1996

NF96-266 Lightning Safety

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Nebraska Cooperative Extension NF96-266

NebFact

Published by Cooperative Extension, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln

Lightning Safety

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Lightning is one of nature's most spectacular displays, but it is far from understood. Lightning is the most frequent weather threat to personal safety during the thunderstorm season. If people knew more about the dangers of lightning, practiced safety, and used common sense before, during, and after thunderstorms, lightning fatalities and injuries could be reduced.

Lightning-Related Deaths

As a safety threat, lightning receives less attention than other dangerous weather phenomenon such as hurricanes, tornadoes, and flash floods. Yet since 1940, lightning has been the leading cause of weather-related deaths (*Figure 1*). From 1940 to 1991, 8,316 people were killed by lightning in the United States, according to statistics from NOAA (National Oceanic and Atmospheric Administration). *Table I* lists lightning and other storm-related fatalities by decade.

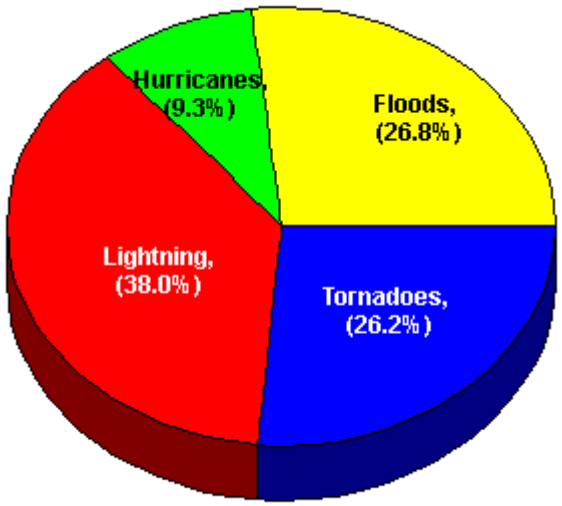

Figure 1. Weather-related deaths from 1940 to 1991 (National Weather Service, 1992)

Because other dangerous weather phenomenon such as tornadoes, hurricanes and flash floods often result in multiple fatalities and great destruction of property, they make headlines. Since lightning usually takes its victims one at a time, the threat of lightning is not given the attention, nor the respect, it deserves. In addition, injuries from lightning average more than 2.5 times the number of deaths from lightning, so the number of people affected by lightning every year is large.

Table I. Average annual severe weather fatalities by decade, 1940 to 1991 (National Weather Service, 1992).

Year	*Lightning*	*Tornado*	*Flood*	*Hurricane*
1940 - 1949	337	154	144	22
1950 - 1959	184	135	79	87
1960 - 1969	133	94	121	59
1970 - 1979	98	99	182	21
1980 - 1989	72	52	110	12
1990 - 1991	73	46	102	8
Total	8,316	5,731	5,828	2,031

Lightning

It is estimated that lightning strikes the ground approximately 100 times each second (8 million times a day). Lightning is divided into two general types: 1) cloud-to-ground lightning, and 2) within-cloud lightning. The United States has at least 100 million lightning flashes of both types every year. Data indicate that about 20 million cloud-to-ground lightning strikes occur annually in the United States.

Lightning occurs due to the separation of huge pools of electrical charges. Ice crystals at the top of the cloud accumulate positive charges; rain drops in the bottom half of the cloud consist mostly of negative charges; the ground below the cloud becomes positively charged. The separation in charges within the cloud is produced by rapidly rising air, called updrafts, interacting with precipitation moving downward within the cloud. The stronger the updrafts, the greater the electrical potential developed.

Lightning flashes when the attraction between positive and negative charges becomes strong enough to overcome the air's high resistance to electrical flow. The entire process takes less than a second, and this is how it happens. The lightning stroke originates from negatively charged "step leaders" at the base of a thunderstorm cloud (*Figure 2*). These step leaders surge downward 150 feet at a time, sometimes more horizontally than vertically, attempting to complete a channel to the ground.

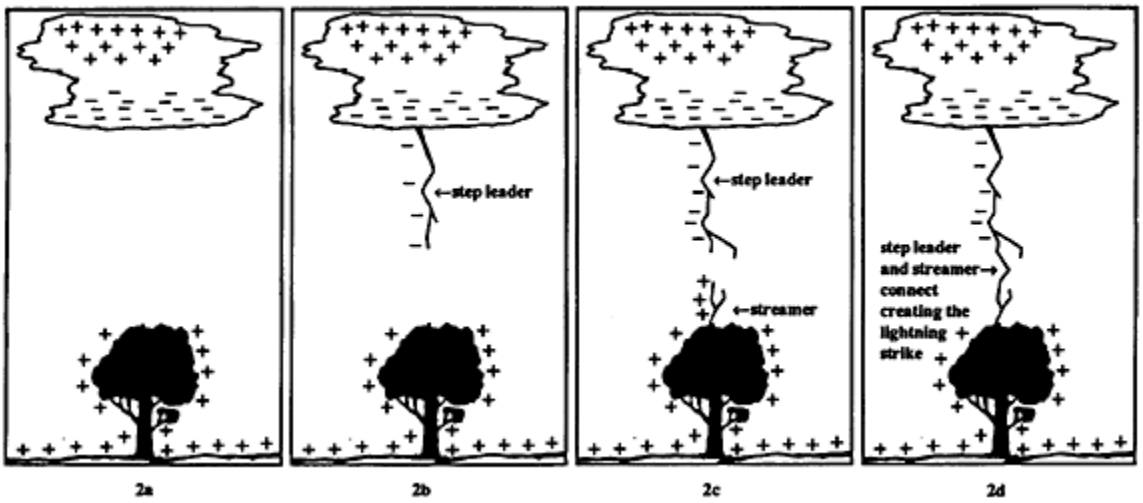

Figure 2. a) Electrical charges separate within the cloud; positive charges accumulate at the top of the cloud, negative charges at the base of the cloud. The negatively charged cloud base inducaes a positive charge at ground level. b) The negatively charged electrons hegin to descend in a zigzaging pattern. This is the "step leader." c) As the "step leader" nears the ground, it draws a positively charged "streamer" upward. This "streamer" is normally drawn from the tallest nearby object. d) As the "step leader" and "streamer" connect, a powerful electrical current begins flowing downward.

When the step leader is close to the ground, one or more positively charged "streamers" are pulled upward, usually from a tallest item in the vicinity (for example: trees, buildings, flag poles, golfers). The last surge of a step leader completes the electrical channel with the ground and the lightning stroke becomes visible. The light seen is the return stroke, an intense wave of positive charge that travels upward about 60,000 miles per hour. The process can repeat several times along the same path in less than half a second, making lightning appear to flicker.

Thunder

The distance between your location and a lightning strike can be easily determined using the "flash-to-bang" method. When you see the lightning ***flash***, count the seconds to the ***bang*** of thunder, then divide the number of seconds by five (sound travels one mile in five seconds) to give the distance in miles from you to the lightning. For example: you hear thunder 10 seconds after you see lightning, divide 10 by five to determine that the lightning strike was two miles from your location.

Thunder is produced when the air surrounding the lightning channel is instantaneously superheated to about 50,000°F (five times the temperature of the sun's surface). When air is heated this quickly it rapidly expands, creating the sound waves called thunder. When lightning strikes nearby, the sound may be a loud bang, crack or snap. The rumbling that follows is caused by the sound waves created from different heights along the channel. The sound reaches our ears at varying times and may last for several seconds.

On average, thunder can be heard up to 10 miles away (50 seconds from flash to bang). During heavy rain and wind, thunder cannot be heard from that distance. But in very quiet locations, especially at night, thunder can be heard farther than 10 miles.

Lightning and People

About 20 percent of people struck by lightning are killed. It is estimated that the chances of being a lightning casualty are one in 600,000. It is a myth that a person struck by lightning is "burned to a crisp." Lightning does not go through a person, rather it tends to flash around the outside of the body. This will often turn the rain water or perspiration on the victim's skin to steam that literally blows the clothing or footwear off their bodies.

Lightning fatalities usually are caused by cardiac arrest; the lightning causes the heart to stop. If CPR (cardiopulmonary resuscitation) is immediately administered to a lightning strike victim, the odds of resuscitating that person increase tremendously. (**Note to potential CPR providers:** There is no threat of electrocution through bodily contact with someone who has been struck by lightning).

Most people struck by lightning survive, mainly because they do not take a direct hit. A near-hit is called a "side-flash." In addition to sometimes being fatal, a side-flash can cause injury, blindness, or deafness. The side-flash hazard depends on many factors, especially the following: distance to the ground strike point, soil water content (which influences electrical conductivity – wet soil conducts better than dry soil), and strength of the electric field. Side-flash deaths are most common outdoors, but also can happen indoors through telephones, electrical appliances, and water pipes connected to sinks, showers, or baths.

Lightning Sensing Technology

Networks of electromagnetic sensors exist across the United States that chart cloud-to-ground lightning strikes. Such networks were developed for forest fire detection and utility company needs. Uses have expanded into such applications as refueling and baggage handling at airports, crowd management at golf tournaments, thunderstorm monitoring and forecasting by weather services, and understanding the lightning flash itself. A satellite-based lightning sensor is being developed to be launched before the year 2000. It will plot within-cloud as well as cloud-to-ground lightning over a much larger portion of the earth than ground-based networks.

Precautions to Take

Avoid dangerous lightning situations!

- Watch for signs of rapid thunderstorm growth.
- If thunderstorms are predicted to grow or move into your area, don't be caught where you can't take shelter on short notice.
- If it will take a while to reach shelter – more than a few minutes – give yourself time to reach the safe place before lightning is an immediate threat. Storms can grow from the small towering cumulus stage to a lightning producer in less than half an hour.
- Clouds don't have to be directly overhead for lightning to strike, it can arc out from the thunderstorm. Therefore, extreme caution should be practiced even after a thunderstorm has passed.

Don't be the tallest object!

- Stay away from trees, poles, and other isolated tall objects. Don't stand in an open area such as a crop field, ball field, golf course, or stadium.

- Don't touch anything that could conduct electricity. Stay off the telephone and out of the bathtub/shower (electricity can travel through wires and plumbing). Stay away from wire fences and water (these can transmit current from a distant lightning strike; swimmers, boaters, and fishermen are particularly at risk).

- Stay in your car or tractor cab. Cars and enclosed tractor cabs are excellent lightning shelters as long as you don't touch the metal frame. Lightning will flash around the vehicle; it is a myth that rubber tires have anything to do with the safety of a vehicle.

- Avoid operating agricultural equipment, especially tillage implements.

- Don't ride in open vehicles (such as ATVs, open tractors, etc.) or on horseback.

- If caught outdoors, don't lie flat on the ground. If you feel your hair stand on end, lightning may be about to strike; crouch on the balls of your feet with your head down (create as little surface area as possible).

Plan ahead!

- Designate a spotter who is watching for the threat of lightning. Decide on the rules for stopping whatever you and your group are doing; follow these rules to leave the dangerous area; and decide in advance where to take shelter when it is necessary.

- Go inside a sturdy building or in the enclosed cab of a vehicle that has a solid metal top. The building should be nonconducting (not metal). Do not be in contact with any metal on the building or vehicle.

- Watch for storms growing quickly before it's too late to take shelter.

- Follow your safety plan, regardless of the stage of the game, the hike, or the fishing.

- Use common sense before, during, and immediately after the strongest parts of thunderstorms. Even if no lightning has occurred, but conditions are favorable for lightning, take the proper precautions and practice these lightning safety rules. Pay much more attention to the lightning threat than to the rain.

- Keep in mind – the average distance from one flash to the next in the same storm may be two or three miles – 10 to 15 seconds flash-to-bang. Take shelter when you are farther away from the lightning than these distances. Do not wait until a flash is close to you. Use good judgement for yourself, your family, friends, students, and others around you.

Acknowledgments

This information was adapted from: Vavrek, J., R.L. Holle, and J. Allsopp. 1993. Flash to bang. *The Earth Scientist*. 10 (4):3-8.

File NF266 under: SAFETY
D-2, General
Issued May 1996

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Elbert C. Dickey, Director of Cooperative Extension, University of Nebraska, Institute of Agriculture and Natural Resources.