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On the observation of lightning in warm clouds

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Up to the latest time nearly all known observations were confirming the view that lightnings occur only in highly developed convective clouds in which glaciation has begun to be apparent. The investigations of clouds, conducted mostly in temperate regions, have not contradicted up to now generally accepted theories according to which the important role in the intensive process of clouds electrification is due to the changes of state of water associated with the forming of precipitation in thunderclouds (Mani *et al.* 1959, Mason 1961). With these views however disagree some further observations which have been made in recent years in tropical latitudes.

It is well known that heavy rain can fall from warm clouds, *i.e.*, clouds all parts of which have higher temperature than the freezing point of water. In spite of that, no phenomenon of lightning (which evidences intensive processes of electrification) had been known in such clouds, save some cases reported by pilots flying in tropical regions, whose accounts were questioned by some writers (Appleman 1957, Foster 1950).

In last years some publications gave results of certain investigations of electric phenomena in warm clouds. The data were obtained by the aid of airships and radar or by measurements and visual observation from the earth's surface, and so far the observation of lightnings were scanty. For this reason attention should be called to any reliable report of such phenomenon in warm clouds no matter what was the kind of observation. In the following a simple observation will be described that took place at the geophysical station Cha-Pa [$\varphi = 22^\circ\ 21'$N, $\lambda = 103^\circ 50'$E, h = 1570 m] in Northern Vietnam (Michnowski 1960).

On 29 June 1959, a few minutes before sunset, one could see single small clouds *Cu*. Only one big orographic cloud was visible on the ridge of Mts Phan Si Pan, being situated to the south of the station and the locality of Cha-Pa. Looking from the hill on which the station was located in the direction SW, *i.e.*, above the valley of river Múóng-Han-Hô, I noticed one interesting cloud. My attention was called by its height and by its shape. The cloud resembled two cones that penetrated each other with their peaks. Just before the sunset the bases of the upper and lower parts appeared about equal and had about the same lengths as the distance between them. At the top of the cloud no glaciation was observed, but instead some distinct shapes characteristic of *Cu* clouds. The top was rising slowly and was well visible on the right side of the ridge of the slope that was seen behind the mountain situated to the east of the locality Cha-Pa. The cloud was above the valley of the river, and in its slow movement to the left it gradually covered distant mountains at the background.

At an instance during the twilight which had just started I noticed distinctly the lightning flash whose trajectory passed from the left side of the top of the cloud to the right region of its base. The thunder was scarcely

TABLE 1

Height of Isotherm 0°C at Cha-Pa during 7^h of local time in June 1958

Day	Pressure	Height	Remarks
1	565	4,89	
2	554	5,05	
3	515	5,63	
4	515	5,63	
5	515	5,63	
6	515	5,63	
7	550	5,10	
8	560	4,95	
9	535	5,30	
10	517	5,37	
11	534	5,35	
12	539	5,25	
13	485	6,10	Max.
14	555	4,95	
15	540	5,23	
16	523	5,50	
17	535	5,27	
18	531	5,33	
19	528	5,41	
20	568	4,80	Min.
21	515	5,59	
22	525	5,45	
23	530	5,40	
24	524	5,50	
25	529	5,40	
26	546	5,15	
27	522	5,47	
28	510	5,70	
29	520	5,52	
30	528	5,45	

heard—except for some subsided murmuring. It was possible to estimate (with the aid of a sufficiently accurate topographical map) the angle, at which the top of the cloud was seen and the distance to the cloud. Taking greatest values of angle and distance in time of lightning, the height of the top of the cloud was estimated at about 2500 m above sea level.

After about 3 minutes had elapsed, another distinct lightning was observed, similar to the preceding one as far as its trajectory is concerned, but weaker than the first. Now the cloud started to divide itself gradually in two parts, upper and lower, looking like reversed cones. During the time of the observation the maximum height of the cloud's top could be 3200 m. The height of the base was not estimated. It was, however, known that in the region of the cloud's appearance the bottom of the valley was about 800 m high.

The measurements of potential gradient and point discharge current, that were registered in the station, did not show any changes which could be ascribed to the observed cloud. The sensitivity range of the instruments as well as the recording system were not sufficient to notice changes due to the observed distant cloud.

On the day of observation no aerological measurements were made at the station. On the basis of previous measurements made during I.G.Y., the estimated minimum of probable values of height of isotherm 0°C could have been on that evening about 4000 m. The measurements and observations made previously were often showing the inversions which could be responsible for the shape and development of the observed cloud.

The lightning phenomena in warm clouds, even if noted rarely give evidence of the possibility of intense electrification of such clouds without participation of the solid state of water. Electrification of this kind is more likely to occur in tropical regions, where the height of isotherm 0°C is higher

than in temperate latitudes and where clouds with vigorous convection can reach sufficiently great size for the occurrence of lightning before they extend above the freezing level (Moore *et al.* 1960).

Thus one may conjecture that the phenomenon of intense electrification noticed in warm clouds may appear also in those parts of vertically developed (above the freezing point) clouds, which are deep enough below the level of this point.

To explain electric processes in warm clouds, it is necessary to continue further observations and investigations in different regions. Further evidence may contribute to the revision or adjustment of present theories (Mason and Latham 1961, Sartor 1961, Vonnegut and Moore 1958) of electrification of clouds and to the deepening of our knowledge on the relationship between precipitation and electrical processes in thunderclouds.

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