RESEARCHES IN THE FREQUENCY ANALYSES OF
WAVEFORMS OF ATMOSPHERICS-III

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Summary

As to researches of atmospheric waveforms and their frequency spectra, we have tried
to derive the traversed distance from the source, employing the results of waveform
analyses.   This is because the base lines of our spherics network in Japan are not
adequate in locating atmospheric origins.   Recently we could find the fact that the phase-
frequency spectra analysed from waveforms have a strong connection with the propagated
distances from their sources.   It is the purpose of this paper to suggest a method of
approximating the location of origins by waveform analyses.

A pair of remarkable relationship exists between the real function of waveform and
complex function of frequency spectrum.   With the aid of Fourier transformation, we can
make the frequency analyses of transient atmospheric waveforms.   The present paper gives
some frequency analytical results of smooth–daytime–type waveforms concerning the dis-
tance obtained by C. R. D. F. triangulation.   The majority of the waveforms used here
were observed during a week in Aug. 1959.   Fig. 1 shows the typical daytime–type
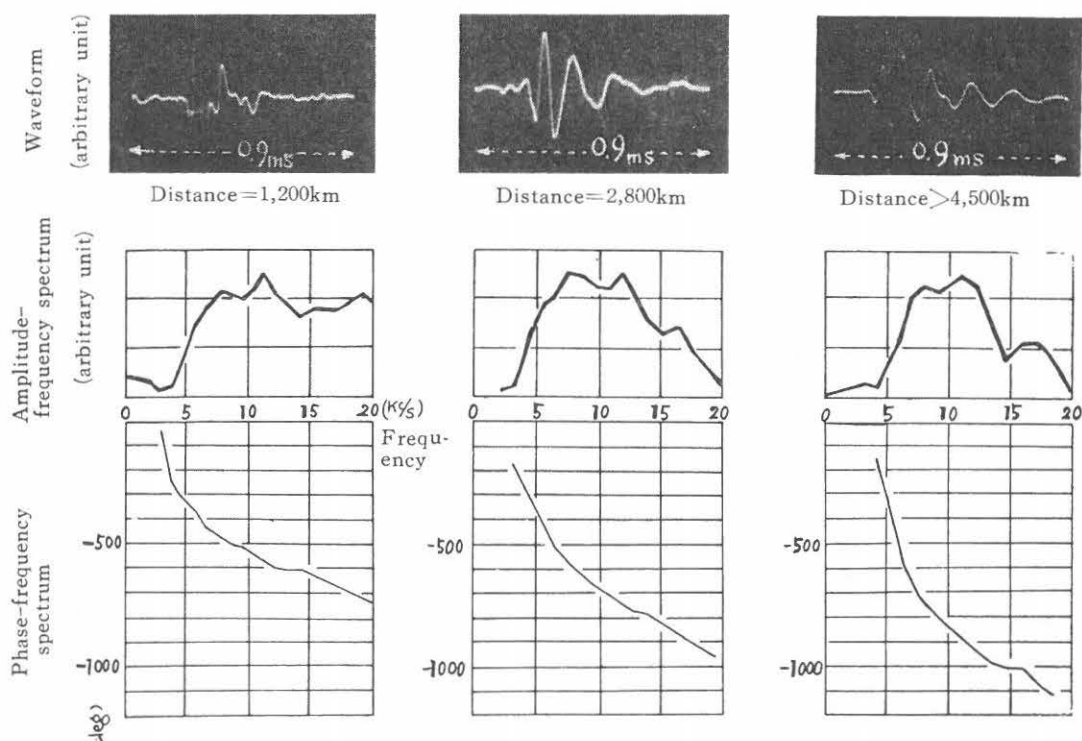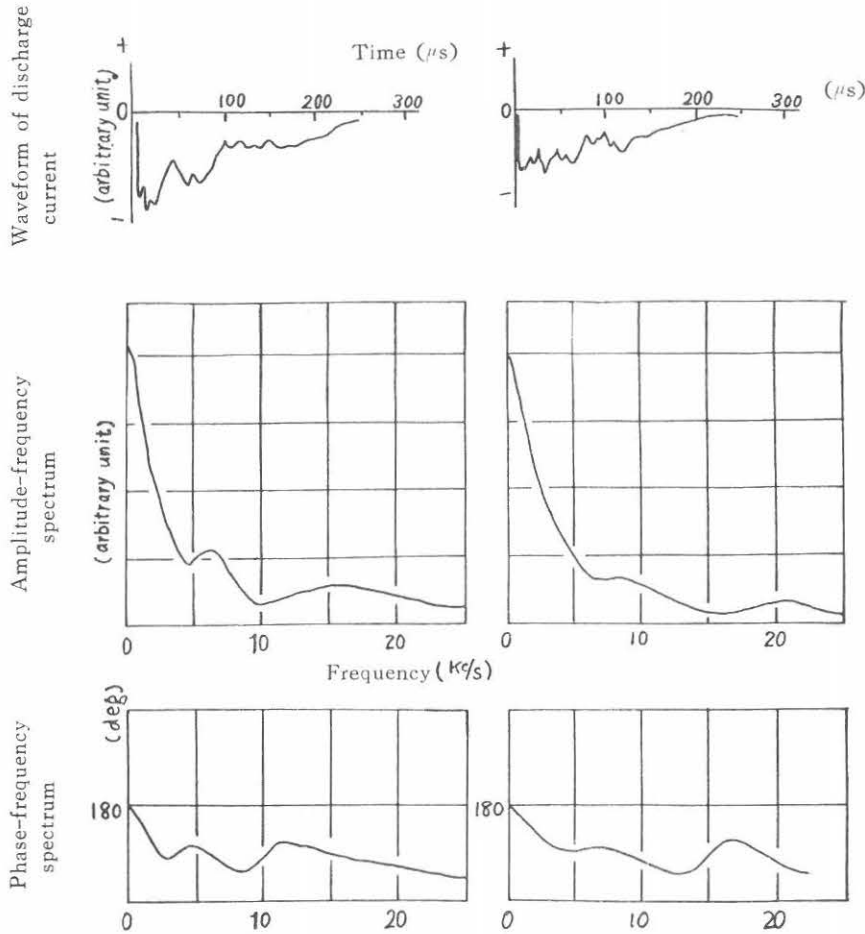

Fig.   1

Fig.　2

waveforms, and the corresponding frequency spectra.　As is shown in Fig. 1 the phase-frequency spectrum represents rather clearly the effect of propagation distance.　The authors studied this problem in terms of the inclination of phase-frequency spectrum curve.　The phase-frequency spectrum of a received waveform is represented by the sum of the phase-frequency spectrum at origin and the propagation phase shift.　In a previous paper,[1] we have described some of the various types of ground discharge currents reported by Norinder et al and their frequency spectra.　Their two examples are reproduced in Fig. 2.　By inspection the fact is found that the phase-frequency spectrum at origin appears to be in a range of about 180 degrees.　Therefore it may be expected that the phase-frequency spectrum of the received waveform is produced mainly by the propagation phase shift.　To investigate the possibility of estimating the propagation distance, the mean value of the tangent to the curve at 6 kc/s and the inclination of the roughly linear portion between 8 and 14 kc/s was employed.　About thirty percent of the fifty analysed waveforms were excluded because of their unreasonable features of phase-frequency curves.　Fig. 3 shows the fact that there is a rough correlation between the mean value of the tangent to the phase-frequency curve and the tsaversed distance, and this value shows a systematic, almost linear, increase with distance, although the

individual point scatters around a reasonably straight line. However it is to be noted that some of the complicated waveforms are also employed in the above analyses. In Fig. 3 white circles indicate values analysed from the typical waveforms, and black circles indicate values analysed from rather popular waveforms. We can not find any difference in the tendency between the black circle and the white circle groups. Finally we may probably be able to deduce the approximate location (allowance ± 500km) by the employment of the phase frequency spectrum curve.

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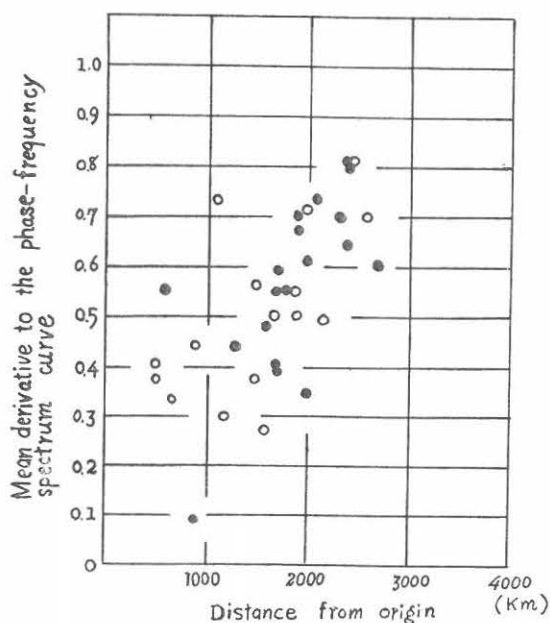

Fig. 3

Reference

(1)   K. Sao: Proc. Res. Inst. Atm. **5**, 12, (1958)