

PRELIMINARY OBSERVATION OF THE LIGHTNING CHANNEL IN THE THUNDERCLOUD

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For a long time, the study of the cloud discharge has been thought to be more difficult than that of ground discharge, because of the invisible lightning channel in the cloud. Recently, the observation of VHF radiation from the lightning became rather easy to make as the progress in electronics. Since the wave length at such a frequency is very short compared with the channel length, the lightning channel may be thought to be equivalent with a series connection of small antennas, so we can investigate details of the channel structure hidden in the cloud by using a VHF receiver. We have tried to make such an observation in the summer 1969 at Imaichi near to Nikko.

Yagi antenna with seven elements, whose half power angular width is about 40° , was installed on top of a vertical pole. Such three antenna systems were each connected to three VHF receivers tuned to 86 MHz. All antennas were set in the same azimuth, and adjusted so as to get vertical polarization. The elevation angles of the antennas were set at 0° , 40° and 80° respectively. The detected outputs from the receivers were fed into the respective three ink-writing-recorder, so that we can get the relative intensity at each elevation angle of the VHF's radiating from a lightning. Depending on the distance from the station to thunderstorm, adequate two of the three outputs were selected and fed into double beam synchroscope. Single sweep of the duration between 100 and 200 ms, was triggered by the output from a receiver. The display on the synchroscope was photographed with a Polaroid camera to know the details of the radiations.

In the summer 1969, we had only one occasion where we succeeded in the storm observation, which gave us some useful results for the discussion. During the observation we could not detect any ground discharge with our eyes, even though on an intermittent and imperfect watch basis, therefore we shall not have any erroneous result even if we take all the recorded lightning to be cloud discharge.

The phase of the storm in discussion here can be divided into three portions in accordance with distances between station and storm. The observational results are shown in Table 1.

Assuming that the channel type did not change at all throughout the period of the storm, we may explain the results give in Table 1 as follows.

Station-to-storm distance (km)	No. of lightnings recorded	Relative VHF intensity with respect to elevation angle of the antenna		
		0°	40°	80°
about 20	8	I	W	W
5-10	7	I	I	W
3-6	5	I	I	I

Table 1. The observational result of the storm on July, 23, 1969 at Imaichi
I means intensive and W weak

1) We can not explain the results obtained in the region of horizontal distance from 3 to 6 km as an effect of cloud discharge of horizontal channel, because the cloud discharge of horizontal channel occurred in such a distance can not make nearly same VHF field intensity to the three antennas.

2) If the discharge channels are vertical, the channel that appear in the horizontal distance from 3 to 6 km must reach an altitude over 12 km, which is likely too high in comparison with the experimental evidence implied in the first row of Table 1. Namely the height of the lightning channel appeared in the distance about 20 km from the station must be estimated to be less than about 7 km, as shown in Fig. 1 which is a reasonable explanation in the vertical plane of the content implied in Table 1. The above reasoning likely leads us to the conclusion that the principal structure of the discharges observed is not of vertical channel.

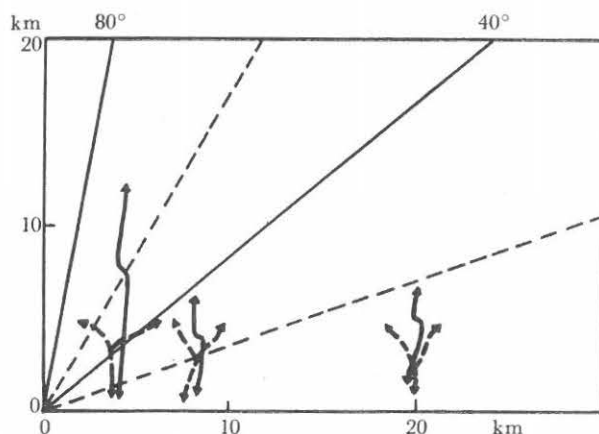


Fig. 1. The two models of the discharge channels in the cloud. Full lines show vertical channels and dotted lines tree-like structure.

3) If we adopt a tree-like model of the cloud discharge shown in Fig. 1, we can easily explain all results. The height of such a discharge will be less than about 5 km.

As for the details of radiation mechanism, what we can say at present is limit as following. We could not find any distinctive difference within the twin record on the double beam synchroscope, so that we could not detect a progressive nature of the lightning streamer. See Fig. 2 as an example.

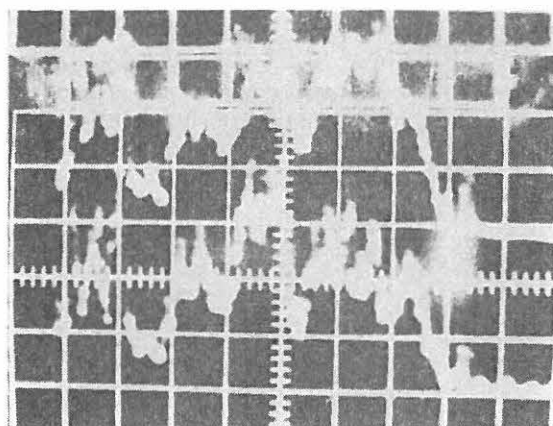


Fig. 2. A record on the double beam synchroscope as an example. The upper part corresponds to 80° elevation of the antenna and lower to 0° . The distance between station and lightning is about 3 km and the sweep duration is 200 ms.

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