Preliminary Observation of Polar Ionosphere
by Low Frequency Pulse Sounder

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The ionization and deionization processes and energy transfer mechanism are quite complex in the lower part of the ionosphere and the lower ionosphere in the polar region has a close relation to auroral phenomena. In spite of the importance of the lower ionospheric observation for analyses of the above described problems, only a few experiments have been carried out till now due to the difficulties caused by low electron density, comparatively high collision frequency and inefficient antenna system. This report gives a summary and results of preliminary experiments on the lower ionosphere by using a low frequency pulse sounder and large-scale antennas which were carried out during the author’s participation as a wintering member, in the 13th Japanese Antarctic Research Expedition (February 1972–February 1973).

The ionosonde of the old type was remodeled into a low frequency pulse sounder consisting of all solid state circuits except the final stages and its main electrical configurations are as follows:

- Frequency range: 50–2150 kHz (manual sweep)
- Peak output power: about 1 kW (presumed value)
- Pulse width: 40–400 μsec (variable)
- Pulse repetition frequency: 40–250 μsec (variable)

The dielectric constant of the snow of the Antarctic Continent is 1.5 at its surface and this value increases with the snow depth and reaches the constant value of 3.2 at the depth of 120 m. The value of tan δ, dielectric loss, is $2 \times 10^{-3}$ at 1 MHz when the snow density is 0.3 (Yoshino and Eto, 1971). Therefore the characteristics of antenna extended on the snow surface are very similar to those of antenna in free space. In practice, the long wire antenna as long as 21 miles was used for VLF experiment at Bird Station in the Antarctic Continent.

Field experiments were carried out three times. The first experiment was carried out at point F16 (69°02'S, 40°03'E) in the Antarctic Continent about 20 km apart from Syowa Station and the ice thickness was 470 m. A couple of doublet antennas for transmitting and receiving were extended on the snow surface and the total length of each antenna was 475 m. The ionospheric observation was carried out at five frequencies; 250, 750, 1200, 1850, 2100 kHz from 0000 hr,
October 19, to 1200 hr, October 21, 1972. During the period, the ionospheric data showed the blackout from about 0700 hr in the daytime, but showed the existence of reflected echoes from the ionosphere in the nighttime.

The second experiment was carried out at Skjegget Peak, Skarvs Nes (69°27'S, 39°35'E). A couple of vertical delta antennas terminated by a resistance of 600 ohms were constructed along the bluff of Skjegget Peak, 360 m high. The length of each element was 500 m. The reflected echoes of 150 kHz, the

Fig. 1. Configuration of doublet antennas at point F18.
The small rectangular shape indicates an experimental cabooth.

Fig. 2. Results of lower ionospheric observation at point F18.
lower limit of the frequency of the receiver used at that time, were also observed with that antenna.

The third experiment was carried out at point F18 (69°02'S, 40°07'E) near F16, and the ice thickness was 752 m. A couple of doublet antennas were extended on the snow surface. One was used for a transmitting antenna 1600 m in total length and the other was used for a receiving antenna 1000 m in total length as shown in Fig. 1. Figure 2 shows the results of lower ionospheric observation made every one minute at F18 by means of the frequency 200 kHz. The observing period was from 0021 hr, February 1, to 2400 hr, February 9, 1973 except the period between 0336 hr, February 3 and 2305 hr, February 5 interrupted by strong blizzard. In this graph, the intensity of the reflected echo is classified into the three grades: strong, medium and weak, furthermore the white rectangle shows the case of existence of the second echo. Reflected echoes appeared in the nighttime between about 1900 hr and 0700 hr, but disappeared in the daytime except on the 6th and 7th. Comparatively strong echoes appeared in the nighttime and there existed weak echoes even in the daytime on the 6th and 7th. At the frequency 200 kHz, reflection was from a vertical height of approximately 105 km most of time, but small variations occurred.

From the experimental results, it was made clear that even the simple antenna just extended on the snow surface was very effective. Reflected echoes from the lower ionosphere in the frequency range between 50–2150 Hz were observed clearly and time variation of the lower ionosphere under quiet and disturbed condition was observed with comparatively low transmitting power (less than 1 kW) by using doublet antennas which were extended on the snow surface.

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REFERENCE