Ducted propagations of whistler mode waves in density enhanced and depression ducts observed by the Arase satellite

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Ducted propagation of whistler mode waves in the magnetosphere is of great importance for the generation of microbursts and resultant loss of radiation belt electrons. Theoretical and simulation studies have shown the propagation characteristics of ducting of whistler mode waves, and in-situ satellite observations have reported many cases that suggest ducting based on the correlation between changes in electron density and changes in wave intensity. To the best of our knowledge, there is only one quantitative comparison between observations of ducting whistler and the ducting theory: a report on the duct propagation of a whistler-mode chorus along high-density ducts (HDDs) (Chen et al., 2021).
Here, we report on the following four modes of ducted propagation cases of whistler mode waves along the increase/decrease of electron density observed by the Arase satellite. (1) Lower-Band (LB) waves propagating along the HDD with wave normal angle (WNA) of around 0 deg, (2) LB waves propagating along the low density duct (LDD) with WNAs distributed between 0 deg and over Gendrin angle, (3) LB waves propagating along the LDD
with WNAs of around Gendrin angle, (4) Upper-band waves propagating along the LDD with WNA of around 0 deg. We estimated the WNAs for each case using singular value decomposition (SVD) method (Santolík et al., 2003) and their characteristics were consistent with ducting theory (Smith et al., 1960). We calculated the frequency range in which waves are ducted based on the ducting theory. We compared this frequency range with the intensity of the observed whistler mode waves and found that the observations were consistent with the theoretical prediction. Furthermore, it is suggested that the WNAs for the cases (2) and (3) have azimuthal distributions based on the comparison between the observations and the SVD analysis of the simulated waveforms.

キーワード：ホイッスラモード波、放射線帯
Keywords: Whistler mode wave, Radiation belt

