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OBSERVATION OF AURORAL HISS BY THE S-310JA-6 SOUNDING ROCKET

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ABSTRACT: S-310JA-6 sounding rocket was launched along the geomagnetic field line from Syowa Station, Antarctica at $00^h56^m00^s$LT on August 28, 1978 by the 19th Japanese Antarctic Research Expedition party. That rocket hit active aurora arcs and brought satisfactory results. We are successful in observing the LHR hiss and etc.. These data will be valuable to investigate the wave-particle interaction in the polar ionosphere.

Introduction

One of the IMS projects in Antarctica is to examine the problem of the wave-particle interaction in the auroral ionosphere. For that purpose, a series of rocket experiments are planned and carried out.

In 1978, four rocket experiments with that purpose by S-310JA sounding rockets were carried out with great success by the 19th Japanese Antarctic Research Expedition party at Syowa Station.

At 00^h50^mLT on August 28, 1978, active aurora arcs appeared at Syowa Station, they being followed by the geomagnetic field variation and the hiss event. Our S-310JA-6 rocket was launched along the geomagnetic field line, hit the aurora arcs and brought satisfactory results.

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Observation

S-310JA-6 sounding rocket was launched along the geomagnetic field line at $00^h56^m00^s$LT on August 23, 1978 at Syowa Station. The records of magnetometer, riometer and VLF hiss-meter on the ground are shown in Fig. 1. From Fig. 1, it is found that hiss activity on the ground drops down at the launching time and is not observed during the flight of the rocket. However, aurora arcs observed throughout the flight by an all-sky camera at Syowa Station, as shown in Fig. 2.

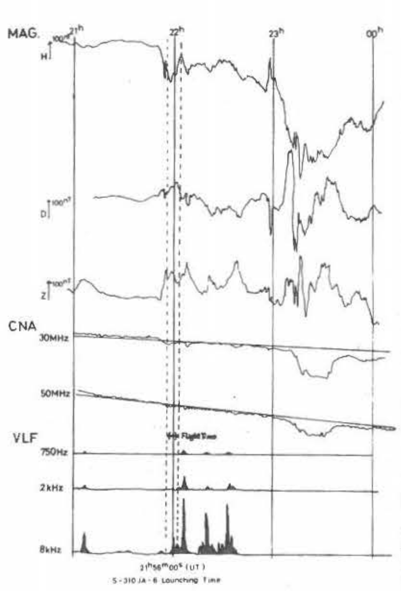


Fig. 1. Ground base observation of MAG, CNA and VLF on 28 Aug. 1978 at Syowa Station.

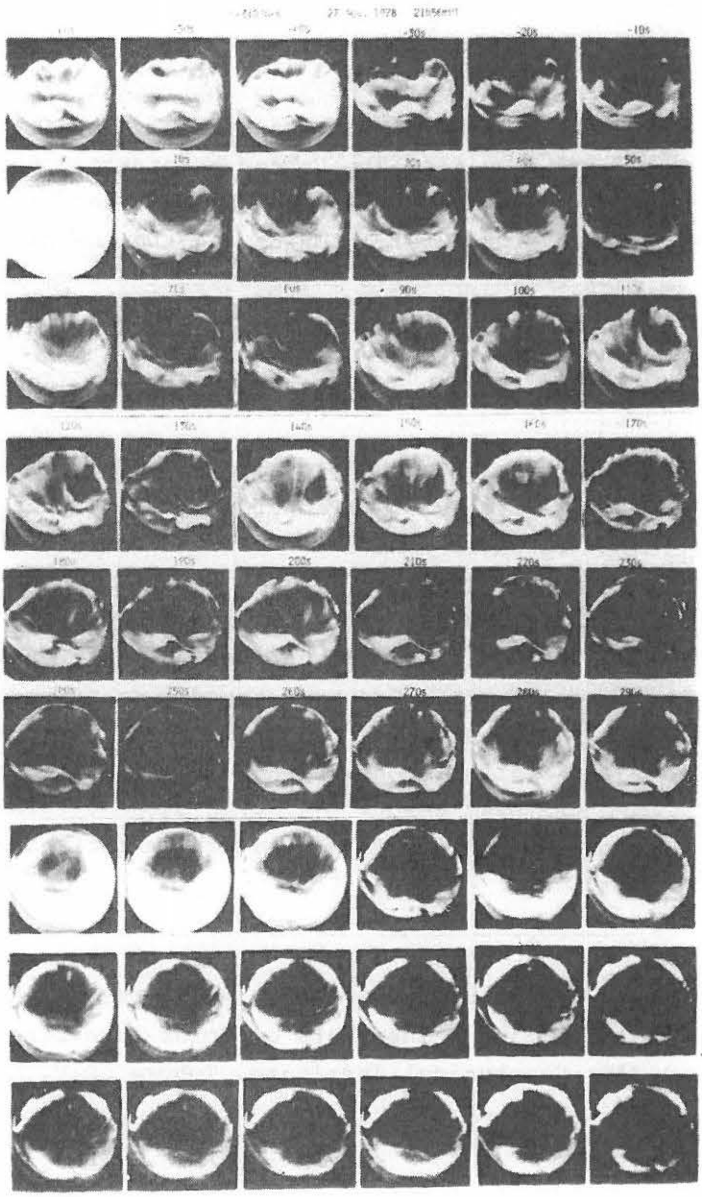


Fig. 2. The data of all-sky camera on 28 Aug.1978 taken every ten second.

On the rocket, the observation started at 56 sec. after the launching. A weak hiss is observed just after the antenna extension at $00^h56^m56^s$ until $00^h57^m10^s$. This hiss is also observed at the same time by a VLF hiss-meter on the ground. For 5 sec. after $00^h57^m10^s$, a hiss is not observed both on the rocket and on the ground. But, from $00^h57^m15^s$, a strong hiss suddenly began to be observed on the rocket and is continued until $01^h02^m30^s$. However, no hiss is observed on the ground. Figs. 3(a) to (d) show the VLF hiss spectra received by a electric antenna with 2m length(tip to tip) on the rocket during the flight.

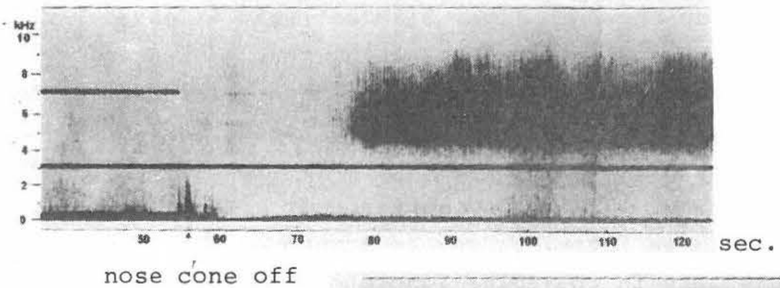


Fig. 3-a.

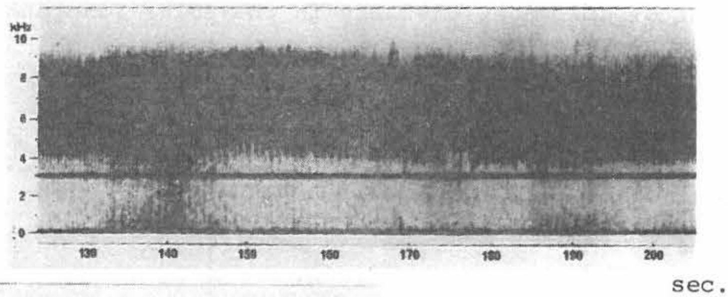


Fig. 3-b.

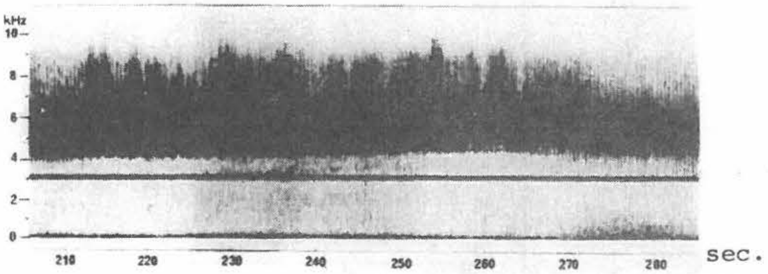


Fig. 3-c.

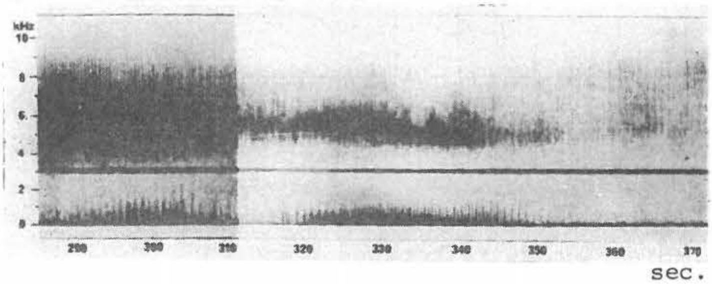


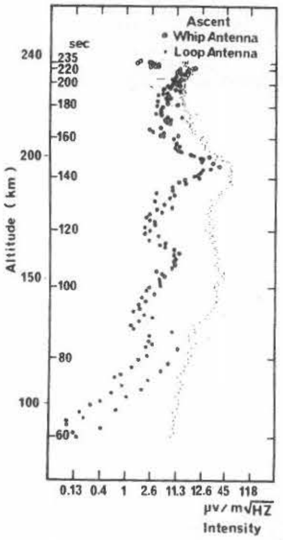
Fig. 3-d.

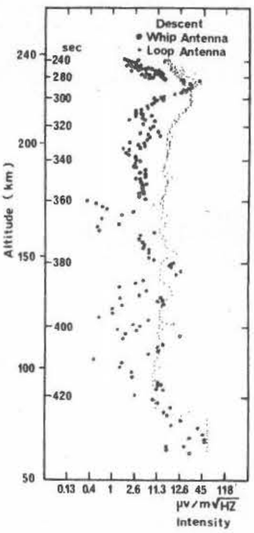
Fig. 3. The VLF hiss spectra by a electric antenna on the rocket.

Observational Results

The principle and the measuring system of our VLF experiment to be loaded on the S-310JA-6 are described in detail by Tanaka et al. (1978). Output signals obtained are the polarization ratio at two specific frequencies of 7 and 3 kHz, the poynting flux direction at 7 kHz and the wide-band signals(0-10 kHz) received by both elctric and magnetic antennas. The magnetic antenna is a shielded loop with 100mmϕ and 20 turn. The electron density profile is shown in Fig.4.

The altitude distributions of the intensity of the wide-band signals from 0 to 10 kHz are shown in Figs. 5(ascent) and 6(descent) respectively. It is found from Fig. 5 that the four peaks can be seen at 130, 155, 195 and 235 km altitude. These peaks correspond to the intense aurora arcs, which can be seen in the records of an all-sky camera as shown in Fig. 2. Fig. 6 shows that one peak can be seen at 227 km altitude. It also corresponds to the intense aurora arcs. From these facts, it may be suggested that the magnitude of VLF wave intensity in the polar ionosphere is related to the flux of precipitating auroral particles.





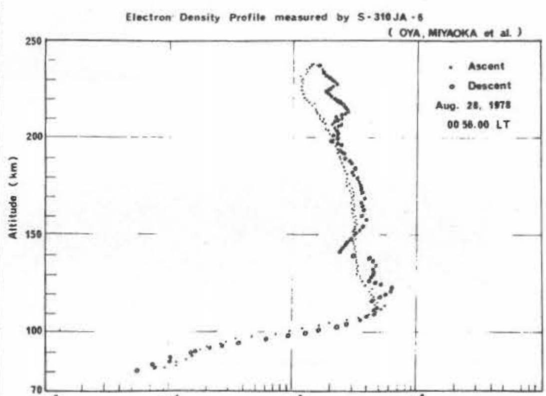


Fig. 4. The electron density profile measured by S-310JA-6 (OYA, MIYAOKA et al.)

Fig. 5. and Fig. 6.
The altitude distribution of radio noise intensity between 1 and 10 kHz by S-310JA-6.

In order to get a further understanding of the VLF spectra, we show the schematic frequency diagram in Fig. 7.

From Figs. 3 and 7, first, we found that the hiss event has a low-frequency cut-off at a frequency about 4 kHz. As this cut-off frequency changes with the altitude of the rocket and moreover, the hiss event is observed only by the electric antenna and not by the magnetic antenna, the hiss may be considered to be a LHR hiss. Second, the hiss event may consist of four series of hiss activity; from 75 sec. to 120 sec., from 120 to 150 sec., from 150 to 220 sec. and 240 to 350 sec. on the ascending path. These series of hiss activity may be observed to be associated with the aurora arcs. The facts are confirmed by the video-data taken at the same time by the television camera at Syowa Station. Third, special features can be seen in the third series of hiss. But now, it remains unexplained that the static wave phenomena are excited by the LHR hiss or by the rocket itself. Fourth, in Fig. 3, there can be seen the burst-like hiss events everywhere, the frequency of which are spreading over 4 to 10 kHz. Comparing these events with the television video data, it is found that they tend to appear at the time when some bright patches are moving along aurora arcs. So they seem to be accompanied with the auroral particles injected into the polar ionosphere.

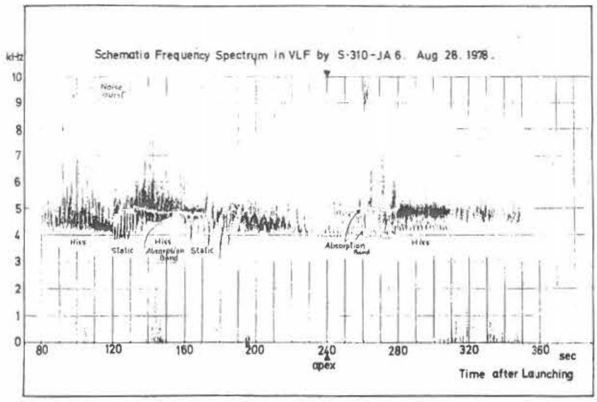


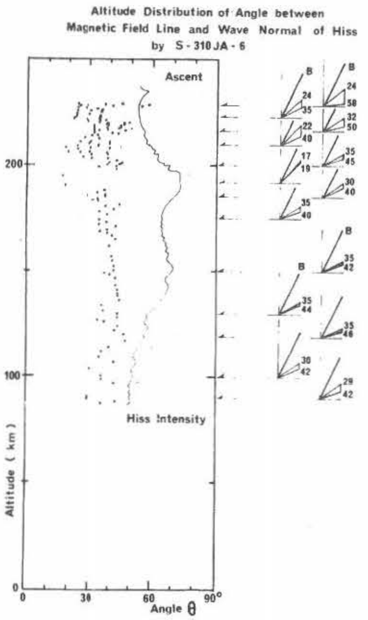
Fig. 7. The schematic frequency diagram of the VLF hiss spectra.

Fifth, in Fig. 3, there can be clearly seen the absorption bands on the second series of hiss(120 - 150 sec.) at about 5.4 kHz and on the fourth series of hiss(240 - 350 sec.) at about 6 kHz. The frequency of these absorption bands correspond to the LHR frequencies at these altitudes, respectively.

Unfortunately, owing to a bad performance of the polarization meter, we can not observe the polarization ratio. However, the ratio of minimum to maximum signals on wide-band, as the loop antenna rotates, is given by

$$E_{min}/E_{max} = \cos\phi$$

where ϕ is the angle of between the rocket spin axis and wave normal dirction. This relation will allow us to find the cone angle without distinguishing between the up- and the down-going direction. Fig. 8 shows the altitude distribution of the cone angle obtained by the above treatment.



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