

SUPERIOR MIRAGE OF LIGHTNING STREAKS

Unusual displays of lightning streaks extending several thousands feet into the cloudless air above the top of cumulonimbus clouds have been reported occasionally^{1,2}. A survey of these accounts reveals the following features—

1. The cumulonimbus cloud from which the flashes extended upwards was in a very active condition.

2. The cloud was frequently illuminated by the normal lightning flashes from inside or opposite sides, indicating that lightning activity was confined more to the opposite side of the cloud away from the observer.

3. The unusual flashes started from the top of the cumulonimbus cloud (but below the top of the anvil) and extended several thousands feet (3000 ft or more) above the anvil top into the clear sky. In these reports there was nothing to show that the flashes reached very high upto the ionosphere

4. The unusual flashes looked like a "series of streamers extending from a single point at the centre of the anvil and spreading out like a fountain" or like an uprooted tree in an inverted position with the roots spreading out at the top.

5. The cumulonimbus cloud responsible for the display, happened to be situated far away; in one case the lower part was below the horizon.

6. The unusual flashes were purple in colour.

In Fig. 1 an attempt has been made to give a rough picture of the phenomenon as reported by different observers.

For an explanation of the phenomenon let us consider what happens inside a cumulonimbus cloud in an active condition. It is well known that a region of well marked inversion exists in the upper layers of these clouds. Some actual values of deviations of temperatures inside a cumulonimbus cell as compared with the temperatures outside in the clear air are obtainable from the results of the U. S. Thunderstorm Project³. In ideal cases, for an active cell in the mature stage, the contrast in temperatures between the regions inside and outside was found to be practically negligible, upto 15,000 ft, but near 20,000 ft, the temperature inside the cloud was as much as 4°C higher than that of the environment.

Temperature inversions in the upper air have been known to give rise to the phenomenon known as "Superior Mirage". Humphreys⁴ has reproduced some illustrations showing images of a distant object appearing inverted over the object itself, as in Fig. 2. The unusual lightning streaks appear to be examples of similar phenomenon. Due to the presence of the inversion, the densities inside the cloud decrease in an irregular manner with the height, with the

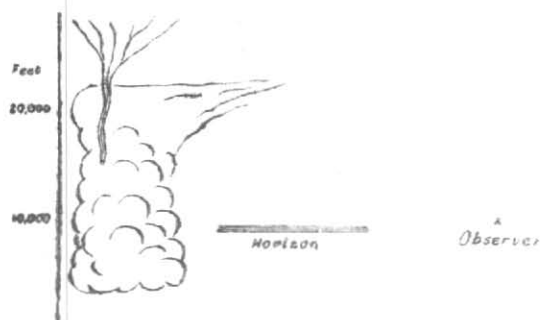


Fig. 1

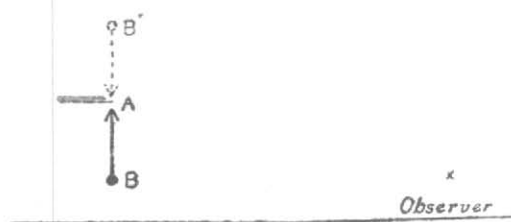


Fig. 2

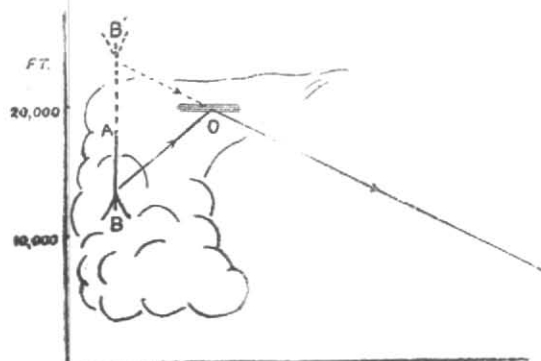


Fig. 3

result that a wave front from the object is distorted and its horizontal movement is so affected as to give the impression of an inverted image of the object above it. For details of this explanation on the basis of movement of light wave fronts, a reference may be made to Humphreys' book⁴.

But as the changes in temperature inside the cumulonimbus cell may be assumed to be fairly rapid, the following simple explanation will equally hold good. In Fig. 3 let AB be a normal lightning streak branching off towards the ground. It may not be directly visible being hidden by the trunk of the cloud, or by the horizon. Some of the rays of light like the one, BO , suffer total internal reflection somewhere near the layer where the temperature rises rapidly and when reach the eye creating the impression of an inverted image AB' . Sound waves are reflected from the ozone layer in a similar manner.

These unusual flashes appear purple in colour, because due to distance all the coloured components of white light are scattered and lost, except the red.

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