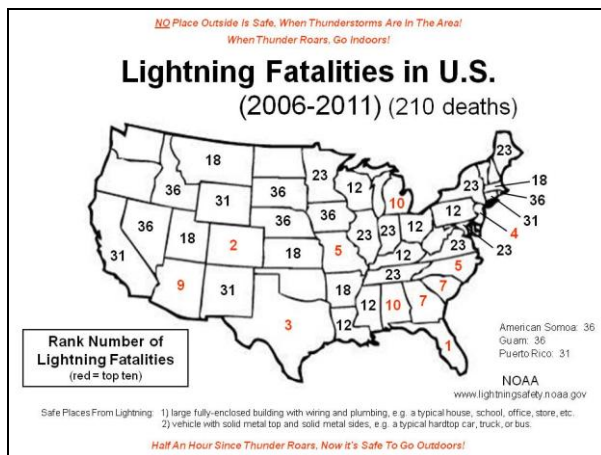
**Figure 12.** Number of U.S. lightning fatalities by state, based on the 2006-2011 new lightning fatality database.



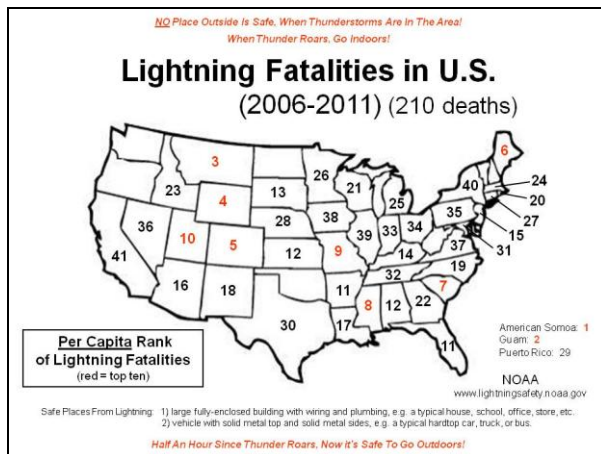
**Figure 10.** Distribution of U.S. lightning fatalities by weekday/weekend, normalized by number of days in each period, based on the new 2006-2011 lightning fatality database.



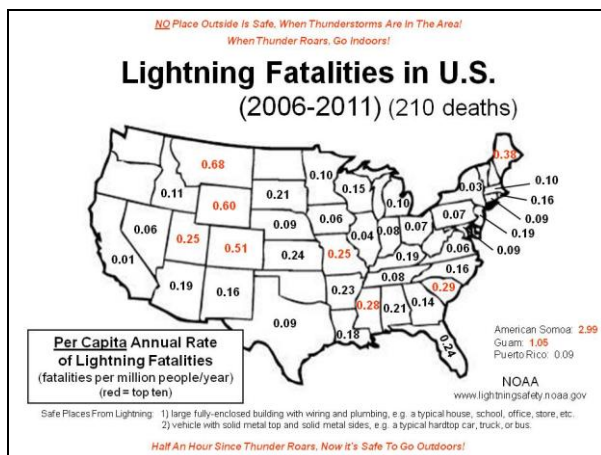
**Figure 13.** Percentage of U.S. lightning fatalities by state, based on the new 2006-2011 lightning fatality database.



**Figure 14.** Rank of U.S. lightning fatalities by state, based on the new lightning fatality database.



**Figure 15.** Per capita rank of U.S. lightning fatalities by state, based on the new lightning fatality database.



**Figure 16.** Per capita annual rate of U.S. lightning fatalities by state (fatalities per million people), based on the new lightning fatality database.

The lightning safety education applications of these new lightning safety visual aids are listed in Table-2. The new visual aid showing the ratio of outdoor and indoor lightning fatalities is especially important (Figure-2). It has been known for many years that most lightning fatalities in the U.S. occur outside. Indeed, that information has been critical to three of the most useful slogans in lightning safety public education, which are included in each visual aid.

The visual aids showing the distribution of lightning fatalities by ages is also important (Figure-5, Figure-6). The large increase of fatalities from children (ages 0-9 years) to youths (ages 10-19 years) suggests that children should be one focus of the lightning safety education efforts. Presumably, when children learn good lightning safety practices, they should be more cautious as they grow older. In addition, children are generally more open to teaching by adults than youths, especially adolescents. This difference of lightning fatalities between children and youths is consistent with previous studies (Lushine et al., 2005).

### 3. Future Work

The NOAA database and visual aids will be updated after the end of each calendar year. These results will be posted at the NOAA lightning safety website ([www.lightningsafety.noaa.gov](http://www.lightningsafety.noaa.gov)). New graphics are under development to explore the distribution of lightning fatalities by state normalized by number of flashes, flash density, number of flashes and per capita, and flash density and per capita. If these new visual aids prove useful, they will be posted at the NOAA lightning safety website. Another new visual aid is under development to show the combined distribution of lightning fatalities by both age and gender, which may help improve lightning safety education. For example, the authors anticipate that males in the age brackets 10-19 years and 20-29 years will be disproportionately overrepresented on a per capita basis.

**Table-2.**  
Lightning safety education applications of the new visual aids based on the new NOAA database.

Figure Number	Description (distribution of lightning fatalities by . . .)	Education Application
2	Outdoor and indoor	<ul style="list-style-type: none"> <li>Continued emphasis required on scheduling outdoor activities to avoid lightning</li> <li>Continued emphasis required on going inside a proper building (Holle, 2009) or a hardtop vehicle (Holle, 2008) when thunderstorms are in the area</li> <li>Reinforces fundamental principle of lightning safety, 'No Place Outside Is Safe When Thunderstorms Are In The Area!'</li> </ul>
3	Activity and location	<ul style="list-style-type: none"> <li>Continued emphasis required on going to safety sooner--nearly 60% of the fatalities were within a few minutes of safety.</li> </ul>
4	Gender	<ul style="list-style-type: none"> <li>More emphasis required on tailoring education to males</li> <li>NOAA 'Lightning Safety Awareness Week' adopted this as their theme for 2012</li> </ul>
5	Age ( <u>not</u> normalized by population in each age brackets)	<ul style="list-style-type: none"> <li>Continued emphasis required on educating children (ages 0-9 years) due to large increase in casualties between children and youths (ages 10-19 years) and children more likely than youths to take advice of adults</li> </ul>
6	Age ( <u>normalized</u> by population in each age brackets)	
7	Month	<ul style="list-style-type: none"> <li>Education best done in late May for 'just in time training' before the onset of lightning fatality season in June</li> <li>Education can also be effective soon after the first lightning casualties of the season (Roeder et al., 2012), usually by late June (Roeder, 2012), by proactively adding lightning safety to the likely media reports</li> <li>Very consistent with lightning season across the U.S. (Holle, 2010)</li> </ul>
8	Day of week	<ul style="list-style-type: none"> <li>Refresher training best done before weekend for 'just in time training' (Roeder et al., 2012)</li> </ul>
9	Weekday and weekend ( <u>not</u> normalized by number of days in each period)	
10	Weekday and weekend ( <u>normalized</u> by number of days in each period)	
11	Number of fatalities per lightning flash	<ul style="list-style-type: none"> <li>Explains one of the challenges in lightning safety education--most lightning incidents are just one fatality and so usually do not get persistent national media attention.</li> </ul>
12	State – number of fatalities	<ul style="list-style-type: none"> <li>Useful in targeting lightning safety education to states or regions where it is most needed</li> <li>Useful in motivating interest in lightning safety (Roeder et al., 2012) (Roeder et al., 2011)</li> </ul>
13	State – percent of fatalities	
14	State – rank	
15	State – per capita rank	
16	State – per capita annual rate	

#### 4. Summary

Lightning is a significant source of storm casualties in the U.S. NOAA has created a new database of U.S. lightning fatalities that includes 210 deaths from 2006-2011. This database is updated continually, usually within a few days of reported lightning deaths. This database is available on-line to the public ([www.lightningsafety.noaa.gov](http://www.lightningsafety.noaa.gov)) and can help improve lightning safety education. Some new graphics summarizing this new database have been created, which can also help improve lightning safety education to the public

#### 5. Acknowledgements

Several improvements were made to the new lightning safety visual aids from reviews from the Working Group of NOAA's Lightning Safety Awareness Week. Mr. Holle of Holle Meteorology and Photography reviewed this paper.

#### 6. References

- Ashley, W. S., and C. W. Gilson, 2009: A reassessment of U.S. lightning mortality, *Bulletin of the American Meteorological Society*, **90**, Oct 09, 1501-1518
- Curran, E. B., R. L. Holle, and R. E. Lopez, 2000: Lightning casualties and damages in the United States from 1959 to 1994, *Journal of Climate*, Vol. 13, 3448-3453
- Holle, R. L., 2011: Recent studies of lightning safety and demographics, *5th Conference on the Meteorological Applications of Lightning Data*, 23-27 Jan 11, 19 pp.
- Holle, R. L., and M. L. Murphy, 2010: Monthly distributions of U.S. NLDN cloud-to-ground lightning, *3rd International Lightning Meteorology Conference*, 21-22 Apr 2010, 13 pp.
- Holle, R. L., 2009: Lightning-caused deaths and injuries in and near dwellings and other buildings, *4th Conference on the Meteorological Applications of Lightning Data*, 11-15 Jan 09, 20 pp.
- Holle, R. L., 2008: Lightning-caused deaths and injuries in the vicinity of vehicles, *3rd Conference on Meteorological Applications of Lightning Data*, 20-24 Jan 08, 10 pp.
- Jensenius, J. S., Jr., and D. B. Franklin, 2012: A review of NOAA's Lightning Safety Awareness Campaign and the Impact that it has produced across the United States, *22nd International Lightning Meteorology Conference*, 4-5 Apr 12
- Jensenius, J. S., Jr., 2011: [NOAA Lightning Safety Blog – May 25](#)
- Jensenius, J. S., and D. B. Franklin, 2006: Lightning kills – play it safe: NOAA's efforts to educate the public on the dangers of lightning, *19th International Lightning Detection Conference*, 24-25 Apr 06, 7 pp.
- Lopez, R. E., and R. L. Holle, 1998: Changes in the number of lightning deaths in the United States during the twentieth century, *Journal of Climate*, Vol. 11, No. 8, Aug 98, 2070-2077
- Lushine, J. B., W. P. Roeder, and R. J. Vavrek, 2005: Lightning safety for schools: An update, *14th Symposium on Education*, 9-13 Jan 05, 10 pp.
- Roeder, W. P., 2012a: A statistic model for the inter-annual and intra-annual fatalities from lightning in the U.S. and comparison to other storm phenomena, *International Lightning Meteorology Conference 2012*, 4-5 Apr 12, 6 pp.
- Roeder, W. P., R. L. Holle, M. A. Cooper, S. Hodanish, 2012: Lessons learned in communicating lightning safety effectively, *International Lightning Meteorology Conference 2012*, 4-5 Apr 12, 20 pp.
- Roeder, W. P., R. L. Holle, M. A. Cooper, and S. Hodanish, 2011: Communicating Lightning Safety Effectively, *4th Conference on Meteorological Applications of Lightning Data*, Paper 1.2, 19-22 Jan 11, 17 pp.
- U.S. Census, 2012: [www.census.gov](http://www.census.gov)