電波伝搬特性解析による電離圏下部領域の電子密度推定の自動化

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Automated estimation of electron density profile in the lower ionosphere by the radio wave propagation characteristics

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SRP-5 sounding rocket was launched from Poker Flat Research Range, Fairbanks, Alaska at 14:17 LT on January 10, 2009. The primary science objective of SRP-5 Project is to measure the plasma density profile of the polar D region ionosphere above Poker Flat Research Range, which was carried out with using a plasma probe, radio receivers, and other sensors. The objective of TPU (Toyama Prefectural University) radio receiver is to investigate the electron density profile in the polar D region at daytime. The electron density profile in the lower ionospheric region is estimated from the absorption of radio waves observed by SRP-5 sounding rocket. We observed three different radio waves, CHENA (257 kHz), KFAR (660 kHz) and KCBF (820 kHz), transmitted from navigation and broadcast stations near Fairbanks, Alaska. They were successfully observed from the altitude 0 to 98 km during the ascent flight. During the rocket ascent, up to about 150 seconds, the intensities of these radio waves attenuate gradually with increasing time, until they reach the system noise level of the receiver at about 110 seconds. These attenuations are due to collisions between the electrons and the neutral molecules in the lower ionosphere.

The approximate electron density profile can be estimated from the comparison between these observation results and propagation characteristics calculated with Full wave method. The estimated electron density profile suddenly increase then decrease at the altitudes between about 80 and 90 km. The magnetic intensity, calculated with Full wave method from this electron density profile, are almost the same as the experimental results.

This estimation process has some problems. At first, we have no clear standard for comparing observation results and propagation characteristics calculated with Full wave method. In addition, we have to iterate many times correcting the electron density profile by handwork, calculating propagation characteristics with Full wave method and comparing observation results and calculated propagation characteristics. This iteration takes too long to estimate appropriate electron density profile. To reduce these problems, we are going to develop an application to realize automated estimation of electron density profile by analyzing radio wave propagation characteristics.

電離圏下部領域の電子密度高度分布を推定する手法として，ロケット観測による直接観測が最も有効であると考えられている．本研究では，ロケット観測で得られたデータを用いて電子密度高度分布を推定する際に用いる電波吸収法の自動化について検討する．

電波吸収法は，まず仮定した電子密度高度分布から Full wave 法を用いて電波強度の理論値を計算し，ロケット実験で得られた観測値と比較する．電波強度の理論値と観測値が一致すれば，仮定した電子密度が妥当であると判断できる．一致しなかった場合，比較して得られた結果にもとづいて電子密度高度分布を修正し，電波強度の観測値と理論値を徐々に一致させ，電子密度を推定する手法である．この手順のうち，電波強度の観測値と理論値の比較および電子密度高度分布の修正を手作業で行っており，電子密度の修正に時間がかかるという欠点がある．また，観測値と理論値を比較する際に定量的な基準がないという問題点もある．

そこで，電波吸収法に定量的な判断基準を導入し，電子密度を自動的に修正して，現状よりも短時間で詳細な電子密度高度分布推定を行うことができるアプリケーションを開発する．現在観測値と理論値の差が大きい部分について電子密度の修正方法を検討している．また，ロケットスピンなど電子密度以外の原因で電波強度が増減することがあるため，その部分を考慮したアルゴリズムを開発する必要がある．