What Would Happen if Lightning Were Eliminated?

by Martin A. Uman

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First, it is appropriate to point out that it may well have been lightning in the primordial soup covering the earth several billion years ago that produced the complex molecules from which life eventually evolved. Laboratory experiments have shown that electrical discharges in what is believed to be the constituents of the primordial atmosphere can create the necessary molecules. Thus, we may be indebted to lightning for the presence of life on earth.

Still, lightning is primarily troublesome rather than helpful, as the contents of this book attest, and except for some of the benefits mentioned in the previous chapter it might seem advantageous to eliminate it altogether. Exactly what would hap-

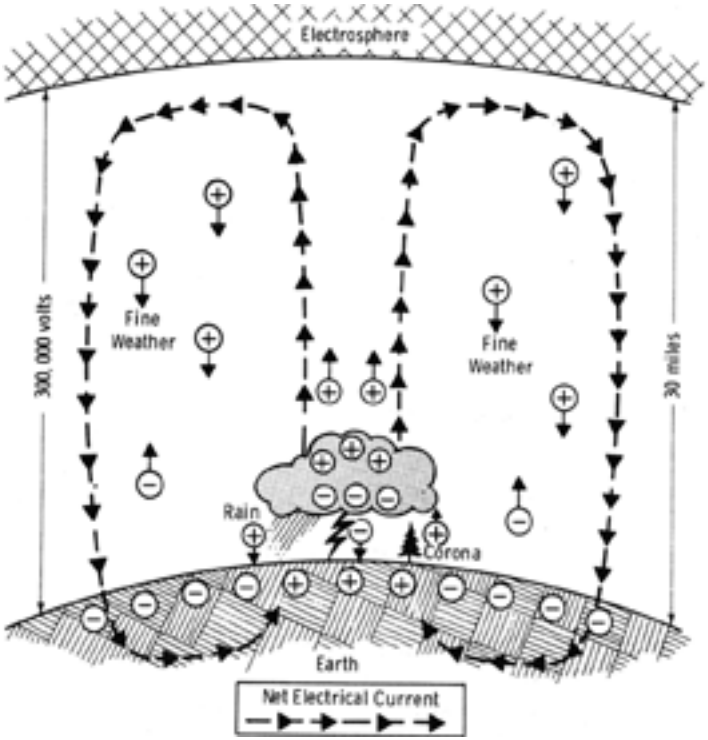

Figure 18.1: Thunderstorms act as batteries to keep the earth charged negatively and the atmosphere charged positively. Atmospheric electrical currents flow downward in fine weather and upward in thunderstorms. Thunderstorms deliver charge to the earth by lightning, rain, and corona discharges.

pen if lightning were eliminated is not known, but clearly the electrical balance of the atmosphere would have to change as we shall see in the following paragraphs. If and how the change in electrical balance would change the weather is not known. Prudence, however, would dictate extreme caution in tampering with lightning.

The electrical resistivity of the atmosphere decreases with height. From the point of view of atmospheric electricity, the resistivity is sufficiently low at an altitude of about 30 miles that the voltage does not vary much above that point. The region beginning at about 30 miles and extending upward is called the electrosphere. (The ionosphere, which reflects lightning

Figure 18.2: Lightning over Lake Chiem in Bavaria, Germany. (Courtesy, Agfa-Gavaert AG)

radio waves downward, begins, as noted in Chapter 17, at about 40 miles and is even a better conductor than the bottom of the electrosphere.) The voltage between the earth and the electrosphere in regions of fine weather is about 300,000 volts. To maintain this voltage the earth has a negative charge of about a million coulombs on its surface and an equal net positive charge is distributed throughout the atmosphere. Measurements have shown that the negative charge on the earth remains roughly constant with time. At first glance, this fact is difficult to understand since the charge on the earth is continuously leaking off into the conducting atmosphere. In fact, calculations show that, if the earth's charge were not being continuously re-supplied, the charge on the earth would disappear in less than an hour.

Figure 18.3: Lightning over the Arizona desert. (Courtesy, J. Rodney Hastings, University of Arizona)

The earth is recharged by thunderstorms. Fig. 18.1 shows how the electrical balance of the atmosphere is maintained. Thunderstorms deliver a net negative charge to the earth as a result of the sum of the effects of the following processes: (1) negative charge carried from cloud to earth by lightning, (2) positive charge carried from cloud to ground by rain, and (3) positive charge carried upward (the equivalent of negative charge carried downward) through the air beneath and above a thunderstorm, the source of the positive charge being corona discharge off grass, trees, and other objects with sharp points on the ground beneath the thunderstorms. The total current flowing beneath all thunderstorms in progress throughout the world at any given time is thought to be about 2,000 amps, and is in

Figure 18.4: A lightning flash exhibiting multiple ground points and the ribbon effect discussed in Chapter 16. (Courtesy, George Marcek, Catalina High School, Tuscon)

such a direction as to charge the earth negatively. An approximately equal and opposite current flows in regions of fine weather. The result is that the net negative charge on the earth and the equal and opposite net positive charge in the atmosphere remain approximately constant.

Finally, if all lightning were eliminated, we earthly viewers would be deprived of one of the most spectacular visual displays that Nature has to offer. In its variety and brilliance lightning puts man-made fireworks to shame, as evidenced by Figs.

Figure 18.5: Lightning initiated by an upward-moving leader from a tower on Mt. San Salvatore near Lugano, Switzerland. Photographs of other discharges to the tower are shown in Fig. 6.1a, b. (Courtesy, Richard E. Orville, State University of New York at Albany)

18.2 to 18.5. Watching lightning is fun; one of the aims of this book has been to make it more so. Many confirmed lightning watchers even enjoy listening to the variety of sounds that comprise thunder.

References

The details of and references to the bulk of the material found in this chapter are to be found in Atmospheric Electricity, J. A. Chalmers, 2nd Edition, Pergamon Press, New York, 1967, pp. 33-35, 292-308.

THE EVENT

PETRIFIED LIGHTNING FROM CENTRAL FLORIDA

A PROJECT BY ALLAN MCCOLLUM

CONTEMPORARY ART MUSEUM
UNIVERSITY OF SOUTH FLORIDA

MUSEUM OF SCIENCE AND INDUSTRY
TAMPA, FLORIDA