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Estimation of electron density profile in the high latitude ionosphere by SRP-5 sounding rocket

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An Improved-Orion sounding rocket SRP-5 has been carried out. The rocket was launched from the Poker Flat Research Range, Fairbanks, Alaska at 14:17 LT on January 10, 2009. The primary science objective of SRP-5 Project ISIS (Ionospheric Science and Inertial Sensing) is to measure the plasma density structure of the high latitude D region ionosphere above Poker Flat Research Range. This will be accomplished using a plasma probe, radio receivers, and other sensors. The objective of TPU (Toyama Prefectural University) radio receiver is the investigation of the electron density profile in the high latitude D region at daytime. The electron density profile in the lowest ionosphere is estimated from the measured absorption of three radio waves.

We observed three different signals, CHENA (257 kHz), KFAR (660 kHz) and KCBF (820 kHz), transmitted from navigation and broadcast stations near Fairbanks, Alaska. Three signals were successfully observed from an altitude 0 km - 98 km during the ascent flight.

The receiver has observed field intensities of three radio waves and waveforms changed to about 100Hz by the downconverter. In the results of the field intensities, 257 kHz, 660 kHz and 820 kHz waves were modulated with an intensity variation up to about 90 seconds. The intensity modulation is due to the directivity of the loop antenna and the rotation of the loop antenna plane. During the rocket ascent up to about 150 seconds, the intensity of these radio waves decrease gradually with increasing time until it reaches the system noise level of the receiver at about 110 seconds. These attenuations in the wave intensity are due to collisions between the electrons and the neutral molecules in the lower ionosphere. In the region more than 150 seconds during the rocket descent, these intensities increase with increasing time. But these intensities suddenly change at about 190 seconds. These changes are due to the rocket tumbling. On the other hand, the spectrums of three radio waves are obtained by the FFT (Fast Fourier Transform) from the waveforms. These spectrum branch off after launch, so that the waveforms are affected by the frequency of rocket spin. In all frequencies, the outermost spectrums disappear at about 90 seconds, so that the rocket went into the ionospheric D region.

The approximate electron density profile can be determined from the comparison between these experimental results and propagation characteristics calculated by the full wave method. The most probable electron density profile in the lowest ionosphere below 65 km is demonstrated in this study

Keywords: radio wave propagation characteristic, electron density profile, ionosphere, sounding rocket measurement