NOTES AND CORRESPONDENCE

Lightning Discharges in Guam and Philippine Islands

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Since the foundation of the Research Institute of Atmospheric, observations of lightning activities with sferics direction finders to the Tropical Asia have been one of the most important project of the Institute, so that some characteristics of the lightning discharges in the Tropics having the effect upon analysis of data obtained with the direction finders, *e.g.* time intervals between return strokes, have been our major interest for a long time.

We have been given the first chance to observe lightning discharges in the Tropics using a electric-field meter with the slow antenna. The time constant of the slow antenna is 1 sec. and the frequency response is from dc to 30 kHz, but it is limited to 2.5 kHz because of the response of magnetic data recorder. The measurements were made on board of the research vessel Hakuho-Maru when the vessel stopped at the port of Guam (14°N, 145°E) in August 1973 and at the port of Cebu (11°N, 124°E) located in Philippine Islands in September 1973. The results obtained by the observations were compared with those obtained at Maebashi (36°N, 139°E) and Imaichi (37°N, 140°E), both located in Japan in the temperate zone, together with those obtained at Zaria (11°N, 8°E) located in Nigeria in the Tropics.

Average vertical profiles of temperatures measured at Guam in August 1973 (Daily Weather Maps, 1973), Luzon Island about 700 km from Cebu in September 1973 (Daily Weather Maps, 1973), and Tateno about 100 km from Maebashi and Imaichi in August 1973 (Aerological Data of Japan, 1973) do not indicate any apparent difference with each other. In addition to it, some meteorological elements measured on the ground at Guam, Cebu (Climatic Table For The World, 1967), Maebashi, and Kaduna about 100 km from Zaria (Rika-Nenpyo, 1970) do not

show also any apparent difference among them.

a) Pre-preliminary discharges

Takeuti *et al.* (1960) have found at Maebashi by the observation of electrostatic field changes due to lightning discharges that about 50% of cloud to ground discharges are preceded by so called pre-preliminary discharges, *i.e.* the cloud discharges occurring just before a cloud to ground discharge. The existence of pre-preliminary discharges have been reconfirmed at Ibadan, Nigeria (Aina, 1971). The occurrence percentages of the pre-preliminary discharges and the distributions of the durations of the discharges measured at Guam and Cebu do not show any apparent difference from those measured at Maebashi.

b) Multiplicities of return strokes

In such a case, where a cloud to ground discharge is composed of multiple return strokes, a part of charge in a thundercloud is neutralized by the first return stroke and adjacent part by the successive strokes. Hence, similar charge distribution in thundercloud is thought to make similar cloud to ground discharge on the multiplicity. Many records of field changes due to cloud to ground discharges at Cebu were saturated, so that only the results at Guam are compared with those at Maebashi (Takeuti, 1965) and Zaria (Harris and Salman, 1972). It is not found that there are any apparent discrepancy among these three localities for the occurrence frequency of multiplicities of return strokes.

c) Time intervals between return strokes

In the above described data, we have not found any large difference between the discharges in the Tropics and those in the temperate zone. However, distributions of time intervals between adjacent return strokes have a systematic dif-

Fig. 1 Log-normal distribution of the time intervals between return strokes measured at Maebashi (open circles), Imaichi (solid circles), Guam (open squares), Cebu (solid squares), and Zaria (triangles).

ference from each other between the temperate zone and the Tropics. The distribution of time intervals at Maebashi (Takeuti, 1965) is similar to that at Imaichi, on the other hand, those at Guam and Cebu are similar to that at Zaria

(Harris and Salman, 1972) as shown in Fig. 1. There are not enough data to discuss this difference but it will be a theme of further study.

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References

- Aerological Data of Japan, August 1973, Japan Meteorological Agency, Tokyo.
- Aina, J.I., 1971: Lightning Discharge Studies in a Tropical Area, I. Cloud-to-ground Discharges *J. Geomag. Geoelectr.*, **23**, 347-358.
- Climatic Table for the World, 1967: Published by The Japan Weather Association, Tokyo.
- Daily Weather Maps, 1973, Japan Meteorological Agency, Tokyo.
- Harris, D.J., and Y.E. Salman 1972: The Measurement of Lightning Characteristics in Northern Nigeria, *J.A.T.P.*, **34**, 775-786.
- Rika-Nenpyo, 1970: Maruzen Co. LTD, Press.
- Takeuti, T., H. Ishikawa, and M. Takagi, 1960: On the Cloud Discharge Preceding the First Ground Stroke. *Proc. Res. Inst. Atmospherics, Nagoya Univ.*, **7**, 1-6.
- Takeuti T., 1965: Studies on Thunderstorm Electricity *Proc. Res. Inst. Atmospherics, Nagoya Univ.*, **12A**.

グアム島とフィリピン群島での雷放電

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熱帯地域にあるグアム島とフィリピン群島で雷放電の観測を行ない、この結果を、同じ熱帯地域にあるナイジェリアでの観測結果及び温帯地域にある日本での観測結果と比べてみた。夏の気象条件は、日本と熱帯地域の間で大差ないことに対応して、雷放電機構も一般的に大差ないことが明らかになったが、相続くリターンストロークの間の時間間隔の分布は、日本と熱帯地域で異なることが判明した。