CORRELATION BETWEEN VLE HISS AND GEOMAGNETIC ACTIVITY IN HOKKAIDO

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1. Introduction

Using the data at Moshiri from Jan. to Nov., 1963, Iwai, Ohtsu (spelled as Outsu formerly) and Tanaka (1964) showed that the correlation between VLF hiss and magnetic storm is very high and the occurrence rate increases during geomagnetically disturbed period and the hiss storms are delayed from 2 to 68 hours with respect to the sudden commencement of a magnetic storm. Harang (1966) showed that low latitude type emissions appear only during strong geomagnetic disturbance and in the last phase or even at the end of the disturbance.

2. Relation with some geomagnetic phenomena

2.1 Magnetic storm

Through the whole observation period, 148 VLF emissions (4-6KHz) were observed and 65 magnetic storms were recorded. It is found that 47.4 % of the emissions follow the magnetic storms. Fig. 1 shows that the occurrence probability of the emissions increases as the magnetic storm becomes more intense.

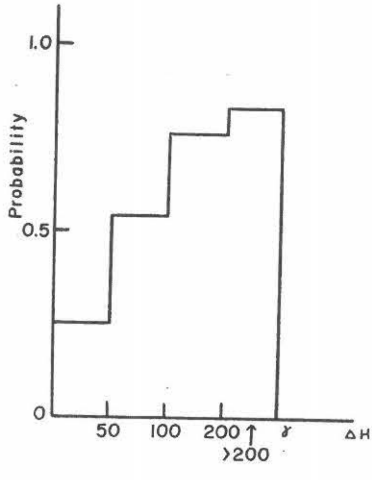

Fig. 1 Occurrence probability of the emissions (4-6 KHz) in each range of the maximum variation of horizontal component (ΔH) in magnetic storm.

Fig. 2 shows the delay time of the emissions from the sudden commencement. The systematic tendency of the delay time and the dependence of the intensity of

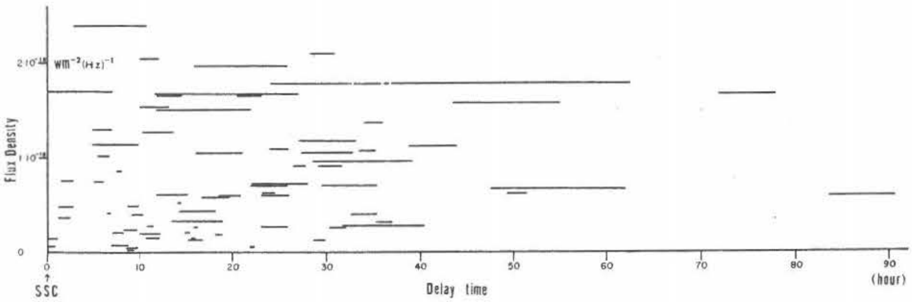

Fig. 2 Relation of the maximum flux density of each emission to the delay time from SSC.
Each straight line shows the duration of each emission.

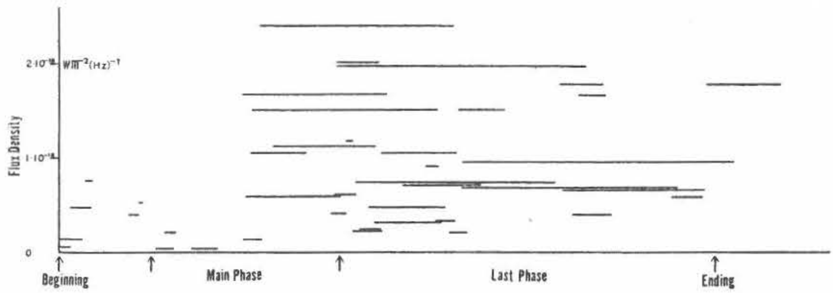

Fig. 3 Dependence of the relative durations and maximum flux densities of the emission (4–6 KHz) on the each phase of 23 magnetic storms. (Time scale is arbitrary.)
The time scale of the each magnetic storm is changed in such a manner that SC, starting times of main phase and last phase and ending time come to coincide, respectively.

the emissions upon the delay time, are not found in this figure. Intensity and duration of the emissions against phase of magnetic storms is shown in Fig. 3. The emissions of high level and long duration are found to occur in the last phase, in general, as noted by Harang (1966). A typical example is shown in Fig. 4. The emissions at 800 Hz, 8 and 12 KHz have been observed since Jan., 1967. The analysis of these data has shown that the emissions at 800 Hz have a similar dirurnal variation as the polar chorus (a type of ELF emissions) which has two peaks once in nigh-time and once after sunrise, but it was difficult to note the emissions at 2 and 12 KHz. The emissions at 8 KHz seem to occur in the same period as those at 5 KHz but in a lower probability. So, the emissions at 12 KHz may be though to be the polar emissions which are unable to propagate to low latitides because of the latitude cut-off effect.

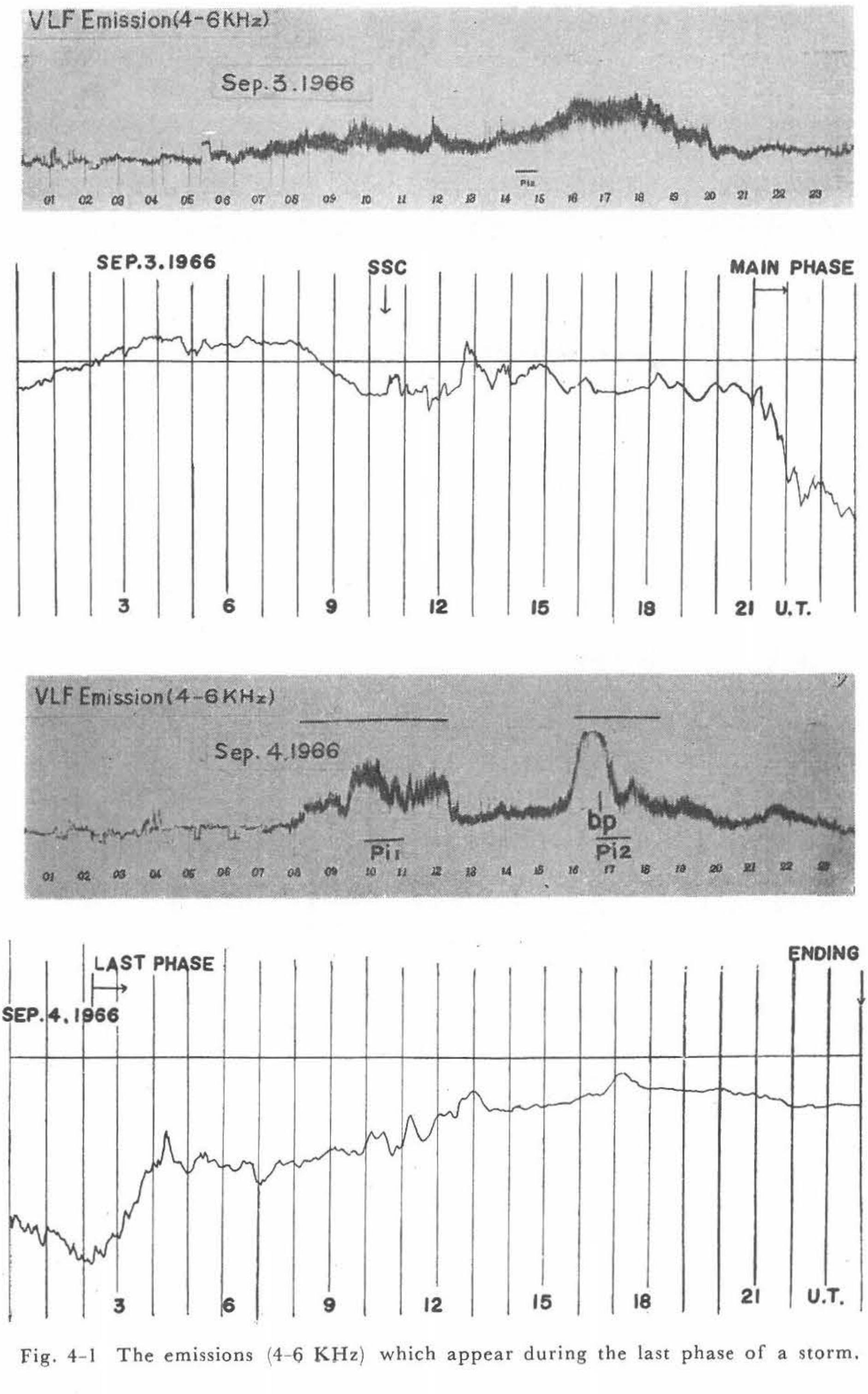

Fig. 4-1 The emissions (4-6 KHz) which appear during the last phase of a storm.

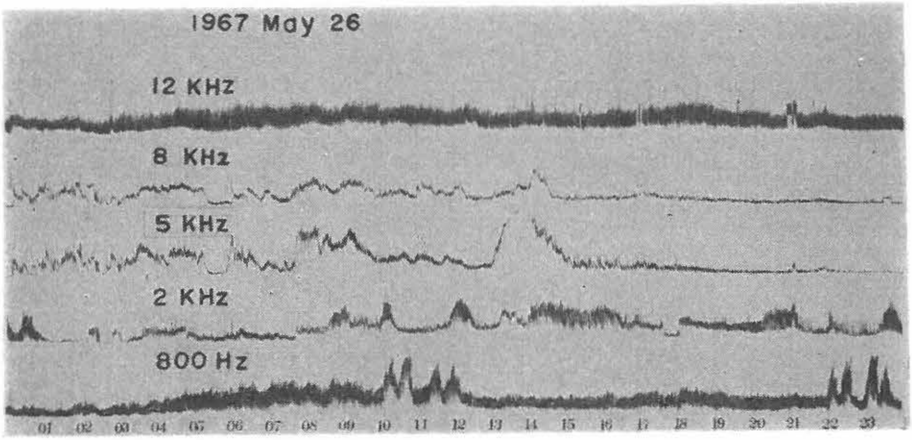

Fig. 4-2 Correlation of the emissions at 8 KHz with those at 5 KHz. It can be seen that the correspondence is pretty well.

The magnetic storm:	beginning	$25^d 12^h 35^m$
	main phase	25 20.3^h
	last phase	$25^d 04.4^h$
	ending	$29^d 20^h$

2. 2 Daily sum of K_p-index

It is shown in Fig. 5 that the occurrence probability of the emissions increases as the daily sum of K_p-index increases. It is not clear whether the occurrence probability decreases in 40-45 range of $\sum K_p$ is due to the limited number of data (6 cases) or due to any other causes. Fig. 6 shows the evidence that the emissions occur even on geomagnetically calm days and some of the emissions do not relate at all with other geomagnetic phenomena, such as bay and pulsation (p_t).

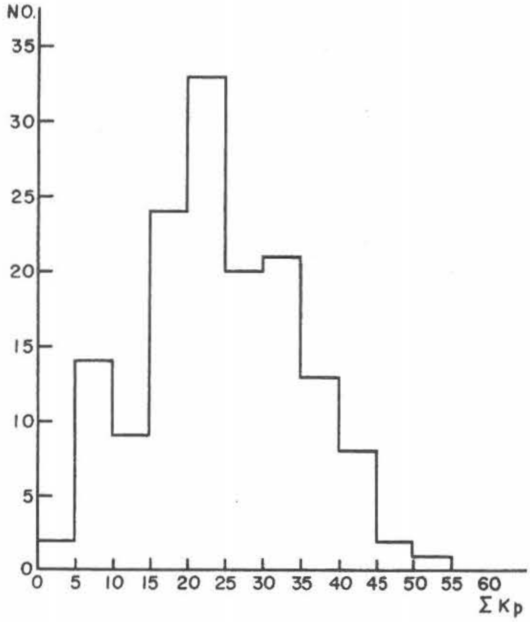

Fig. 5 Occurrence number of the emissions (4-6 KHz) in each range of the sum of K_p -index from 12 hours before to 12 hours after the starting time of emission.

2. 3 Pulsation and bay

Fig. 7 shows the relation between the emissions, which do not

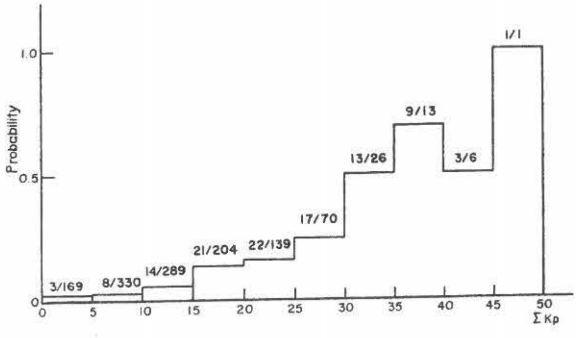

Fig. 6 Occurrence probability of the emissions (4-6 KHz) in each range of the daily $\sum K_p$ on the day where the emissions start. Numerator equals to the number of emissions and denominator to the number of days in each range of the daily $\sum K_p$.

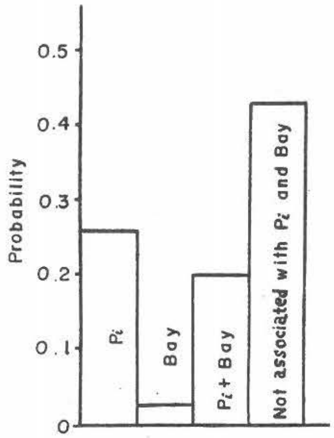

Fig. 7 Relation of the emission (4-6 KHz), which do no follow magnetic storm, to p and bay.

follow a magnetic storm, and the geomagnetic events, p_i and bay. Fig. 8 is a typical case, in which p_i and bay correspond well to the emissions. From Fig. 7 it is known that about 56 % of emissions which did not follow a magnetic storm occurred asociated with pi and bay. But it is remarked here that the number ratio of the emission occurrence to all pi occurrence will be reduced much from the value given above, because the occurrence number of p_i is far more than of emissions. For the emissions which have not any correlation with magnetic storm, p_i and bay, it may be probable that atmospherics were mistaken for emissions for some of them, because it is very difficult to distinguish the emissions from atmospherics, and also it has been imagined though not confirmed, that some of intense emissions may originate from a source of small scale but lieing near the observing site.

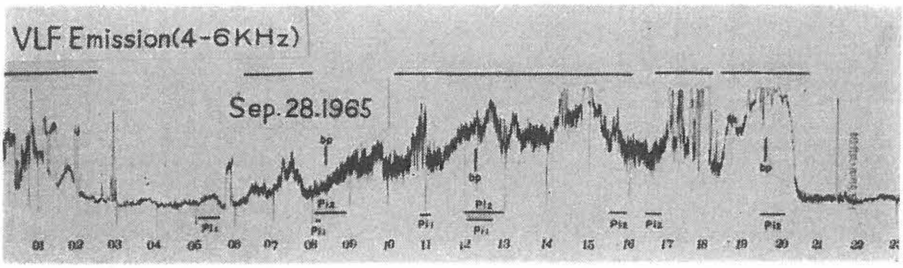

Fig. 8 An example of the emissions to which magnetic bay and pulsation correspond well,

3. Diurnal and seasonal variations

Fig. 9 shows the diurnal variation of the occurrence number of emissions (4-6 KHz) observed at Moshiri. Most emissions are observed from local midnight till early morning. Fig. 10 shows the seasonal variation of the occurrence probability of the emissions which follow the magnetic storms. Fig. 11 shows the ratio of number of the emissions in the daytime and the ratio of that in the nighttime to number of all emissions which follow the magnetic storms. It is generally believed that low latitude type emissions appear during strong magnetic storms (Iwai et al. 1964, Harang 1966) and propagate from the auroral zone in the earth-ionosphere wave guide (Ondoh 1961, 1966 and Jörgensen 1966). So, the results shown in Fig. 10 and Fig. 11 seen to agree well with the explanation of the

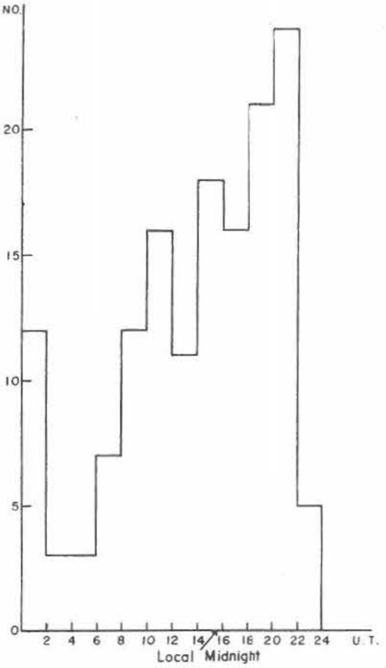

Fig. 9 Diurnal variation of the occurrence number of the emissions.

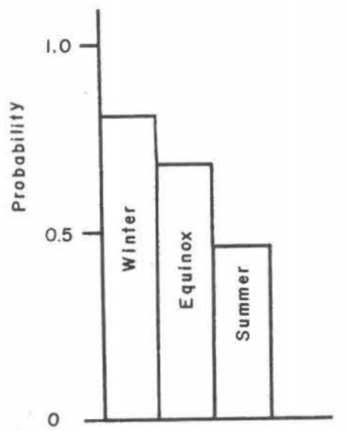

Fig. 10 Seasonal variation of the occurrence probability of the emissions (4-6 KHz) which follow the magnetic storms.

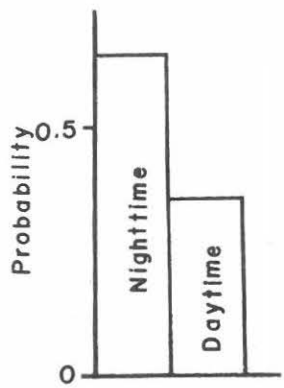

Fig. 11 The ratio of the number of the emissions in the daytime and the ratio of the emissions in the nighttime to that of all emissions which follow the magnetic storms.

propagation of emissions from the auroral zone, because the propagation condition for VLF waves is good in winter and in the night.

4. Conclusion

The occurrence rate of VLF emissions increases as the magnetic storm becomes more intense, and a series of high level VLF emissions occurs in a high occurrence probability in the last phase of a magnetic storm. They showed a high probability of occurrence when the daily sum of k_p-index is large. It is found that about 56% of emissions which did not follow a magnetic storm were observed asociated with p_i and bay.

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