

THEORY OF THUNDERSTORMS.

DANIEL HULL, University of Notre Dame.

The fundamental principle involved in this theory is the following: A thunderstorm is impossible till the top of the cloud is frozen, which may be extended to: No actual rain or snowfall is possible till the top of the cloud is frozen.

Figure 1 shows successive stages of growth of a typical summer cloud observed near the horizon under favorable conditions of temperature and pressure for a rapid growth. Air sultry, barometer falling.

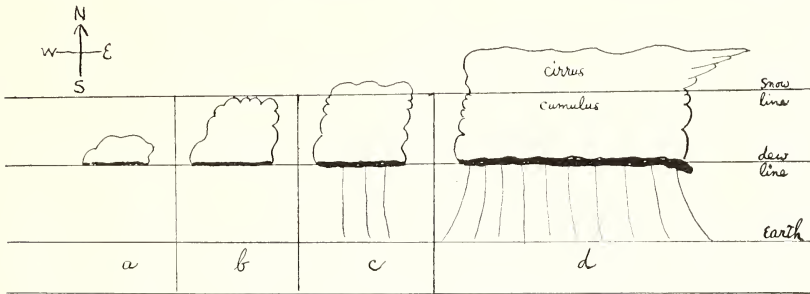


Fig. 1—Growth of a typical summer cloud: *a*, about 9:00 or 10:00 a.m.; *b*, cumulus, an hour or so later; *c*, nimbus, towards noon when its top has risen above the snowline and precipitation has commenced; *d*, early afternoon when thunderstorm has developed. Note that the nearer the cloud top to snow line, the sharper the curl and above the snow line this "curl" fades into cirrus.

At the dew line, the water vapor in the air condenses and becomes visible as fog (cloud) in a slowly rising air column. This cloud is made up of minute globules of water, each surrounding a tiny dust-speck as nucleus. This dust-speck, terrestrial rather than cosmic, is carrying a minute charge of static electricity acquired when leaving the earth's surface under the influence of wind.

Figure 1, *a* and *b*, shows this mass of water dust rising to the snow line. So long as this cloud remains below the snow line, there can be no precipitation, no electrical display, because the billions of water globules are carrying similar charges and all repelling one another. This gives rise to the curly top appearance of the cloud usually known as "thunder heads". But, let the rising air column carry this cloud top above the snow line (fig. 1, *c* and *d*), and, presto, these globules are instantly converted into myriads of pointed ice crystals, and their static charges are collected from point to point of these crystals and accumulated in the frozen top of the cloud till the potential difference between this total charge, so accumulated, and the earth may be sufficient to cause a neutralizing spark to pass from cloud top to earth (chain lightning).

If the cloud top is not rising fast enough, the intervening moist air between cloud top and earth may act as conductor for a silent (brush) discharge of electricity. This happens with light gentle rain or snow-fall, whereas the faster the cloud top is rising, the heavier the rain or hailfall and the more frequent and stronger are the "sparks" of lightning.

If the uprising air column in this cloud (nimbus) is rising faster, like the draft in a high chimney, the storm becomes more violent in precipitation, electrical display and air disturbance (wind). The extreme case giving rise to rotation about the up-draft. This type of thunderstorm is the dreaded tornado.

We see then, that, as long as the cloud is between dew line and snow line, nothing happens except a strikingly beautiful "cumulus" cloud—a bunch of water dust—a vast electrical condenser, carrying its charge on the surfaces of its myriad spheres and with no way to discharge this; but once above the snow line, the spheres become pointed crystals and their charges collect by streaming off the crystal points, leaving these crystals to freeze into small groups, called snowflakes, which presently have sufficient mass to fall, some below the snow line where they are coated with ice by coming in contact with the "water dust" of the cumulus part of the cloud. If, as frequently happens, this sleet is again carried in the uprushing air column in this nimbus, above the snow line, it becomes coated with ice crystals and heavy enough to again fall, possibly to earth, as a hailstone, or, as usually happens between dew line and earth, it melts and falls as a rain drop, growing as it falls through the humid air.

The interior of hailstones shows invariably a snowy white nucleus surrounded by concentric shells of clear ice alternating with a whiter snowy layer, each one of these bearing witness to a trip back above the snow line where the snowy layer was formed. Therefore, we conclude that the larger the hailstones so formed (not aggregated) the more severe the storm, because the stronger the uprising air column in this nimbus.

With rare exceptions, lightning in passing between cloud top and earth follows the belt of rainfall because these drops grow in falling and so acquire charges from smaller globules till overcharged, this overcharge helping the potential difference causing the spark.

At some future time, I should like to explain why this theory was developed by constant observation during 40 or more years in different parts of the United States, Canada and Mexico—apparently different conditions always giving rise to the same phenomena, always pointing invariably to the text of this article: A thunderstorm is possible only when the top of the cloud is frozen, and why.