stepped leader — The beginning of a lightning strike, when small streamers of sparks begin to zigzag downward in a forked pattern.

streamer — the upward flow of a positive charge from the ground.

thunder cloud — a storm cloud charged with electricity and producing lightning and thunder.

thunderstorm — created when a lower layer of warm air rises into a layer of cold air, resulting in a powerful updraft of warm, moist air and violent downdraft of rain and hail.

Things to think about

*Some scientists believe they have seen lightning flashes on other planets. What atmospheric conditions would need to exist on those planets for lightning to occur?

*Florida has been nicknamed the "Lightning Capital of the U.S." It receives three times more number of lightning strikes than anywhere else in the country; 10 percent of the people struck by lightning in the U.S. live in Florida. Why?

A Survivor's Story

There are people who have been hit by the single greatest natural force on the planet and survived, in fact this happens to some 150 people each year in the United States. Allan Gapske is one of them. He was playing a round of golf with two friends when it started to rain:

"It just so happened there was a shelter behind the green, so we ducked into there, and we were just sitting down there waiting for the rain to pass. It must have been maybe two minutes, when all of a sudden the whole place went up. It was just like a hand grenade going off. I went black after that. All I remember is standing up, and I was 15 feet fro m where I was before."

Gapske had been hit by an upward streamer of the lightning, which was drawn to the shelter by the tall trees surrounding it. The lightning must have entered him through the metal spikes in his shoes. Although the force of the lightning threw him 15 feet across the ground, he was lucky to be alive. His friend, Terry, standing near him in the shelter, was not so lucky. Terry took a direct hit, and the thunderbolt was so powerful that it set him on fire. The electric shock triggered a massive heart attack that killed him instantly. Since the lightning strike, Gapske has had pains in his legs, which also itch, and sometimes his heart accelerates for no apparent reason. Doctors can't explain the periods of accelerated heart rate, but they believe Gapske's leg pains may be from the lightning searing his nerves.

Internet Resources

http://www.usatoday.com/weather/tg/wstroke/wstroke.htm
Illustration of how lightning reaches the ground.
http://www.nssl.noaa.gov/edu/ltg/
General information and interesting facts on lightning.
http://www.azstarnet.com/~anubis/sabintro.htm
Agirl who was actually struck by lightning tells her story and goes into detail about lightning safety.
http://thunder.nsstc.nasa.gov/primer/
Adetailed site with a well-rounded look at lightning.
http://www.nofc.forestry.ca/~kanderso/ltgfaq.html
Frequently asked questions; for scientific minds.
http://science.nasa.gov/newhome/headlines/essd11jun99_1.htm
Lightning info from NASA's International Conference on Atmospheric Electricity.

OtherResources

For students:

Graf, Mike. *Lightning! and Thunderstorms.* Weather Channel Series, Simon and Schuster, 1998.
Heuer, Kenneth. *Thunder, Singing Sands, and Other Wonders: Sound in the Atmosphere.* Dodd, Mead, & Co., 1981.
Simon, Seymour. *Lightning.* William Morrow & Co., 1997.
Uman, Martin A . *All About Lightning.* Dover Publications, Inc., 1986.

For adults:

Fraidley, Warren. *Storm Chaser: In Pursuit of Untamed Skies.* Independent Publishers Group, 1996.
Mangold, Vernon L. *Life and Lightning: The Good Things of Lightning.* Upublish.com, 1999.
Watts, Alan. *The Weather Handbook.* Sheridan House, 1994.
Williams, Jack. *The Weather Book.* Vintage Books, 1997.

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EXTREME WEATHER

Although "you can't do anything about the weather," as the old saying goes, people are fascinated with it. Extreme climates, such as the frigid, desolate plains of Antarctica, attract adventurers who pit their stamina against the unrelentingly harsh environment. Armchair weather-watchers are curious about the oddities: the hottest place on Earth, the driest, the rainiest. Episodes of violent weather—tornadoes, hurricanes, blizzards, turbulent thunderstorms—remind us that much in the natural world is still outside of human control. This series explores many types of extreme weather, from inhospitable locations such as the completely arid Atacama Desert in northern Chile to killer storms that can destroy a town in minutes. It also discusses how meteorologists use increasingly sophisticated technology to track approaching storms and issue life-saving warnings before "nature takes its course."

LIGHTNING

Lightning is the single greatest natural force on the planet. Striking the ground 100 times every second, it has killed 8,000 Americans in the last 50 years and causes over $2 billion worth of damage each year. It is the second biggest weather killer in the U.S., with only floods claiming more lives. Lightning travels at 60,000 miles a second and hits the Earth at 55,000 degrees Fahrenheit, five times the temperature of the surface of the sun. Just one lightning strike contains 100,000,000 volts of electricity—and it only takes 120 volts to kill a human. Learn how this awesome power source is generated in the atmosphere. Watch a NASA fighter plane fly into a violent thunderstorm to learn exactly what happens when an aircraft is struck. And meet some of the lucky few who have been hit by lightning and survived.

Awesome Power

The awesome power and destructive force of lightning are generated by the heat of the sun and water in the atmosphere. The life of a thunderstorm starts when warm, moist air rises up from the hot ground, pushing into a layer of cold air high above; the moisture in the warm air condenses into cumulus clouds. As these grow larger, they turn into one giant thunder cloud, a cumulonimbus. Stretching up to 60,000 feet high, it scrapes the stratosphere, with the top of the cloud spreading out into an anvil shape.

The violent winds swirling inside collide drops of water and particles of ice into each other. These particles become electrically charged, separating into positive charges at the top of the cloud and negative at the bottom. Lightning begins when the negative charge starts zigzagging downward in a forked pattern.

This pattern is called a stepped leader. As it nears the earth, the leader draws a streamer of positive charge up from the ground. That streamer could come from a tree, a telephone pole, a building or a human being. As the leader and streamer meet, a powerful electrical current begins to form. This creates a ground strike, an intense wave of positive charge traveling upward at 60,000 miles per second. The process can repeat several times along the same path in less than a half a second, making the lightning flicker.

Ninety percent of lightning strikes remain within thunder clouds; only one in ten hits the ground. Even so, there are some 20 million ground strikes a year. The thunder you hear is the result of the air around the lightning being superheated, expanding so violently that it sounds like an explosion.

Alaboratory in Paris is at the leading edge of lightning conductor research, hoping to offer organizations like NASA invaluable information on how lightning behaves. Scientists at this laboratory can create lightning on demand, thanks to the biggest indoor generator in the world, over 200 feet high. Six million volts are built up in the generator and channeled along to the tip, the point of discharge. As impressive as this technology is, though, it would take a generator 20 times bigger to recreate the voltage of natural lightning.

With massive thunderstorms occurring every day, it is inevitable that lightning will cause major devastation. Yet lightning can be beneficial as well. In forests around the world, it triggers over 10,000 fires a year. These fires rejuvenate the forests by recycling minerals (which the trees have absorbed over centuries) into the ground as ash. Soil also benefits from lightning—the heat of lightning flashes produces 100,000,000 tons of hydrogen fertilizer worldwide each year.

Timeline

1752 — Benjamin Franklin flies a kite during a Pennsylvania thunderstorm to show that lightning is electrical. As lightning flashes, sparks jump from a key fastened to the bottom of a damp kite string. Franklin's hand is insulated by a silk ribbon attached to the string.

July 13, 1977 — Lightning hits a power transformer 50 miles north of New York City; the resulting short circuit shuts down the city for 20 hours. On a hot summer's night, 10 million people are without light or air conditioning. Streets are jammed as traffic lights go out, the subway system is closed down, trains are trapped between stations and people are stuck in skyscraper elevators. Shops are ransacked, and more than 700 looters are caught; looters also start some 600 fires.

1980s — NASA deliberately flies a fighter plane into the most violent thunderstorms; the goal is to have the plane be hit as many times as possible to find out exactly what happens when an aircraft is struck.

March 1991 — More than 15,000 lightning strikes result from a single, six-hour storm over Illinois, Iowa, Missouri and Wisconsin.

November 1994 — In Duranca, Egypt, lightning strikes a train carrying fuel oil, derailing it near an oil depot. This triggers a fireball that surges through the town, destroying everything in its path. Five hundred people die, and thousands are left homeless.

1995 — Scientists discover a new kind of lightning, which they name "elves." These short, bright bursts of lightning flash at the edge of space, high above the clouds. Each lasts for less than 1/1000th of a second. Other high-altitude kinds of lightening recently discovered are "jets" and "sprites." Both are fast-moving showers of light that burst upward from storm clouds. Jets are blue or green, sprites are red.

Lightning comes in dif ferent forms

There are four main kinds of lightning:

* ***Intracloud*** — occurs when lightning arcs between centers within the same cloud that have an opposite charge (that is, positive and negative). This is the most common kind of lightning
* ***Cloud-to-ground*** — the kind we are most familiar with, and the most dangerous kind.
* ***Intercloud*** — occurs when lightning leaps between two different clouds across a gap of clear air.
* ***Sprites & Elves*** — these are upward shooting halos of lightning above a cloud that produces a strong cloud to ground stroke.

Lightning can look different:

* ***Ball lightning*** — appears as a bright round spark, floating in the air.
* ***Colored lightning*** — appears to flash red or blue.
* ***Sheet lightning*** — seems to come in flat waves.
* ***Ribbon lightning*** — flashes like streamers in the sky.

Some safety tips:

* Get out of an open area. Statistically, the most dangerous place of all is a golf course.
* Stay away from things likely to be struck, such as a tall tree, an open area, a telephone pole, a wire fence.
* Get out of the water.
* If you start to tingle, crouch down and curl into a ball. But don't lie down, because an electrical charge can move along the ground.

Vocabulary

anvil — a shape taken by a thundercloud, with a narrow base and wide, flat top.

cumulonimbus cloud — a giant thunder cloud. This type of dense cloud develops vertically through all cloud levels; consisting of water droplets, ice crystals and sometimes hail, it is associated with thunder, lightning and heavy showers.

Faraday cage — a metal structure where the frame absorbs lightning and sends it safely to the ground; named after Michael Faraday (1791-1867), English scientist noted for his work in electricity and magnetism.

generator — a machine that changes mechanical energy into electrical energy.

ground stroke — a lightning strike that hits the ground.

negative charge — having an excess of electrons. (See also "positive charge.")

positive charge — having a deficiency of electrons. (See also "negative charge.")