OBSERVATIONAL RESULTS OF ELECTRON DENSITY PROFILE BY S-310JA-7 ROCKET

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Abstract: In order to measure the ionospheric plasma in the polar region, a sounding rocket was fired at 221550 LT on March 27, 1978 from Syowa Station in Antarctica. Maximum electron density of about 1×10^{6} cm^{-3} was obtained, which is the highest value among the observational results obtained during 1971–1978.

1. Introduction

A sounding rocket S-310JA-7 was fired from Syowa Station and reached the maximum altitude of 219 km. The period when the rocket was flying coincides with the substorm expansion phase and auroral break-up phenomena occurred during the rocket flight. Four times of multiple echoes from the E_s layer, frequency of which extended to about 6.6 MHz, were observed on the ionograms until 2215 LT on March 27. However, a trace of the reflected echoes from the ionosphere disappeared on the ionograms after 2230 LT, hence the ionospheric condition was auroral blackout. Riometer records of 20 MHz and 30 MHz cosmic noise absorption (CNA) showed intense absorption at 2217 LT and large absorption continued until about 2250 LT

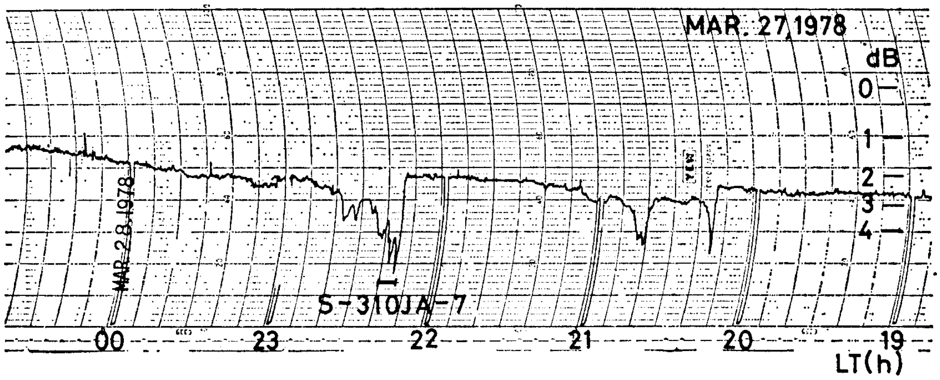

Fig. 1. 30 MHz riometer record at Syowa Station.

and thereafter CNA level recovered to the usual quiet day values. The maximum absorption of the 30 MHz CNA was 3.9 dB as shown in Fig. 1. The value of the horizontal geomagnetic variation indicated about 740 nT just after the rocket firing and thereafter it exceeded 1000 nT. The auroral break-up occurred 50 s after the rocket firing, aurora moved southwards and auroral activity became quiet 100 s after the rocket firing. However, auroral activity became active again 210–310 s after that and brightness of the visible aurora became intense.

2. Results

The electron density was measured from the electron current flowing into the grid of the Faraday cup which was mounted on the top of the rocket. Fig. 2 shows the observational results of the electron density by the rocket S-310JA-7. The electron densities were measured at the altitude ranging from 75 km to 219 km. The amplifier became saturated because the electron density between 85 km and 135.5 km in the ascending time was very high. Therefore, the electron densities were guessed from the current data of the thermal energy analyzer aboard the same rocket. The obtained results are represented by the plotted curve in Fig. 2. Fig. 2 shows that local maximum electron densities of about 9.4×10^5 cm^{-3} were observed at 85 km and 120 km. The electron density decreases monotonically from 120 km to 219 km in the ascending time. There is found a local decrease in the electron density at 180 km in the ascending time, but this feature may be related to the time fluctuation of the high-energy particle precipitation. The electron density shows a nearly constant value of 1.6×10^5 cm^{-3} in the region between 120 km and 87.3 km in the descending time, the electron density decreases abruptly below 80 km.

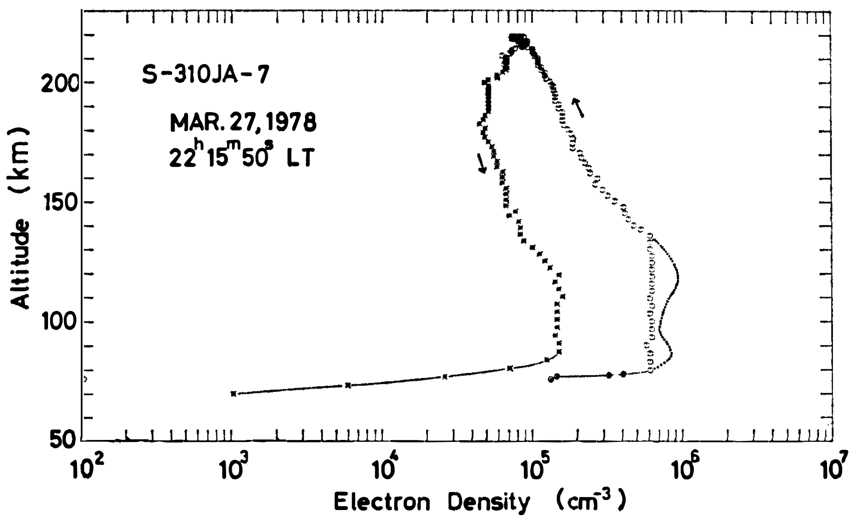

Fig. 2. Electron density profiles by S-310JA-7.

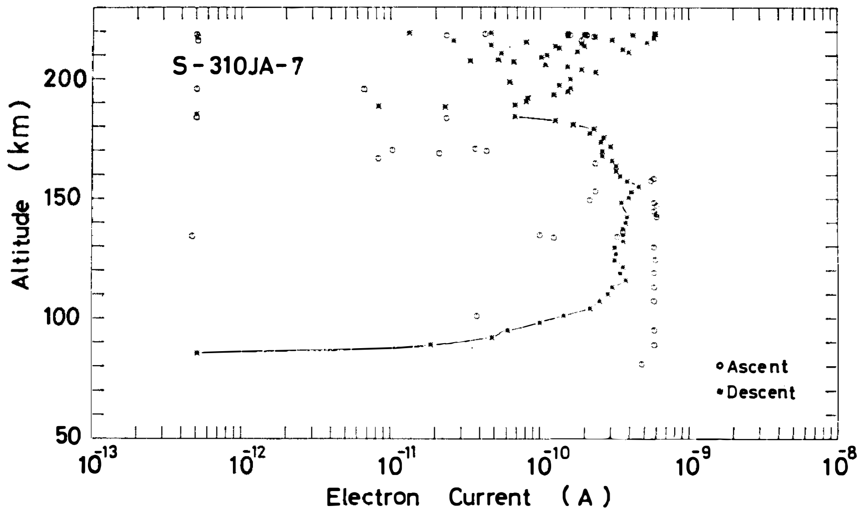

Fig. 3. Current profiles of precipitated electrons with energy greater than 105 eV by S-310JA-7.

Fig. 3 shows the electron current of the energetic electron whose energy is greater than 105 eV flowing into the collector of the Faraday cup. The current shows a saturated value of 6×10^{-10} A in the region between 81 km and 148 km in the descending time and this fact indicates that a large current is brought by the large flux of the precipitation accompanied with auroral breakup phenomena. Large fluctuations in the flux of the precipitation were observed in the region between 216 km and 188 km in the descending time and the fluctuations are greater than one order of magnitude. The electron current between 182 km and 107 km shows a nearly constant value of $3\text{–}4 \times 10^{-10}$ A and this means there are relatively constant fluxes in the region.

As it is clear from Figs. 2 and 3, there seems to be good correlation between the electron current of the energetic particle precipitation and the electron density profile. The saturated region of the energetic electron current coincides with the saturated region of the electron density in the ascending time, and above this altitude the electron density decreases monotonically as the energetic electron current decreases. The electron density changes similar to the precipitation flux between the apex of the rocket trajectory and 182 km. The electron density shows a local minimum near 182 km and the electron density increases as the flux increases below that altitude. It is shown that the electron density decreases abruptly below 85.3 km corresponding to the fact that the flux becomes nearly zero at 85.3 km in the ascending time.

The electron densities of the *E* region have a good correlation with the auroral 5577 Å line intensities observed on the ground, that is, the maximum electron densities of about 9.4×10^5 cm^{-3} in the ascending time and about 1.6×10^5 cm^{-3} in the descending time correspond to the 5577 Å line intensities of about 30 k*R* and 10 k*R*, respectively. Also there seems to be a good correlation between the current profile of the precipitated electrons and the profile of the auroral X-ray intensities with energy greater than 4 keV observed by the same rocket. Furthermore, the electron temperature, electric field intensity, electro-magnetic and electro-static wave intensities and high-energy particle intensity were observed simultaneously, thus energetics and various phenomena in the polar ionosphere, especially in the active auroral condition, may be analyzed by using these data. These research problems are the subjects for future studies.

Acknowledgments

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