

THUNDER-STORM PROBLEMS IN ATMOSPHERIC ELECTRICITY¹

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Cumulus caps—Because of conflicting claims with reference to their connection with thunder-storms, special attention was given to the so-called cumulus "caps." "Cap" is used to mean one of those limited sheets of cloud which often appears right above a cumulus top, but which soon after is either pierced by the cumulus as it rises or gently falls upon the cumulus, or clings to it. While in the first stage, that is, while a small sheet, usually curved, directly above the cumulus, it is most properly called a cap.

During the spring and summer of 1931, there was a most unusual opportunity of studying these caps at Manila because of the protracted thunder-storm period. The types observed were very varied, but may be grouped under five types. (a) The first type is a sharply outlined layer, usually but not always curved, often reminding one forcibly of a white-penciled eyebrow; the layer may be very sharp, or wide like a ribbon, single or multiple, faint or densely white; cumuli have been seen with as many as four or five superimposed caps. (b) The second or misty type results when, during an active thunder-storm, the first type settles on top of the cumulus and thickens, as is often the case, to form a mist, generally brilliantly white; there may be included in this type also the bright white mist into which the existing thick stratus is changed by a rising cumulus. (c) The flocculus type, in which a continuous sheet is not formed, consists of little clouds like some forms of alto-cumulus. (d) The pennant type is really only a cap of the first or second type, wind-blown to one side. (e) The wispy or smoky type is formed at times if a cumulus top very slowly falls after just getting a cap; the top seems to be connected with the place of the former cap by smoke-like wisps or tendrils. There can be absolutely no question that caps can occur at other than cirrus heights, as this phenomenon has been observed at Manila times almost without number, especially when the air is much stratified.

It has been stated very positively and as positively denied that there can be no lightning unless the cumulo-nimbus has been "capped" at *cirrus* height. The writer has had no experience in investigating the thunder-storms outside of Manila, but with regard to thunder-storms at that place it can be stated that in all unambiguous cases no lightning has ever been observed until the cumulus has been capped at *cirrus* height. At Manila, no cumulus gave lightning if capped only at heights lower than cirrus. This statement must be taken carefully as it stands. Unambiguous cases are comparatively rare, since the following conditions must be fulfilled: (a) The cumulus must be watched practically from its infancy to be sure of observing the very first lightning or of hearing the

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