Contents

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Lightning

What is Lightning?

Lightning is typically a secondary hazard of thunderstorms and occurs with all thunderstorms Lightning is a very large spark of electrons which move quickly from one place to another. Electrons are the negatively charged parts of an atom. They rotate around the center of the atom, which is positively charged. An electron is much too small to be seen with the human eye. When lightning strikes, the electrons move through the air at such a high rate of speed that the air around them glows. The streak you see in the sky is the path of electrons through the air.

Physics Of Electricity

Lightning is basically a flow of electric current from areas with a lot of positive charges to places with a lot of negative charges. A lightning strike has several basic steps.

First, static electricity builds up within the thundercloud and causes the ground to become positively charged. Next, a small negatively charged stream of electrons move downward toward the positive electrons in the ground. When that stream nears the ground, a positive charge leaps up, making a connection. The positive charges continue to move upward, creating a brilliant flash.

This flash typically lasts a few tenths of a second, with lightning moving at speeds up to 100,000 miles per second.

Sources of Lightning

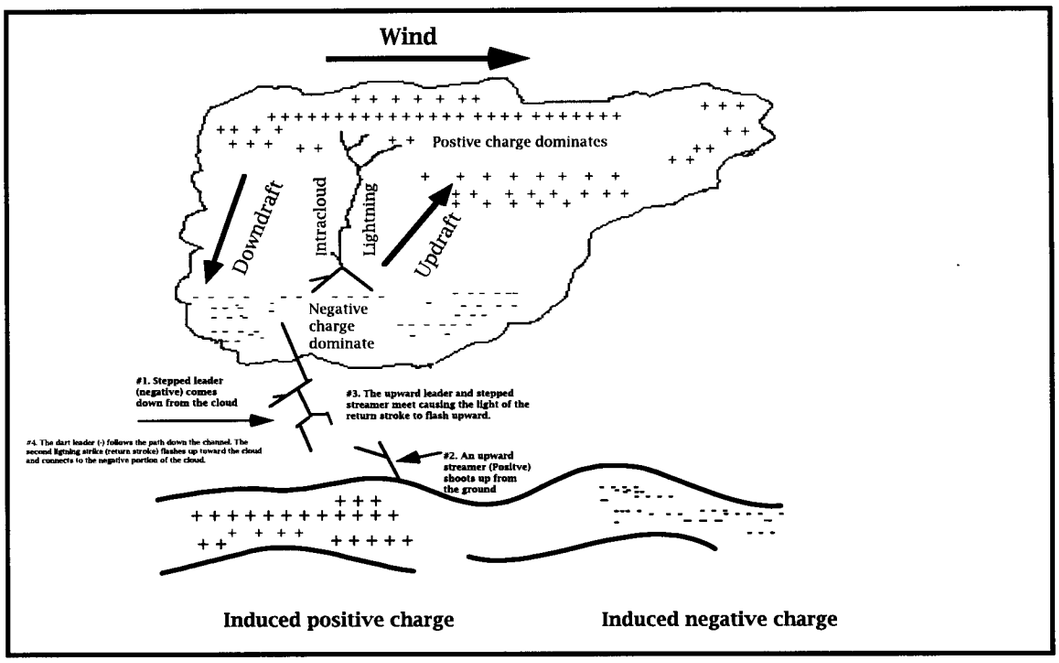
Thunderstorms are the most common sources of lightning. But there are other sources which include: rocket exhaust, violent tornadoes and erupting volcanoes. Lightning occurs during sandstorms, snowstorms and in ice clouds that are not thunderstorms.

Superheated Air...the Sound of Thunder

Thunder is a shock wave created by the heating of air by the heat of the lightning. The return stroke of lightning quickly leaves quite a bit of energy along the ***leader channel*** (vertical conveyor of energy) which heats the air. This heating takes only millionths of a second; the air in the channel rapidly expands, creating a pressure considerably greater than normal. This pressure quickly expands into the surrounding air, compresses it and moves outward in all directions. This creates a shock wave, a major disturbance in the air which travels faster than the speed of sound. These pressure changes create the sound that we call thunder. The audibility of thunder is 15

The Four Main Parts of Lightning

- Stepped leader
- Upward Streamers
- Return Strokes
- Dart Leaders



Schematic view of charge separation within a thundercloud and the induced charges on the earth. When the electrical energy is great enough, opposite charges will attract and connect to form lightning.

The complete event is called a flash. Each flash typically lasts a few tenths of a second. There are flashes within one cloud, cloud-to ground, cloud-to-air and cloud-to-cloud. Flashes within a cloud are more frequent than cloud -to-ground. In the US there are about 5 intracloud flashes for each cloud-to-ground.

Charging of the air (necessary for lighting) almost always occurs when any particulate matter is subjected to strong winds (friction). The negative region of charge is usually concentrated at the freezing level in the atmosphere. The closer the region is to the ground, the more likely that cloud-to-ground lightning will take place. A cloud-to-ground lightning strike begins as an invisible channel of electrically charged air moving from the cloud toward the ground, called a **stepped leader**. When the leader reaches the ground, or an upward charges **streamer**, the channel brightness moves from the bottom up, called the **return stroke**.

The visible stroke moves from near ground to cloud. The stepped leader moves in steps about 50 yards long, 50 millionths of a second expire in between steps. The negative charge lowers from the cloud downward at an average velocity of 75 miles/second. The luminous diameter of the stepped leader, as indicated in photos is between 1 and 10 yards wide. Most of the current is in the core, less than one inch in diameter. The strokes are typically 40 or 50 thousandths of a second apart.
Luminosity in the return stroke travels at up to 20-thousand to 60-thousand mile/sec.

Electrons at all points of the channel move down-**ALWAYS**-even though the region of high current and luminosity go up. Each flash usually involves three or four return strokes. This is because streamers move upward from the top of the previous return stroke, into higher areas of the negative charge region of the cloud. When the charge is available, a continuous rather than stepped leader moves down the channel, called a **dart leader**. The dart leader moves down the path set up by the channel for the subsequent stroke, each longer, from higher in the cloud- travelling at 1000 miles/sec. generally, the following strokes have less charge and less current. Dart leaders only come down the path after the continuing current steps. The stepped and dart leaders carry the charge into the channel.

How Much Energy?

There is a large amount of energy put out in a lightning bolt — 10,000 to 20,000 amps, occasionally ranging up to hundreds of thousands of amps. (A 100 watt light bulb uses about 1 amp)

The peak temperature of lightning is about 55,000° F, compared with the sun's surface temperature, which is approximately 11,000° F.

Statistics/Facts

- Lightning averages 93 deaths and 300 injuries each year.
- Several hundred million dollars damage annually to property and forests.
- Average flash could light a 100 watt bulb for three months.
- Your chance of being struck by lightning is 1 in 600,000 (chances are greatly reduced by following the safety guidelines.
- Most lightning accidents occur when people are caught outdoors.
- The air near the strike is heated to 50,000° F. - five times hotter than the sun.
- Many fires in Western US and AK are started by lightning.
- Florida has the most lightning strikes.
- The average vertical strike is 3-4 miles long.
- Professor Uman of UF has concluded the stroke to be about 1 inch wide.

What Should You Do if Caught In a

If you can hear thunder, you are close enough to be struck by lightning. Seek shelter! If you find yourself caught in a storm, the following actions may save your life:

- Find a low spot away from trees, fences and poles. Make sure the place you pick is not subject to flooding.
- If you are in the woods, take shelter under the shorter trees.
- If you feel you skin tingle or your hair stand on end, squat low to the ground on the balls on your feet. Place your hands on your knees with your head between them. Make yourself the smallest target possible and minimize contact with the ground.
- Do not go into a ravine, because underground water may provide a conduit for electricity underneath the ravine, which could reach you.
- Do not go under a rock overhang. You can be the conduit by which lightning crosses from the top of the overhang to the bottom.
- If you are boating or swimming, get to land and find shelter immediately!

<u>When indoors:</u>

- Do not shower or bathe

Do not use the telephone unless it's an emergency. Do not answer the telephone unless t is a portable, with no wires attaching the hand unit to the base.

- Unplug appliances

Activities

Make Your Own Lightning

Drag your feet across a carpet for a minute or two and build up a negative charge. Touch something metal like a door handle. As the negative charges move from your body to the positive charges on the metal, you will feel an electric charge or "lightning"

Static Electricity

Materials:
- Balloon
- Wall

Blow up a balloon and knot it. Rub the balloon across your hair for a few seconds and place the balloon on the wall. You will notice that static electricity has built up enough to keep your balloon in place on the wall. As the charge dissipates, the balloon will begin to fall.

Bottle Charge

Materials:
- plastic bottle
- carpeted area
- hanging plastic materials

1. Hang plastic materials from string on coat hanger

2. Charge up a plastic bottle by rubbing it quickly on a carpeted surface about 20 times. Don't squash the bottle.

3. Slowly move the charged bottle close to hanging plastic materials. Do they move towards the bottle? What happens after they touch the bottle?

Give a friend some static. Hold the bottle (charged) close to their skin. It is a hair-raising experience!!!
What happened and why? Opposites attract. As you rub the bottle over the carpet, it picks up a negative charge. The extra negative electrons in the bottle attract the positive charges in the hanging plastic material, dragging it close to the bottle...at least until you touch it again.

The Audibility of Thunder

To estimate the distance (in miles) between you and the lightning flash, count the seconds between the lighting and the thunder and divide by 5.

Words to know:

Stepped leader

Upward Streamers

Return Strokes

Dart Leaders

Electron

Discussion Questions:

1. *How does lightning form?*
2. *Must there be a thunderstorm for lightning to be present?*
3. *Where is a safe place to go when you see lightning? Where are some unsafe places?*
4. *How many amps are there in a bolt of lightning?*