WHAT EVERYONE NEEDS TO KNOW ABOUT LIGHTNING

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Lightning is a gigantic electric spark in the atmosphere. Most lightning that people see takes place between a cloud and the ground. But lightning more often occurs within a cloud, between a cloud and the air, and between two clouds. The latter three types of lightning may damage aircraft in flight, but they usually do not cause harm on the ground. It is lightning striking the earth that can kill people and cause fire. Lightning occurs on the Earth about 100 times each second. Lightning heats the air explosively, creating the pressure wave that we hear as thunder.

A lightning flash from a cloud to the ground consists of one or more strokes. A stroke appears as a single brightening of a channel (path) between the cloud and the ground. Typical cloud-to-ground flashes are 5 to 7 kilometers long. Flashes in clouds may travel horizontally up to 10 kilometers or more. Roughly half of all lightning discharges to earth strike ground at more than one point with the spatial separation between the channel terminations being up to many kilometers.

Until the mid-1700's, lightning was a great mystery of nature. The ancient Greeks and Romans thought lightning was a weapon of the gods. Some African peoples believed individuals and places hit by lightning were cursed. For several centuries people in Europe and America naively thought that they could keep lightning away by ringing church bells, which caused the deaths of many of those pulling the ropes. Systematic studies of thunderstorm electricity can be traced back to May 10, 1752 in the village of Marly-la-Ville, near Paris, France. On that day, in the presence of a nearby storm, a retired French dragoon, acting on instructions from French scientist Thomas-Francois Dalibard, drew sparks from a tall iron rod that was insulated from ground by wine bottles.

The results of this experiment, proposed by Benjamin Franklin, provided the first direct proof that thunderclouds contain electricity. The Marly experiment was repeated thereafter in several countries including Italy, Germany, Russia, Holland, England, Sweden, and again France. Franklin himself drew sparks from the probably moist hemp string of a kite after the success at Marly, but before he knew about it. In addition to kites, balloons, mortars, and rockets were used to extend conducting strings into the electric field of the cloud. In all these experiments, the metallic rod (such as in the experiment at Marly) or the conducting string was polarized by the electric field of the cloud, so that charges of opposite polarities accumulated at the opposite ends of the conductor. As the gap between the bottom end of the conductor and ground was decreased, a spark discharge to ground occurred. The scale and effect of this spark discharge are orders of magnitude smaller than those of lightning. In designing his experiments, Franklin did not consider the possibility of a direct lightning strike to the rod or the kite. Such a strike would almost certainly have killed the experimenter. Thus all those who performed these experiments risked their lives.

Benjamin Franklin
Source: www.biography.com

Types of lightning

The most common source of lightning is the type of cloud known as a *cumulonimbus* or a *thundercloud.* Lightning can be classified in two ways: (1) by its origin and initial direction of propagation and (2) by the appearance of the flash.

Origin and direction of propagation. The most common type of lightning is *intracloud lightning,* which occurs within a cloud. Intracloud lightning neutralizes positive and negative charges that have built up in a thundercloud. Charges that flow from the cloud to the air create *cloud-to-air lightning.* A flow of charges between two clouds—a relatively rare event—produces *cloud-to-cloud lightning.*

Intra-cloud Lightning

Source:www. Australiasevereweather.com

Lightning between a cloud and the earth may be of either downward or upward type, depending on the direction in which the charges first flow. Downward lightning originates in the cloud, while upward lightning is initiated from tall objects on the ground. About 90% of cloud-to-ground lightning transport negative charge to ground, and 10% transfer positive charge. Occasionally, both positive and negative charges are consecutively transferred to ground by the same flash.

How lightning develops

Charges in a cloud. The development of all types of lightning requires a cloud becoming electrically charged. Most researchers believe that charging occurs when various forms of water and ice within the cloud collide with one another.

Tiny pieces of ice that are rising in updrafts within the cloud collide with heavier soft hail that is falling. Interactions between these particles in the presence of small water droplets facilitate mass and charge transfer between the particles. At relatively low temperatures (relatively high altitudes) the small ice crystals become positively charged and the heavier soft hail negatively charged. Separation of oppositely charged particles by distances of the order of kilometers is accomplished by action of updrafts and gravity.

The top of the cloud becomes positively charged, and the bottom becomes negatively charged. In addition, a small positively charged region can be created below the negative region.

Appearance. People have given names to various visual aspects of lightning: forked lightning; streak lightning; ribbon lightning; bead lightning, also called chain lightning; heat lightning; sheet lightning; and ball lightning. Forked lightning is a flash that has several visible branches. Streak lightning appears to illuminate a single jagged line. Ribbon lightning appears as parallel streaks of light. It occurs when wind separates the individual strokes of a flash. Bead or chain lightning is a flash that breaks up into a dotted line as it ends.

Forked Lightning

Source: http://cacarc.wordpress.com

Heat lightning, often seen on summer nights, seems to occur without thunder. Actually, it is lightning that occurs so far away from an observer that its accompanying thunder cannot be heard. Generally, the distance from the observer is beyond about 25 kilometers or so. But the people underneath heat lightning experience a normal thunderstorm. Sheet lightning appears as an illumination of part of the sky. The flashes that produce sheet lightning are either so far away that their characteristic shape cannot be seen, or the flashes are hidden by clouds.

Ribbon Lightning

Source: www.students.cis.uab.ed

Ball lightning usually occurs after a cloud-to-ground flash. It appears as a glowing, fiery ball that floats for several seconds before disappearing.

Lightning processes. Each negative downward flash typically contains 3 to 5 component strokes or just strokes, the observed range being 1 to 26. Time intervals between these strokes are typically of the order of tens of milliseconds and they explain why lightning often appears to the human eye to “flicker”. Each lightning stroke is composed of a downward-moving process, termed a leader, and an upward-moving process, termed a return stroke. The leader creates a conducting path between the cloud charge source and ground and distributes negative charge from the cloud source along this path, and the return stroke traverses that path moving from ground toward the cloud charge source and neutralizes the negative leader charge. Thus, both leader and return stroke processes serve to effectively transport negative charge from the cloud to ground.

Lightning strikes the Burj Dubai Tower

Source: http://www.guy-sports.com

The first-stroke leader appears optically to be an intermittent process, hence the term stepped leader, while the tip of a subsequent-stroke leader appears to move continuously. The continuously moving subsequent-stroke leader tip appears on time-resolved photographs as a downward-moving "dart", hence the term dart leader. The apparent difference between the two types of leaders is related to the fact that the stepped leader develops in virgin air, while the dart leader follows the "preconditioned" path of the preceding stroke or strokes. Both types of leaders produce bursts of x-ray emission with energies up to about 250 keV (twice the energy of a chest x-ray). The electric potential difference between a downward-moving stepped-leader tip and ground is probably some tens of millions of volts.

Triggered Lightning at the University of Florida's, International Centre for Lightning research and Testing

Source: http://www.lightning.ece.ufl.edu/

When the descending stepped leader attaches to the ground, the first return stroke begins. The first return-stroke current measured at ground is a pulse with a peak of about 30 kiloamperes (thousands of amperes). The return stroke effectively lowers to ground the charge originally deposited on the stepped-leader channel including all the branches, as well as any additional cloud charge that may enter the return-stroke channel.

The high-current return-stroke wave rapidly heats the channel to a peak temperature near or above 30,000 K and creates a channel pressure of 10 atm or more, resulting in channel expansion, intense optical radiation, and an outward propagating shock wave that eventually becomes the thunder (sound wave) we hear at a distance.

In the second stroke, once the bottom of the dart leader channel is connected to the ground, the second (or any subsequent) return-stroke wave is launched upward, which again serves to neutralize the leader charge. The subsequent return-stroke current at ground typically has a peak of 10 to 15 kiloamperes.

Each cloud-to-ground lightning flash involves energy of the order of 102 joules, which is approximately equal to the energy required to operate five 100-watt light bulbs continuously for one month.

Note that not all the lightning energy is delivered to the strike point, only 0.1 to 1% of the total energy.

Triggered lightning:

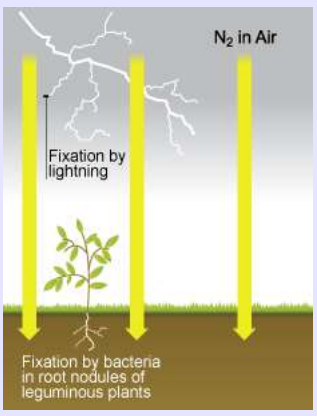
Lightning can be artificially initiated (triggered) launching a small rocket trailing a thin grounded wire toward a charged cloud overhead. To date, approximately 1,000 lightning flashes were triggered worldwide using this technique. The results of triggered-lightning experiments have provided considerable insight into natural lightning processes that would not have been possible from studies of natural lightning due to its random occurrence in space and time. Triggered lightning is a very useful tool to study the interaction of lightning with various objects and systems.

Extraterrestrial lightning:

Lightning occurrence is not limited to the Earth's atmosphere. There exists convincing evidence for lightning or lightning-like discharges on Jupiter and Saturn. Currents in Jovian lightning are expected to be 10 to 100 times larger than in Earth lightning.

ANY POSITIVES FROM LIGHTNING?

After a thunderstorm passes and it's safe to venture outside, take a deep breath. The air will smell very fresh and clean, with perhaps an earthy perfume caused by the release of oils from pine trees and other plants. Both rain and lightning help to clear the atmosphere of dust, pollens, and pollutants. A spark of lightning does this by combining those particles; the heavier mass is more apt to fall to the ground.



Lightning combines Nitrogen with Oxygen to give vital plant nutrients

Source: www.bbc.co.uk

Heat and pressure from lightning also turns nitrogen and other gases in the air into useful compounds such as nitrogen oxides (NO and NO2) and nitric acid (HNO3). These compounds act as a natural fertilizer to help plants make vital proteins.