

Ionospheric penetration characteristics of VLF whistler mode waves by ground-based and satellite observations in the polar region

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In order to evaluate polar ionospheric penetration characteristics of VLF whistler mode waves, we conducted simultaneous observations of natural VLF waves by using multipoint ground-based stations in Antarctica and Akebono satellite. In the ground observation, the magnetic field intensity and its polarization in 4 spaced frequency channels (0.5, 1.0, 2.0, and 6.0 kHz) were observed at three stations around Japanese Syowa station in Antarctica, during the entire year of 2006. The ground observations showed interesting difference in the wave intensity as well as the polarization at each station. These differences have important information to evaluate the VLF ionospheric exit point. To rigorously evaluate the exit point, we have performed theoretical calculation by using full-wave analysis. The full-wave analysis calculates the whistler Gaussian beam propagation taking into the effect of the magnetized ionosphere. For example, for an auroral hiss emission, we have estimated the exit point by comparing between the ground observations and full-wave calculations. The estimated results showed that the direction of the exit point for auroral hiss was clearly correlated with the auroral activity.

Moreover, in order to evaluate the ionospheric propagation of whistler mode waves in more detail, natural VLF waves above the ground-based stations were observed by Akebono satellite. We can calculate the wave normal vector and the Poynting flux of the natural VLF waves in the ionosphere by using the VLF instruments onboard Akebono satellite above the ground-based stations. The satellite and ground observations showed the possible and impossible situations for the ionospheric penetration of VLF down-going whistler mode wave.

In this presentation, we will discuss quantitatively ionospheric penetration characteristics of the VLF whistler mode waves in the polar region by using the ground-based and satellite observations and theoretical result by full-wave analysis.