CIVIL AIR PATROL – ARUNDEL COMPOSITE SQUADRON

July 2004	SAFETY	LIGHTNING

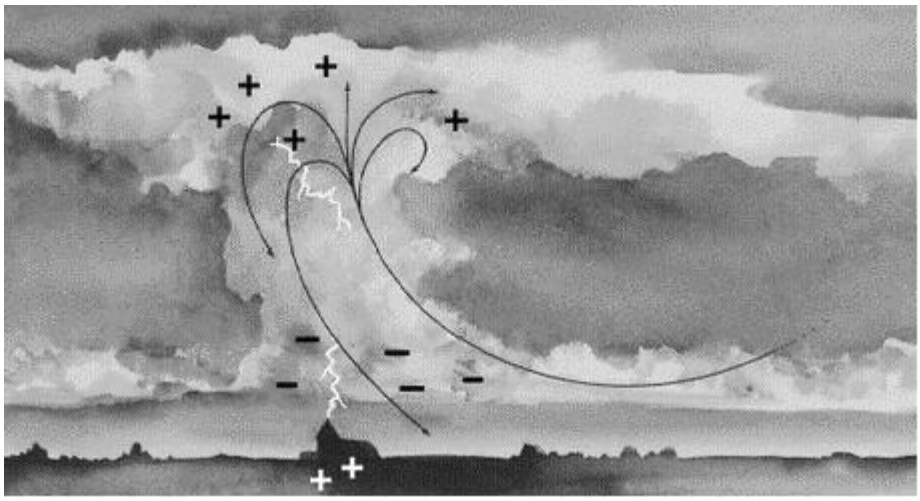
Thunder is good, thunder is impressive, but it is lightning that does the work – Mark Twain

Lightning storms are indeed frightening spectacles. With the arrival of summer thunderstorms, lightning is not far behind. It is an awesome display of nature's electrical forces. Lightning is a brief but very large current of negative charge, which travels from cloud to ground along a "wire" of air molecules that have been ionized or "ripped apart". Lightning frequently occurs with summer thunderstorms. Cumulonimbus clouds, which are large vertically developed clouds with strong updrafts, are typically associated with lightning. In order to understand lightning, one must have a basic knowledge of nature's water cycle, as well as how electric fields work.

Moisture accumulates in the atmosphere in what we see as clouds. Clouds contain millions and millions of tiny water droplets. Some of these tiny water droplets exist as ice particles suspended in air, at higher elevations. As warm, moist air rises in the atmosphere, the surrounding cooler air causes the water vapor to condense into tiny liquid water droplets. This condensation gives off heat, which warms the rising air further, allowing it to be more buoyant, and rise to even higher altitudes. This upward moving air is known as updraft. Some clouds can grow to heights in excess of 39,000 feet, releasing incredible amounts of energy through the condensation of water vapor within the cloud itself.

In an electrical storm, the storm clouds are charged like giant capacitors in the sky. The upper portion of the cloud is positive and the lower portion is negative. Exactly how the clouds acquire

these charges are still not agreed upon within the scientific community. One theory states that these are due to the collisions between the water vapor in the rising warm air, and the water droplets that formed through condensation. The importance of these collisions is that the electrons are knocked-off the rising moisture, thus creating a charge separation.



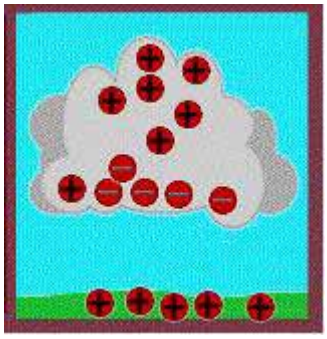
The newly knocked-off electrons gather at the lower portion of the cloud, giving it a negative charge. The rising moisture that has just lost electrons carries a positive charge to the top of the cloud. In addition to these collisions, freezing also plays an important role. As the rising moisture encounters colder temperatures in the upper cloud region and begins to freeze, the frozen portion becomes negatively charged, and the unfrozen droplets become positively charged. At this point, the rising air currents have the ability to remove the positively charged droplets from the ice, and carry them to the top of the cloud. The remaining frozen portion, which is negatively charged, then falls to the lower portion of the clouds.

As the electric field in the cloud becomes more intense, the electrons on the earth's surface are repelled deeper into the earth by the strong negative charge at the lower portion of the cloud. This repulsion of electrons causes the earth's surface to acquire a positive charge. All that is needed now is a conductive path for the negatively charged cloud to contact the positively charged earth surface.

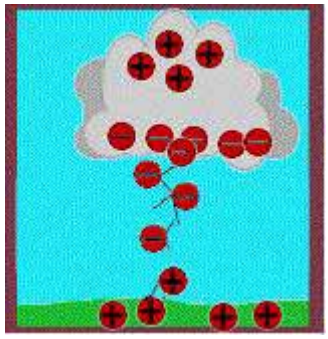
When the electric field becomes very strong (i.e. tens of thousands of volts per inch), conditions are ripe for the air to begin to break down. The electric field causes the surrounding air to be ionized. What this means is that the electrons and the positive ions in the air are now further apart than before. The electrons can now move more freely around the air molecule, with the end result of the air becoming more conductive. This ionized air is also known as plasma.

Once the ionization process begins and plasma forms, paths are starting to be created for the electrical current to flow. These paths are called step leaders. The step leaders propagate toward the

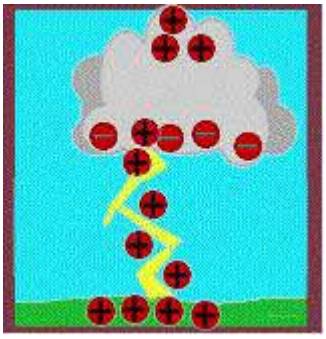
earth in stages, but not necessarily in a straight line. The air may not ionize equally in all directions. Dust or other impurities in the air may cause the air to break down more easily in one direction, giving a better chance that the step leader will reach the earth faster in that direction.



Electrically charged cloud and ground



Step leaders and positive streamers already began to form



Lightning

As the step leaders approach the earth, objects on the surface begin responding to the strong electric field. The objects reach out to the clouds by "growing" positive streamers. Just about anything on the surface of the earth has the potential to send out a positive streamer, including the human body. Once positive streamers are formed, they do not grow. It is the step leaders that eventually find their way to the positive streamers. After the step leader and the streamer meet, the ionized air (plasma) has completed its journey to the earth, leaving a conductive path from the cloud to the earth. With this path complete, current flows between the cloud and the earth. We see this current as lightning. This discharge of current is nature's way of trying to neutralize the electrical charge separation.

Any time there is an electrical current, there is also heat associated with the current. Since there is an enormous amount of current in a lightning strike, there is also an enormous amount of heat. The air around the lightning becomes so hot that it actually explodes. This explosion occurs because the air expands very rapidly. We hear this explosion as thunder. Thunder is actually a shockwave radiating away from the strike path. We see the lightning first, then hear the thunder afterwards. This is because the speed of light is much faster than the speed of sound. Light travels at a speed of about 186,000 miles per second, whereas sound travels at a speed of about 0.2 mile per second.

SAFETY in a LIGHTNING STORM

Over 1,000 people get struck by lightning every year in the United States, and over 100 of them die as a result of the strike. Lightning is something to take very seriously.

Outdoor Safety – If you are caught outside in a storm, always look for appropriate shelter. This would include a building or a car. If you are in water, such as the ocean or swimming pool, get out of it as fast as you can. Stay away from trees because they attract lightning. Avoid high ground and open spaces. Never lay down on the ground. After lightning strikes the ground, there is an electric potential that radiates outward from the point of contact. If your body is in this area, current can flow through you, potentially causing cardiac arrest, burns, and organ damage. If you cannot find shelter, then put your feet as close together as possible and crouch down with your head as low as possible, without touching the ground. The objective is to make yourself as small of a potential target as possible; position your body as low to the ground as possible; and minimize how much of your body is in contact with the ground.

Indoor Safety – If you are indoors, stay off the phone. If you must call someone, use a cordless phone or cell phone. Take off your headset. Stay away from water and plumbing pipes (bath tub, shower, sink, etc.). Stay away from doors and windows. Turn off and unplug appliances (TV, computer, power tools, etc.).

COMMON MISCONCEPTIONS

The following are some misconceptions about lightning:

1. **Ben Franklin was struck by lightning – No way! Ben Franklin was very lucky to survive his experiment. The spark he saw was a product of the kite/key being in a strong electric field. Had the kite/key actually been struck by lightning, Mr. Franklin would most likely have been killed.**
2. **Rubber tires keep you safe in a car because they do not conduct electricity – In strong electric fields, rubber tires actually become more conductive than insulating. The reason you are safe in a car is because the lightning will travel around the surface of the vehicle and then go to the ground.**

3. **The tallest object in a storm always get struck by lightning – Taller objects have a higher probability of a strike, but as discussed above with step leaders, lightning can strike the ground at a close distance to a tall object.**
4. **Surge protectors will save your electronics (TV, VCR, PC) if lightning strikes your power line – No way! Surge protectors provide protection for power surges in the line from the power company, but not from lightning. To really guard against lightning strike damage, you need a lightning arrester. The arrester uses a gas-filled gap that acts as an open circuit to low potentials, but becomes ionized and conducts at very high potentials. If the lightning hits the line you are protecting, the gap will conduct the current safely to ground.**
5. **Lightning rods "attract" lightning – Lightning rods do not attract lightning. Rather, they provide a low-resistance path to ground when lightning strikes occur. Lightning rods are tall metal rods, about 1 inch in diameter. They are placed on the roofs of buildings, and are connected to copper or aluminum conductive grids, which are buried in the ground nearby. When lightning strikes, they provide a low-resistance, safe path for the lightning (electric current) to go.**

GET MORE INFORMATION

References:

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