Section 2. Source of Atmospherics

Main source of atmospherics is a lightning discharge appearing in and round a thunder-cloud. Therefore the trend of our activity is within the category of electricity in the environmental atmosphere, and closely related to many topics in the research field of atmospheric and space electricity. For example, meteorology of thunderstorm from micro to synoptic study, electricity of thunderstorm, lightning discharge mechanism, electromagnetic effect of atmospheric discharge phenomena extending from UHF down to ELF Schumann resonance, global electric circuit in the enviromental atmosphere, electrical state of the free atmosphere up to height of lower region of the ionosphere are all within the reach of our activity. However, the activity at present has mainly been and will be directed toward the study of electromgnetic radiation from lightning discharge with special interest toward the genesis of ELF atmospherics and atmospheric source signals in UHF through VLF band.

Frequency spectral characteristics of atmospheric source signals have been studied, using a mobile field site shown in Fig. 1, to see the effect of a particular discharge mechanism involved in a lightning flash, e. g., leader, return stroke, etc., on the nature of spectral distribution of the source signal peak intensity in VLF to VHF band to respond the possible demand in the space age (Iwata and Kanada 1967).

Simultaneous electric field measurement of individual lightning discharge at three field sites with separation distance of the order of 10 km from each other contributed to the thunderstorm electricity researches (Takeuti 1966a; 1966b).

A joint ELF atmospherics research program was realized in the summer season in 1965 and has been continued in the summer of 1967 in co-operation with Geomagnetic

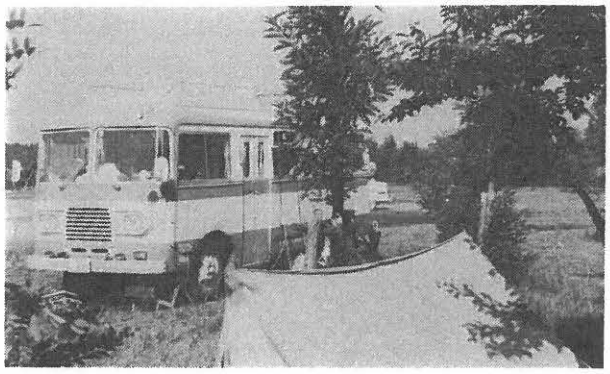

Fig. 1. Mobile field site at Imaichi, Tochigi, working for the atmospheric source signal study in 1967.

Observatory, Meteorological Agency at Kakioka. ELF atmospheric waveform has been observed at four field sites, Tottori, Kagoshima, and Kakioka including the source signal measurement at Imaichi in the hope that we could see the discharge mechanism which produces ELF atmospherics.

ELF electromagnetic effect of a particular lightning discharge can be recorded, in this way, at the four widely separated distances, i. e., within 10 km, and at 80, 500 and 900 km from a lightning discharge. (Ishikawa, Iwata and Takagi 1967).

Damage in properties and loss of man powers due to a heavy shower is very serious in Japan every year. It is believed that heavy shower in Japan is generally produced in association with the three meteorological events, and they are thunderstorm, typhoon and rainy front in early summer. Therefore any attempt in the research field of atmospheric electricity, for example the attempt to correlate the electrical activity of a thundercloud with the amount of rainfall in the cloud or the attempt to connect the location of individual lightning flashes, which can be fixed with a method of atmospheric direction finding, with the meteorological structure of a typhoon etc., would be very useful in view of the weather forecasting, if the attempt could actually promise a successful future. In view of the application of atmospheric electricity to a weather forecasting we have made preliminary observation of thunderstorm related electricity and meteorology (Takeuti, Ishikawa and Iwata 1967).

Atmospheric electricity in the free atmosphere below the E-region of ionosphere is of another interest for us in relation with the global electric circuit and the electrical state of stratosphere and mesosphere. It includes the D-region of ionosphere which controls the propagation of atmospheric radio waves in VLF and ELF range. There are two ways of approach in this trend of atmospheric electric research, the one is the indirect ground level observation and the other is the in situ observation with a space vehicle. In view of the indirect observation on the ground level, one of the best place to do it is over the seawater. It is suited for this purpose, because least atmospheric electric disturbance due to aerosols is expected over oceans except for sea salt nuclei. We have made two ocean atmospheric electric observations this year, one on board a boat Ryofu Maru, Meteorological Agency, and the other on board a boat Tansei Maru, Ocean Research Institute, University of Tokyo, and the experimental result of the ocean atmospheric electricity observation will be published elsewhere in the near future.

As to the in situ measurement of upper atmospheric electricity, we have made two preliminary measurements with a rocket Gerdien condenser applying a drop sonde technique. Although we succeeded in the measurement of atmospheric ions only for the first flight in April 1966 and did not succeed in it for the second flight fired in January 1967, we could confirm the existence of the ions which have a mean mobility smaller than that of small ions in the upper atmosphere from 30 to 55 km altitude (Ishikawa, Takeuti, Iwata and Morita 1968). Shown in Fig. 2 are the instruments for the second flight, including Gerdien condenser and ionization chamber.

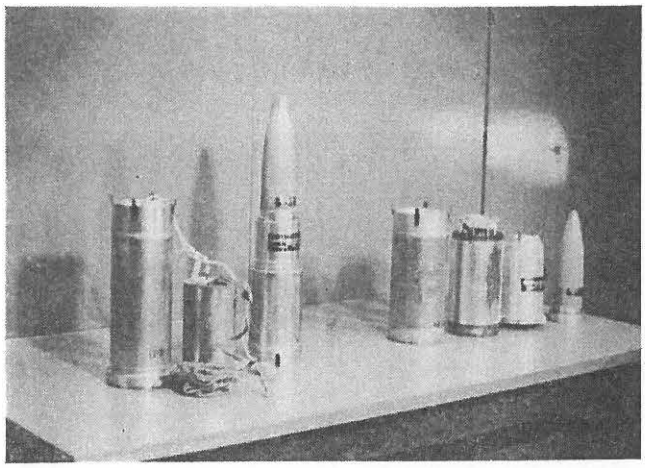

Fig. 2. Gerdien condenser assembly for the measurement of atmospheric ion conductivity and density along with ionization chamber assembly for the atmospheric ionization measurement in the final check for the IT-160-1, and IT-160-2 rocket flight.

A balloon measurement of atmospheric ions above the exchange layer is also of our interest, and pursued along with the drop sonde measurement. We have made two balloon borne Gerdien condenser measurements of atmospheric ions, one in September 1966, and the other in October 1967, aiming the measurement of diurnal variation of the atmospheric ion conductivity and density in relation with aerosol content in the stratosphere and mesosphere (Takeuti, Ishikawa and Iwata 1966). An example of field work on a balloon flight is illustrated in Fig. 3.

—Haruji ISHIKAWA—

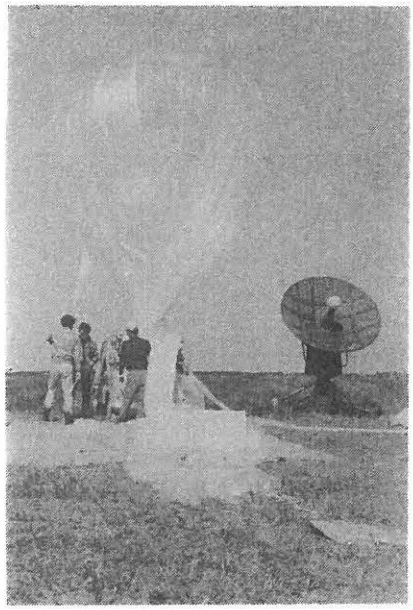

Fig. 3. Ready to a test balloon flight for atmospheric electricity measurement.

Publications (1966-1968)

Ishikawa, H., Iwata, A. and Takeuti, T.: Experimental study of the origin of ELF atmospherics, this volume.

Ishikawa, H., Takeuti, T., Iwata, A. and Morita, Y.: Preliminary experiment of atmospheric ion measurement in the transitional region of the atmosphere, this volume.

Iwata, A. and Kanada, M.: On the nature of frequency spectrum of atmospheric source signals, Proc. Res. Inst. Atmospherics, Nagoya Univ., **14**, 1-6 (1967)

Takeuti, T.: Studies on thunderstorm electricity. II Ground discharge, J. Geomagnetism and Geoelectricity, **18**, 13-22 (1966)

Takeuti, T.: Studies on thunderstorm electricity. III Charge separation and related meteorological phenomena, J. Geomagnetism and Geoelectricity, **18**, 355-362 (1966)

Takeuti, T., Ishikawa, H. and Iwata, A.: Preliminary measurement of negative ion density with a balloon borne Gerdien condenser, J. Geomagnetism and Geoelectricity, **18**, 493-494 (1966)

Takeuti, T., Ishikawa, H. and Iwata, A.: On the forecast of thunderstorm behavior, (in Japanese) Tenki, **14**, 22-24 (1967)