

## SHORT NOTE

### ON CLOUD-TO-SEA DISCHARGES

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To find out the general characteristics of lightning discharges under different conditions, the author and his colleagues have observed the discharges not only in summer but also in winter in Japan (Takeuti, Nakano, Nagatani, and Nakada, 1973; Takeuti and Nakano, 1974), in the tropics (Takeuti, Nakano, and Nagatani, 1975), and on the ocean (Takeuti and Nagatani, 1974). As a part of this series of work, the cloud-to-sea discharges have been observed by a video camera and a field meter with a slow antenna, the frequency response of which is limited up to about 500 Hz, on board of the research vessel Ryofu-Maru during the period of June through July in 1975 at the Solomon Sea between New Britain and Bougainville Island, east of New Guinea.

Although the electrical characteristics of the point struck by the lightning discharge on the sea has never been reported by anyone, the characteristics is supposed to be very different from that on the ground. Any difference between the electrical characteristics of the strike points on the sea and those on the ground might cause different nature in discharges. For example, the frequency distribution of multiplicities of return strokes for the cloud-to-metal tower discharges measured at Monte San Salvatore in Switzerland (Berger, 1972) is not the same as that for the cloud-to-ground discharges measured at Maebashi in Japan (Takeuti, 1965), as shown in Fig.1. The point of this paper is as to whether some difference exist or not between the cloud-to-sea discharge and the cloud-to-ground one.

1. Multiplicities of return strokes: The frequency distribution of multiplicities of return strokes for the cloud-to-sea discharges is similar to that for the cloud-to-ground ones measured at Maebashi as shown in Fig.1.

2. Time intervals between return strokes: Takeuti et al. found that distributions of time intervals between adjacent return strokes have a systematic difference from each other between the temperate zone and the tropics (Takeuti, Nakano, and Nagatani, 1975). As shown in Fig.2, the distribution for cloud-to-sea discharges measured at the Solomon Sea in the tropics is similar to that for cloud-to-ground discharges measured at Guam and Cebu, both located also in the tropics.

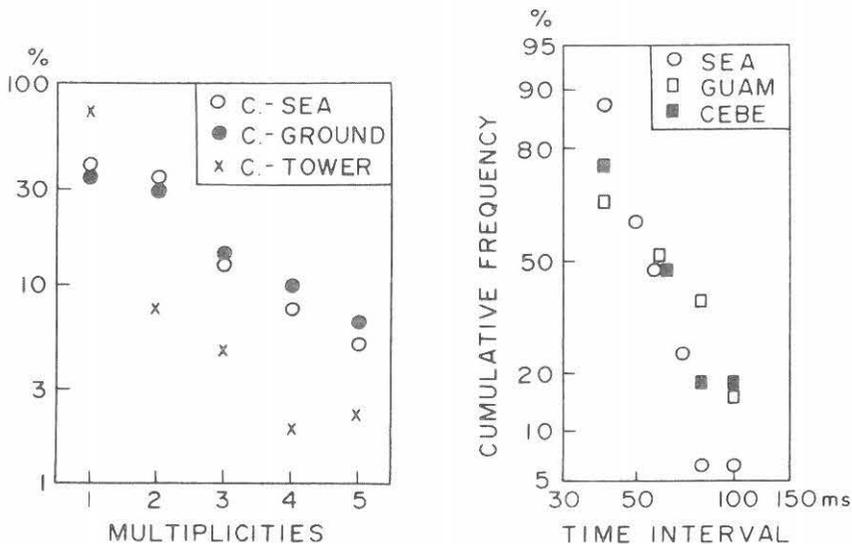


Fig.1. Multiplicities of return strokes in lightning discharges. The cloud-to-sea discharges (open circles), the cloud to ground ones (solid circles), the cloud to metal tower ones (crosses) (after Berger, 1972).

Fig.2. Log-normal distribution of the time intervals between return strokes measured at the Solomon Sea (open circles), Guam (open squares), and Cebu in the Philippine Islands (solid squares).

3. Polarity of discharges: It has been found from the records of field changes of 39 cloud-to-sea discharges that all discharges neutralized negative charges in thunderclouds, which is also true for usual cloud-to-ground discharges.

4. The first leader strokes: Three first leader strokes were recorded

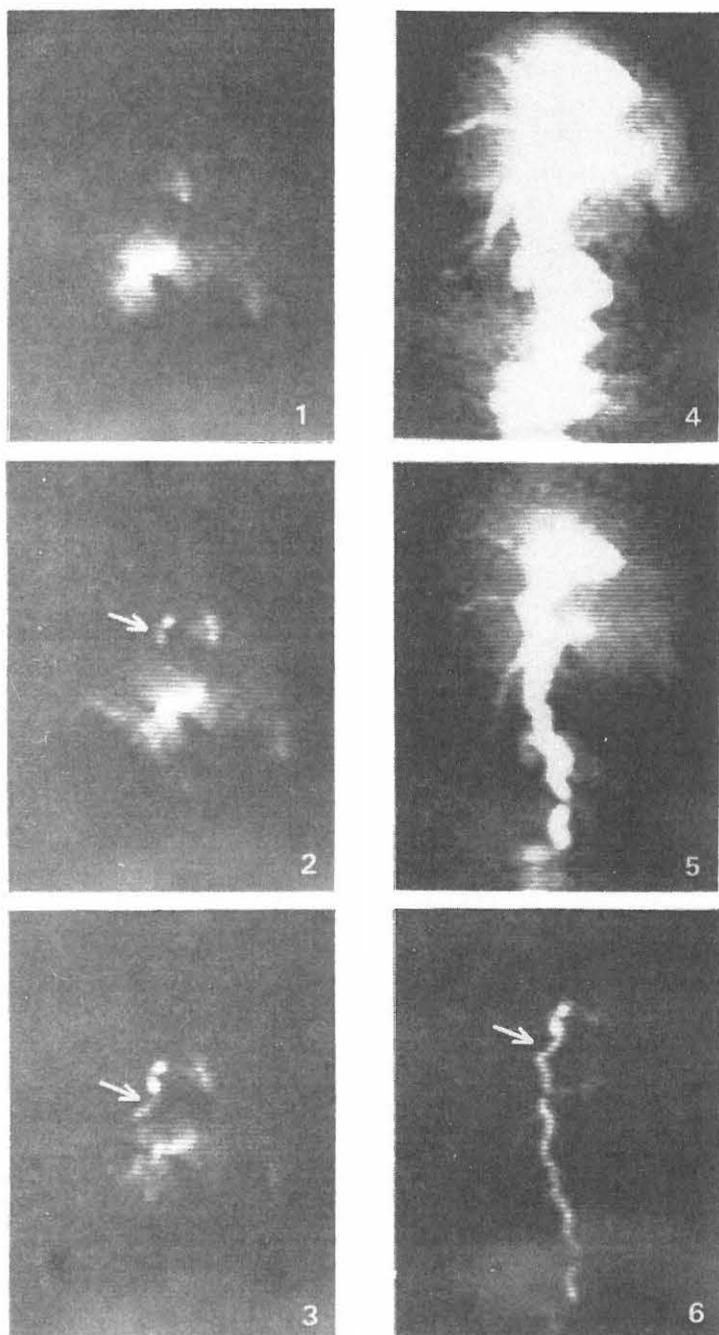


Photo.1. A cloud-to-sea discharge recorded with the video camera. Each picture was completed in successive  $1/60$  sec. The arrows in No.2 and 3 show the development of the first leader stroke and that in No.6 shows corresponding part in the return stroke channel.

with the video camera. The strokes developed from the cloud towards the sea, as shown in the example of photo.1.

Usually, the thunder can hardly be heard in a vessel's room in the existence of noisy sound from the vessel's engine. Accordingly, it is very difficult to estimate the distance to the strike point by the measurement of time interval between the discharge and the thunder. Fortunately, very intensive thunder originated from the very close cloud-to-sea discharge could once be heard in the noisy room during the observation. The field change due to the first leader stroke in the discharge was of negative polarity as same as that in usual cloud-to-ground discharge. Insofar as the above results are concerned, no discrepancies have been found between the cloud-to-sea discharges and the cloud-to-ground ones. Similar observations shall be repeated from January to April 1976 on board of the research vessel Hakuho-Maru.

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