Proceedings of the Research Institute of Atmospherics,
Nagoya University, vol.25 (1978) —Activity Report—

Section 5. Atmospheric Radio Noise and Thunderstorms

A statistical frequency spectrum of the atmospheric noise (abbreviated as SFS) inELF-VLF bands is expressed in terms of the field strength at a very low percentage, V_n, for example, n =0.1,0.2 or 0.5 %. It can be a useful index in locating the thunderstorm within a distance of some 100 km, because SFS is dominantly contributed by individual atmospherics emitted from the nearest acting thunderstorm as compared with farther located ones. In fact, it has been found that individual SFS in ELF-VLF bands observed when the nearest thunderstorm is within some 100 km from a measuring site, always displays a remarkably characteristic feature as compared with individual SFS for farther thunderstorms. Let the former be called the small distance thunderstorm type and the latter the long distance thunderstorm type. The two types can easily be distinguished by inspecting shapes of individual SFS drawn on a graph with the ordinate of field strength and abscissa of frequency.

Lots of SFS data of small distance thunderstorm type were obtained for two months in summer of 1974, as a result of measurements of SFS at intervals of 5 minutes at the Sakushima Observatory in the Mikawa Bay in Japan. Some 150 out of these data were found to have the corresponding radar echo data, each of which was observed at the Nagoya Meteorological Station at about the same time as the observing time of SFS. Such a close correspondence between SFS and radar data led to the following comparisons and investigations of the two different kinds of data.

Behaviors of SFS in ELF-VLF bands have been considered by applying the waveguide mode theory of propagation and individual SFS data have been investigated making use of informations on the corresponding echo-distances, echo-strength,echo-heights and so on. The results obtained from theoretical calculations and data processing can be summarized as follows. (1) Shapes of SFS for small distance thunderstormtype are understandable in view of the waveguide mode theory of propagation, (2) the distance dependency found in observed SFS shape-changes may be derivable from the same theory,(3) a particular relationship between the echo-distance and echo-height derived by using SFS and radar data is very similar to that derived by a traditional method in the past,(4) there is a tendency that the higher the echo-height

is, the more intense the electrical activity in thunderstorms is. The results obtained in the above investigation will be published as soon as possible including what was to be published in 1977.

During the winter of 1976/77, in a Japan-U.S. cooperative study, thunderstorm were observed at Unoke, the Hokuriku area, in cooperative with Prof. Brook and Dr. Raymond of the New Mexico Institute of Mining and Technology, Socorro, N.M.,U.S.A. Simultaneous measurements of field changes produced by lightning were made at four widely separated stations. Additional measurements included video camera recordings of lightning channels and 5 cm radar reflectivity profiles. The following conclusions are based upon the analysis of eight flashes to ground from three storms:

1) return strokes generally lowered positive charge to earth. Only one out of the eight flashes lowered negative charge.

2) In 50% of the ground flashes, a barely detectible rapid return stroke field change was followed by a large, slow, continuing current. The continuing current field change accounted for about 95% of the total field change.

3) The positive current flashes to ground occur both as single and multiple stroke discharges. The discrete multiple strokes appear to be separated by abnormally long time intervals, averaging about 100 msec in duration. These intervals do not include long continuing currents which last for about the same length of time.

This winter, the cooperative study were again made and number of the station was extended into seven so that we could exactly estimate the positions and quantities of harges neutralized by the flashes to ground using the field changes data.

Data obtained by thunderstorm observation in Sweden during summer of 1976 was analyzed. Using the result, we have classified the thunderstorm into following two types:

1) Normal summer type as observed at Upsala in Sweden and Maebashi in Japan. The majority of ground flashes of the storm type neutralize negative charge in the cloud.

2) Hokuriku winter type as observed in Hokuriku area in Japan during winter. Most of the flashes of this storm type neutralize positive charge in the clouds. The storm observed on July 25 at Kiruna in Sweden showed the transitional characteristics from the normal summer type to Hokuriku winter one.

January 9,1978
-Taketoshi Nakai-
-Tosio Takeuti-

Publications

Nakai,T.:On the Time and Amplitude Properties of the Electric Field Near Sources of Lightning in the VLF,LF and HF bands,Radio Sci., Vol.12, No.3, 389-396 (1977).

Nakai,T. and J.Frisius: The Random Scatter of Special Parameters of VLF-Atmospherics, J.Atmos.Terr.Phys (in press).

Nakai,T. : On the Statistical Frequency Spectrum Near the Source of Atmospherics, to be submitted in 1978.

Nakano,M.: Characteristics of Lightning Channel in Thunderclouds Determined by Thunder, J.Met.Soc. Japan, Vol.54, No.6,441-447 (1976).

Heydt,G. and T.Takeuti: Results of the Grobal VLF Atmospherics Analyzer Network,Electrical Processes in Atmospheres, Steinkopff Press (1976)

Takeuti,T. and M.Nakano: On the Lightning Discharges in Winter Thunderstorm, ibid, (1976)

Takeuti,T.: On Cloud-to-Sea Discharges, Proc. Res. Inst. Atmospherics, Nagoya Univ., Vol.23, 17-20 (1976)

Takeuti,T.,M.Nakano, and Y.Yamamoto: Remarkable Characteristics of Cloud-to-Ground Discharges Observed in Winter Thunderstorms in Hokuriku Area, Japan, J.Met. Soc. Japan, Vol.54, No.6, 436-440 (1976)

Takeuti,T.,M.Nakano,H.Ishikawa and S.Israelsson: On the Two Types of Thunderstorms Deduced from Cloud-to-Ground Discharges Observed in Sweden and Japan, ibid, Vol.55, No.6 (1977 in press)

Takeuti,T.M.Nakano,M.Brook,D.Raymond and P.Krehbiel: The Anomalous Winter Thunderstorms of the Hokuriku Coast, J. Geophys. Res. (in press).