THE LIGHTNING PHENOMENON

As a thunderstorm builds, various mechanisms produce a stratified charge in the storm cloud, with a particular charge at the base of the storm cloud. Remember playing with magnets as a kid? Like charges repel and opposite charges attract. This charge on the base of the storm cloud induces a shadow of opposite charge on the surface of the earth beneath it.

As the storm cloud builds, the difference in potential between the cloud base charge and the ground charge increases, with the cloud base charge trying to pull the ground charge off the surface of the earth.

As the charged storm cloud travels across the earth, it drags the ground charge along beneath it. When the ground charge reaches a structure, the cloud base charge pulls it up onto the structure. If, before it moves away, the charge on the base of the storm cloud manages to concentrate sufficient ground charge potential on the structure to overcome the dielectric (resistance) of the intervening air, an arc (lightning strike) occurs.

The lightning strike begins with the formation of stepped leaders branching downward from the cloud charge. These stepped leaders propagate in jumps of about one hundred and fifty feet, working their way downward toward the ground charge. Stepped leaders are the tendril-like branches visible in a photograph of a lightning strike. We see a lightning strike in two dimensions, but it has depth too, so there are an entire field of stepped leaders.

When the stepped leaders reach to within five hundred feet or so of the ground, the attraction becomes so intense that objects and structures on the ground begin to break down electrically and respond by shooting off streamers of ground charge upward toward the stepped leaders. Whichever streamer reaches a stepped leader first “wins” the competition and completes the ionized channel that becomes the lightning strike. Occasionally, two or more will meet simultaneously, and forked or branched lightning will occur. The other streamers and stepped leaders simply never mature and dissipate.

Once the ionized path is completed, the lightning discharge occurs. Although a strike may appear to be a single flash, it is actually a series of flashes. The lightning discharge occurs for approximately one thousandth of a second, shuts off for approximately two hundredth of a second, on for one thousandth, off for a couple of hundredth, repeating the process multiple times. When the difference in potential between the cloud charge and ground charge is no longer sufficient to continue the discharge, the event ends.

This process describes negative cloud-to-ground lightning which constitutes the vast majority of strikes. For the purposes of this discussion, it is not critical whether the cloud base charge is positive or negative. It can vary and the entire process can occur in the opposite direction.