Taking the sting out of storms

Lightning gets less publicity than hurricanes or tornadoes, but it exacts a higher toll in human lives than either of them. Research on ways to divest thunderstorms of their electric arsenal has brought encouraging results.

by Louise A. Purrett

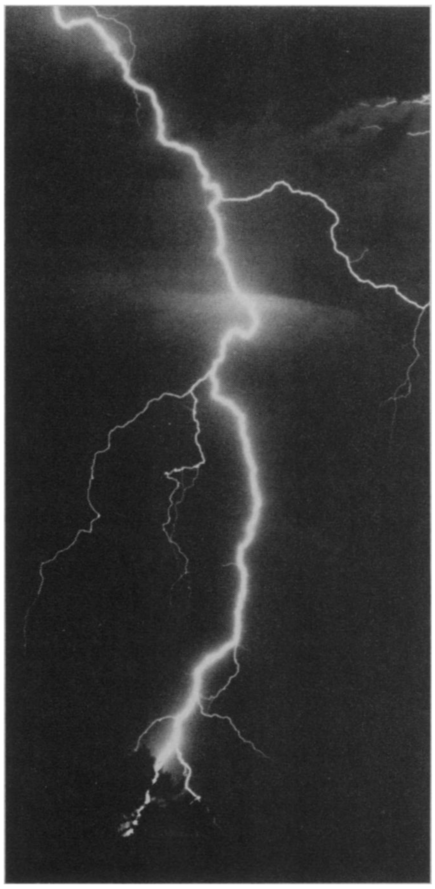
Getting zapped by a bolt of lightning is generally thought to be an unlikely occurrence. That is probably why, even in the days when lightning was believed to be an instrument of divine punishment, most sinners persisted in their perversity. But it is really not so rare for a person to be struck. Each year in the United States alone, lightning kills 600 persons and injures 1,500. In fact, the toll from lightning is higher than from tornadoes or hurricanes. Property loss caused by lightning amounts to more than $100 million a year.

Stimulated by this record of devastation, researchers from the National Oceanic and Atmospheric Administration and from the U.S. Forest Service are working on ways to reduce the hazards of lightning.

In July and August, Heinz Kasemir of NOAA's Atmospheric Physics and Chemistry Laboratory in Boulder, Colo., and five other NOAA scientists conducted a six-week lightning-modification experiment.

If an electrically conductive pointed object is introduced into a strong electrical field, such as a thunderstorm, it develops a positive and negative pole. Electrically charged particles, or ions, then escape from the pointed ends, positive ions from the positive end and negative ions from the negative end. The phenomenon is called corona discharge, and the resulting flow of ions is often seen as a faint glow on airplane wing tips and treetops. The result is to increase the electrical conductivity of the atmosphere, allowing the electrical charge in a storm to continuously bleed off instead of building up to the point where a discharge can occur.

In the normal course of events, says Kasemir, the electrical field of a storm builds up to a peak and then diminishes. The NOAA scientists dropped "chaff"—aluminized nylon fibers 10 centimeters long—into the electrical fields of storms and then measured the time it took the field to decay. They found that the electrical field decays faster when the cloud is seeded with chaff—about five times faster, in fact.



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Kasemir is encouraged by these results, which he is presenting at the December meeting of the American Geophysical Union in San Francisco. "They're not good enough for a statistical analysis, but if you're there and you see the field decay faster than ordinary, you are convinced. I am convinced it works."

The Forest Service's lightning modification program, directed by Donald M. Fuquay, has been going on for 25 years. The Forest Service has a very real interest in the problem: Lightning is the greatest single cause of forest fires in the western United States, igniting about 10,000 fires a year. Most forest fires are small and quickly suppressed, but even a small fire can indirectly harm the forest ecosystem.

Lightning is most likely to set off a forest fire when the timber is very dry, as at the end of a long period of hot, dry weather. So it was thought at first that the most logical method of attacking the problem would be to keep the trees moist by increasing rain or relative humidity.

Unfortunately, the hot, dry spells that make forests most flammable are marked by a complete absence of clouds, and without clouds, you can't make rain. But, if there are no seedable clouds, there are no thunderstorms and therefore no danger of lightning, right? Wrong, says Fuquay. The first storms to come at the end of a long drought are small marginal storms that produce small amounts of rain and lots of lightning.

The researchers turned, then, to the possibility of directly reducing the amount of lightning produced by a storm. How a thunderstorm becomes electrified is not yet completely understood, but basically what happens is that a storm cloud develops a positively charged area in its frozen upper layers and a negative charge in its lower levels. The ground is normally negatively charged with respect to the atmosphere, but as the negatively charged thunderstorm passes over, it induces a positive charge in the ground below. This positive charge follows the storm like a shadow, flowing up trees and high buildings in an effort to establish a flow of current between cloud and ground. When the difference between the positive and negative charges becomes great enough to overcome the insulating effects of the air, lightning occurs.

It has been observed that electrification in a cloud seems to be associated with the presence of rimed aggregates of ice crystals, supercooled water droplets and ice crystals all coexisting together. If there were fewer ice crystals or water droplets, there was less electrification. Thus, the researchers reasoned that if the cloud is seeded with silver iodide crystals the supercooled water would freeze around them, removing one of the three constituents necessary to electrification from the cloud system.

Though they would have preferred to learn more about lightning and thunderclouds before beginning actual experiments, the forest-fire problem was so urgent that Fuquay's group decided to carry out some cloud-seeding experiments and at the same time try to obtain a better understanding of the occurrence and characteristics of lightning storms and lightning fires.

The Forest Service researchers conducted a two-year pilot program and found that seeding did seem to reduce the occurrence of lightning. In 1965, they began in earnest with a three-year lightning modification experiment called Project Skyfire. The results were encouraging.

Seeded storms produced 66 percent fewer cloud-to-ground bolts, 52 percent fewer intracloud discharges, and 54 percent less total lightning than storms that were not seeded. The rate at which cloud-to-ground flashes occurred also was reduced. Over a five-minute period, the maximum rate averaged 8.8 flashes for unseeded storms and 5.0 for seeded storms. The average duration of discharges decreased from 235 milliseconds for unseeded storms to 182 milliseconds for seeded storms. Perhaps most encouraging, the average duration of continuing current in hybrid discharges decreased from 187 milliseconds to 115 milliseconds. It has been suggested that hybrid discharges, with their long-continuing currents, cause most forest-fire ignition.

The Forest Service is planning no more seeding experiments at present; it is now in the process of developing numerical models for the physical development of a storm and its electrical properties. But the Bureau of Land Management has been carrying out an operational lightning modification program in Alaska. The program is purely operational, with no attempt to develop theoretical bases for seeding. Alaska has a severe lightning fire problem. There are on-and-off droughts in the interior of the state and lightning is prevalent everywhere. Fuquay says his group is considering joining in the Alaska project with instrumented aircraft next summer. BLM is quite satisfied with the results of its operations, he says. "Whatever they're putting into it, they're getting their money's worth. We'll just try to put it on a more scientific basis."

Where will it all lead? Fuquay says the Forest Service won't try to prevent lightning from every storm. There is even a body of opinion that a certain amount of lightning and resulting fires are necessary for ecological balance. A problem occurs when an epidemic of forest fires occurs during a brief period. During one 10-day period in July 1940, for example, 1,488 lightning fires were reported in western Montana and northern Idaho. Such outbreaks overload the Forest Service's fire fighting personnel. "We look at it as trying to affect just those storms that lead to severe overload in the number of fires." □