Florida lightning deaths and injuries 1998-2003 and mitigation strategies using lightning data.

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I. Introduction

The number of lightning related deaths and injuries from 1998 through 2003 in Florida are conveyed with detailed information on death and injury monthly and annual totals, and time, location, and demographics of victims. The first crack of thunder is a warning to seek shelter, but many reports indicated victims were struck by the first flash of lightning in a developing thunderstorm. This paper suggests a method to issue lightning alerts for impending lightning.

II. Lightning Deaths and Injuries

The base information was gathered from the National Climatic Data Center Storm Data and local newspapers. From 1998-2003, 48 people were killed and 276 were injured by lightning, averaging 8 deaths and 46 injuries per year. Males were struck more often than females - almost 80 percent of the time. Additionally, lightning killed males more than females with 42 male and only 6 female deaths. This makes males seven times more likely to die from lightning strikes.

A. When victims were struck

For the years studied, 2001 was fifty four percent higher than the average of those years (Fig.1), while 2003 was twenty five percent above the average yearly deaths. The spike in injuries in 2001 could be attributed to multiple injuries and deaths from single lightning strikes and increased thunderstorm activity during that year.

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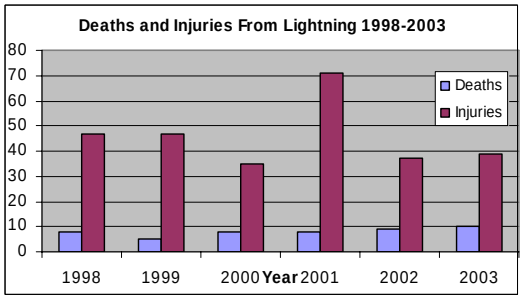

Fig.1. Deaths and injuries from lightning 1998-2003 by year.

Most victims were injured or killed during the summer months (Fig. 2). The greatest number of injuries occurred in June (90 injuries) with the second most in July (78 injuries). August was the peak month for the number of deaths (14 deaths) followed by June (13 deaths). No one was struck by lightning in the month of January and very few people were struck February through April and October through December.

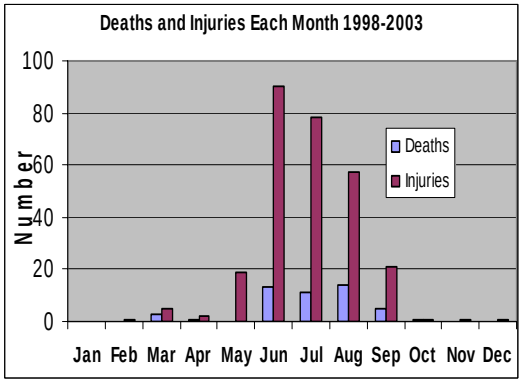

Fig. 2. Deaths and injuries from lightning 1998-2003 by month.

The most injuries and deaths occurred in mid afternoon (Fig. 3) with the peak (38 strike events) between 2-3 PM while 29 strike events occurred from 3-4 PM. Few lightning strike injuries and deaths occurred late at night and none occurred during early morning hours.

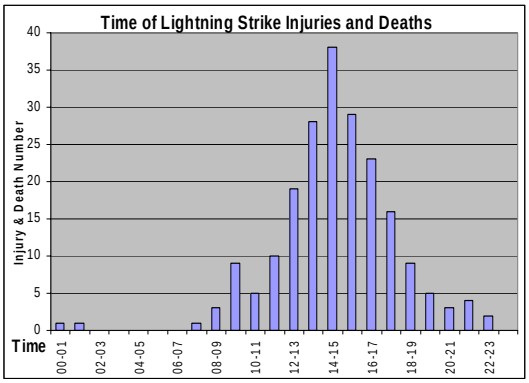

Fig. 3. Deaths and injuries from lightning 1998-2003 by hour.

Thursday is the day of the week with the greatest number of injuries (34 injuries), (Fig. 4), which may be attributed to workers outside.

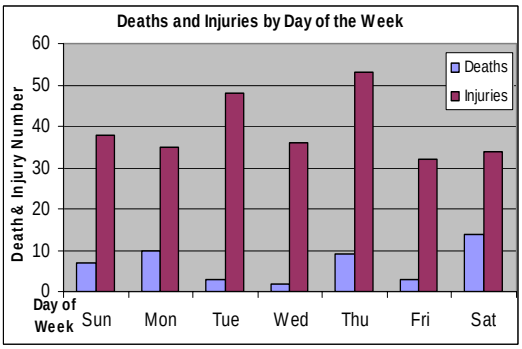

Fig. 4. Deaths and injuries from lightning 1998-2003 by day of the week.

Saturday has the largest number of deaths (14) during the time period from 1998-2003. Wednesday had the least amount of deaths from lightning (2) and Friday had the lowest amount of lightning injuries (32) during this time period. The greatest amount of people were affected by lightning on July 4, 2001 and 2002 as 12 people on these days both years were either killed or injured by lightning.

B. Where victims were struck

Climatologically, a lightning maximum exists over west-central Florida (Hodanish 1997). This maximum coincides with high population densities. Hillsborough County had the greatest number of total deaths and injuries and neighboring Pinellas County came in third with Broward County along the southeast coast in second. Pinellas County had the most injuries and Hillsborough the most deaths. The Tampa Bay WFO area had the most lightning victims during the 1998-2003 time period with 37.5% of the deaths and 39.5% of the injuries (Fig. 5). The Melbourne WFO area had the second highest number of injuries but the Miami WFO area experienced the second largest number of deaths in the state's WFO.

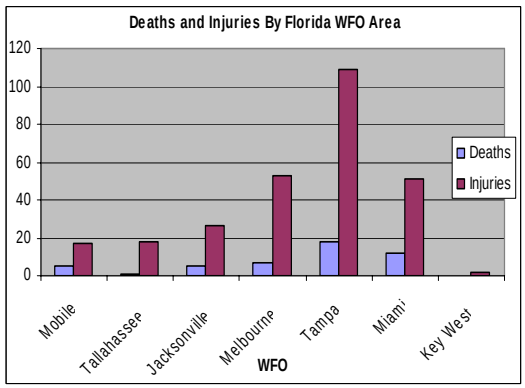

Fig. 5. Deaths and injuries from lightning 1998-2003 by NWS WFO area.

Despite numerous safety awareness programs informing people not to seek shelter under trees, many do not follow this advice. From 1998-2003, a quarter of the lightning victims were under trees or makeshift shelters (Fig. 6). Beaches and water locations account for 17% of people struck.

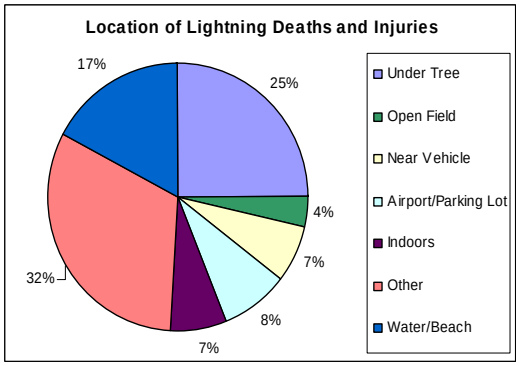

Fig. 6. Location of deaths and inuries.

In 2000, a 14-year-old male was killed by a lightning strike while standing on the beach behind his family's summer home in Jacksonville. People inside buildings accounted for 7% of the total. In 2001, a woman in Pinellas Park, FL was shocked when touching a metal door handle while lightning struck nearby outside. Outdoor areas are the most dangerous though. In 2003, a firefighter was struck by lightning just after putting out a fire at Tampa International Airport.

III. Lightning mitigation

To develop a strategy for short-term lightning alerts, a study of developing warm season convection over Florida using infrared (11 micron) cloud top temperature indicates a typical threshold of -40C to -45C for lightning initiation. The latest version of the National Weather Service Graphical Forecast Editor (GFE) includes input of satellite data. The satellite grid can be automatically scanned using a script to indicate potential lightning initiation locations. The GFE script, or "Smart Tool", sets an increasing lightning probability based on decreasing cloud top temperature. For example, a satellite grid temperature area of -50C is assigned a higher probability than an area with temperatures around -30C. One case study (Table 1) indicated some first strikes occurred well away from colder cloud top temperatures.

Figures 7 and 8 show an example of results from the lightning probability Smart Tool and IR satellite and lightning plot at 2015 UTC 12 Nov. 2004. Another example at 1745 UTC 12 Nov. 2004 is depicted in figures 9 and 10. Both examples indicate higher probabilities near the locations of lightning flashes but over forecast in areas down wind of the strongest convective elements.

Next, another script runs a GFE text formatter to compose a Short Term Forecast, or Nowcast, indicating lightning probabilities over counties that exceed a particular threshold. Given a particular probability, "call to action" statements included in the Nowcasts indicate lightning is possible. For lower probabilities, wording indicates that an occasional lightning strike is possible with stronger wording for higher probabilities. A standard phrase mentions that lightning can strike well away from the center of a thunderstorm in these Nowcasts.

The next developmental step for the automated lightning alert is the addition of radar data to the GFE database. The reflectivity data would serve to cross check to eliminate areas with cold cloud tops but weak convection. Further studies of thunderstorm activity will fine tune the probability scheme.

This new tool should be combined with a continuing public education campaign regarding the dangers of lightning to mitigate injury and loss of life.

Table 1. Time of first flash, cloud top temperature at flash location and coldest cloud top temperature within 20 km, on 31 July 2004.

Time of first flash (UTC.)	**Cloud top temperature at flash location.**	**Coldest cloud top temperature within 20 km.**
1610	-9.5	-34.5
1615	7.5	-41.0
1745	-3.5	-43
1820	-7.5	-52.0
1940	-1	-10.0
1950	10	-19.5
2050	-9.5	-24.5
2125	-1.5	-42.0
2130	-6	-42.0
2150	-2.5	-41.0

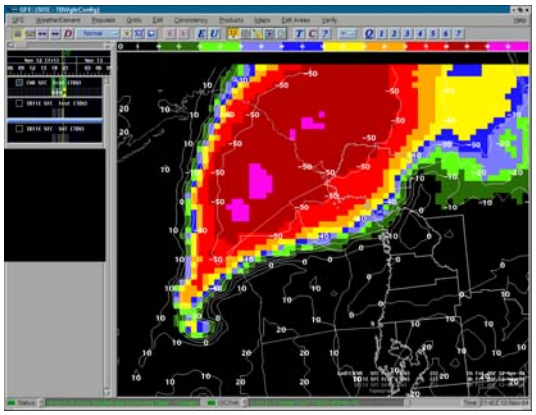

Fig. 7. Lightning probability 2015 UTC 12 Nov. 2004

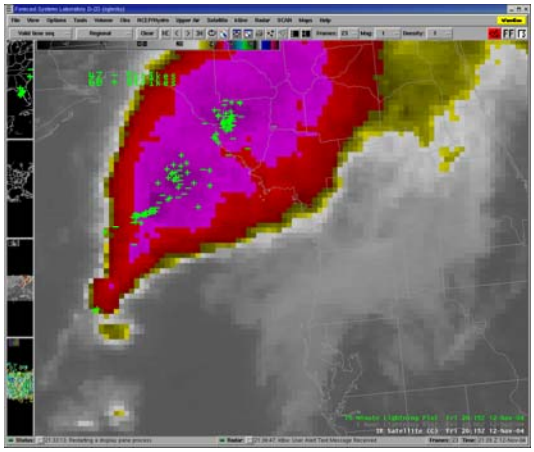

Fig.8. IR satellite and lightning plot 2015 UTC 12 Nov. 2004

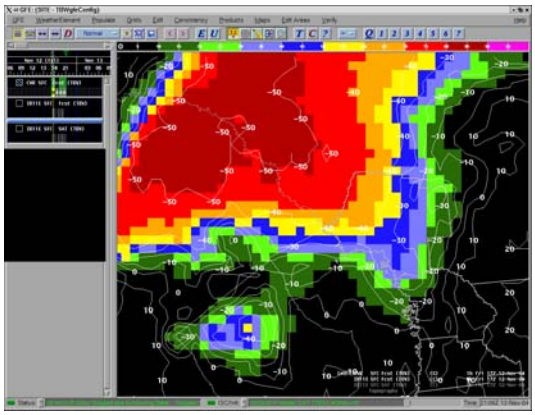

Fig. 9. Lightning probability 1745 UTC 12 Nov. 2004

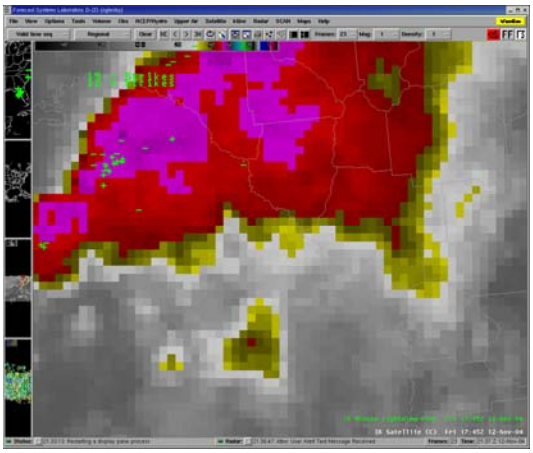

Fig. 10. IR satellite and lightning plot 1745 UTC 12 Nov. 2004

IV. Conclusion

Accounts of lightning deaths and injuries often indicate victims were struck well outside of rain areas, and often by the first flash of lightning. The year 2001 had a spike in the total number of injuries and deaths from lightning. As more people come to Florida with a lack of lightning education, these values have the potential to increase. Using the automated GFE scripts, cloud top temperatures are interrogated and a probabilistic Nowcast product is issued to alert Florida residents. Although lightning alerts may seem redundant, stressing lightning awareness and safety may save lives.

V. References

Hodanish, S., D. Sharp, W. Collins, and C. Paxton, 1997: A 10-yr Monthly Lightning Climatology of Florida: 1986-95. WAF, 12, 439-448.