Feasibility of a radio tomography technique of electron density profile by using non-ducted propagation whistlers

Yoshitaka Goto[1], Yoshiya Kasahara[2], Toru Sato[3]

[1] Dept. of Communications and Computer Eng., Kyoto Univ., [2] Dept. of Information and Systems Eng., Kanazawa Univ., [3] Informatics, Kyoto Univ.

Theoretical researches have been carried out on multisatellite radio tomography experiments for a large region of electron density profile in the magnetosphere[1,2]. Their methods are based on a kind of active sensing which requires several interspacecraft measurements. On the other hand, there are various kinds of natural waves in the magnetosphere. Thus it is significant to use these waves for the investigation of plasma environments from the perspective of a passive remote sensing.

VLF waves in the whistler mode reflect the geomagnetic fields and electron density along the propagation paths. By using the OMEGA signals(10.2kHz) which had been used for the global navigation, the method to estimate a large region of electron density profile in the plasmasphere has been studied[3,4]. However, OMEGA navigational stations were terminated their operation in 1998 due to the replacement of their functions by GPS. In the present study, we examine the feasibility of a method to estimate electron density profile in the plasmasphere by using the observations of whistlers.

Based on the ground-based measurements of whistlers, researches have been carried out on the long term variation of electron density profile in the magnetosphere by examining the dispersions of whistlers. As the propagation paths of non-ducted whistlers observed by the satellite are different depending on the frequency, it is difficult to estimate electron density from the spectrum of such non-ducted whistlers. On the other hand, different propagation paths of non-ducted whistlers enable us to estimate a large region of electron density profile by the tomographic approach. However, the problem is extremely complicated because the paths of non-ducted whistlers must be determined by in-situ dispersion relations. In the present study, we use the model fitting method for the estimation of electron density profile in the same way for OMEGA signals. Namely the electron density profile is estimated so that the observed and theoretically calculated whistler spectrums are consistent each other. The global electron density profile is represented by several parameters, and the parameters are determined based on the index of estimation derived from the whistler spectrum.

According to the observations by the Akebono satellite, whistlers were usually observed in the plasmasphere and the occurrence probability is beyond 30¥%. Thus the essential information for our method can be easily obtained by the satellite observations. However the whistlers which we can use at present are restricted to the most general whistlers whose frequency decreases with time. The utilization of other kind of whistlers, for example those resulted from the LHR reflections, is the challenging future problem.

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