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S-310-40 号機による夜間電離圏下部領域の中波帯電波伝搬特性観測
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 the loop antenna consists of three loop antennas in order to measure three components of four radio waves. Then we can obtain the propagation directions of radio waves in the ionosphere directly.

A propagation vector can be obtained from the propagation characteristic of radio wave. It is possible to estimate electron density profile from a propagation vector, because the propagation vector is dependent on the electron density profile in the radio wave propagation region. We have estimated the electron density profile by the propagation vector. When the electron density profile estimated by the propagation vector was compared with the electron density profile measured with the Langmuir probe and the impedance probe onboard the S-310-40 sounding rocket, it was found that electron density becomes the maximum at an altitude of 104 km.

We show the results of propagation characteristics of radio waves in the ionosphere and explain the propagation vector of radio wave in the ionosphere. And the electron density profile in the ionosphere can be estimated by the propagation vector. We will show the result that it is investigated the influence the lowest ionosphere region has on a MF band radio wave in this study.

キーワード: 電離圏, 電波伝搬特性, ロケット実験
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