

Measurement of propagation characteristics of MF band radio waves in lower ionosphere by S-310-40 sounding rocket

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The ionospheric D region is important in radio wave propagation because it absorbs energy from waves at MF, HF and VHF, and it reflects LF and VLF signals. Then D region is present only during daylight hours. Therefore, in the night-time, the MF band radio waves are propagated as far as an area where its radio waves cannot be propagated in the daytime. This reason why the radio waves cannot receive is that the D region is disappeared at night. However, the MF band radio waves that transmit from distant place have not been often received at the mid latitude in the night-time. In this time the sporadic E region cannot be observed by the ionogram. We guess that the D region appear in the lowest ionosphere like a daytime. To farther study the structure of the lowest ionosphere, we propose a method to measure the very low electron densities that occur at altitudes from 50 km to 90 km using the partial and perfect reflection characteristics of electromagnetic waves.

S-310-40 sounding rocket experiment was carried out at Uchinoura Space Center (USC) at 23:48 JST on 19 December, 2011. The purpose of this experiment is the investigation of characteristics of radio wave propagation in the ionosphere and the estimation of electron density structure in the lower ionosphere, when the intensity of radio wave measured on the ground will be attenuate at night-time. In order to measure the radio waves, a LF/MF band radio receiver (LMR) is installed on the sounding rocket. The LMR has measured the propagation characteristics of four radio waves at frequencies of 60 kHz (JJY signal from Haganeyama radio station), 405 kHz (NDB station from Minami-Daito), 666 kHz (NHK Osaka broadcasting station) and 873 kHz (NHK Kumamoto broadcasting station) in the region from the ground to the lower ionosphere. The LMR consists of a loop antenna, a pre-amplifier and a detector circuit. The loop antenna is set up in the nose cone, which is transparent to the LF/MF band radio waves, and is not deployed during the flight. Therefore, the LMR can measure the relative attenuation of radio waves from the ground up to the ionosphere. Furthermore three components of four radio waves measure by using three loop antennas. We can obtain the propagation directions of radio waves in the ionosphere directly.

We will explain a new radio wave receiver with the loop antenna system (LMR) on-board S-310-40 sounding rocket and show the results of propagation characteristics of radio waves in the ionosphere. And the approximate electron density profile can be determined from the comparison between propagation characteristics observed by the LMR and propagation characteristics calculated by the full wave method. The most probable electron density profile in the ionosphere is demonstrated in this study.

Keywords: Propagation characteristic of radio wave, Ionosphere, Rocket experiment