Relationship between energy of pulsating auroral electrons and duct propagation of chorus wave: simultaneous observations with EISCAT radar, ground-based all-sky imagers, and Arase satellite

Yuri Ito[1], Keisuke Hosokawa[1], Yasunobu Ogawa[2], Yoshizumi Miyoshi[3], Mizuki Fukizawa[2], Kiyoka Murase[2], Shin-ichiro Oyama[3], Satoko Nakamura[3], Yoshiya Kasahara[4], Shoya Matsuda[4], Satoshi Kasahara[5], Yoichi Kazama[6], Tomoaki Hori[3], Shoichiro Yokota[7], Kunihiro Keika[5], Shiang-Yu Wang[6], Sunny W. Y. Tam[8] and Iku Shinohara[9]

[1]*UEC*

[2]*NIPR*

[3]*ISEE, Nagoya Univ.*

[4]*Kanazawa Univ.*

[5]*Univ. of Tokyo*

[6]*Academia Sinica*

[7]*Osaka Univ.*

[8]*ISAPS, NCKU*

[4]*ISAS, JAXA*

Auroras are classified into two broad categories: discrete auroras, which have a distinct arc-like shape, and diffuse auroras, which have an indistinct patchy shape. Most of the diffuse auroras are known to show a quasi-periodic luminosity modulation called pulsating auroras (PsA). Magnetospheric electrons causing PsA are generally scattered through wave-particle interactions with chorus waves and precipitate into the ionosphere, being referred to as “PsA electrons”. Recent studies demonstrated that sub-relativistic electrons originating from the radiation belt precipitate into the ionosphere during intervals of PsA. It was also pointed out that the energy of PsA electrons tends to be higher when the shape of the optical structure is patchy. These facts suggest that the loss process of such highly energetic electrons in the magnetosphere can be visualized by observing the shape/distribution of PsA and the energy of PsA electrons. In order to test and further validate this visualization method, it is crucial to understand what factors control the morphology of PsA and the energy of PsA electrons, although past studies have not sufficiently examined PsA and electron precipitation in this regard.

In this study, the Arase satellite, ground-based all-sky imagers, and the European Incoherent SCATter (EISCAT) UHF radar were used in combination to carry out simultaneous magnetically conjugate observations of PsA. We investigated the relationship between the morphology of PsA and the energy of PsA electrons by using the data set. First, the energy spectra of PsA electrons were estimated from the ionization profile obtained by EISCAT with an inversion technique, a modified version of CARD originally developed by Brekke et al. (1989). The estimated spectra were compared with those of energetic electrons observed by LEP-e and MEP-e onboard Arase. As a result, it was confirmed that when the footprint of the satellite was close to the sensing area of EISCAT, the energy spectra of precipitating PsA electrons and their temporal variation were in good agreement with those of magnetospheric electrons within the loss cone at the satellite location. In addition, the energy of PsA electrons tended to change in accordance with the transition of the morphology of PsA. Specifically, when the boundary of the patch structure is distinct, the energy of the corresponding PsA electron exceeded 10 keV. Based on these observational results, we hypothesize that both the morphology of PsA and the change in the energy of PsA electrons are controlled by the existence of "ducts," which are tube-like regions where the electron density is lower or higher than the surrounding area. Those duct structures guide chorus waves along the magnetic field to propagate to higher latitudes (Figure 1). In order to test this hypothesis, now we are analyzing PWE data obtained by Arase to infer the spatial structure of electron density in the source region of PsA. In this presentation, we introduce the observational results and discuss the factors controlling the morphology of PsA and the energy of PsA electrons by showing the electron density estimates in the magnetospheric source region.

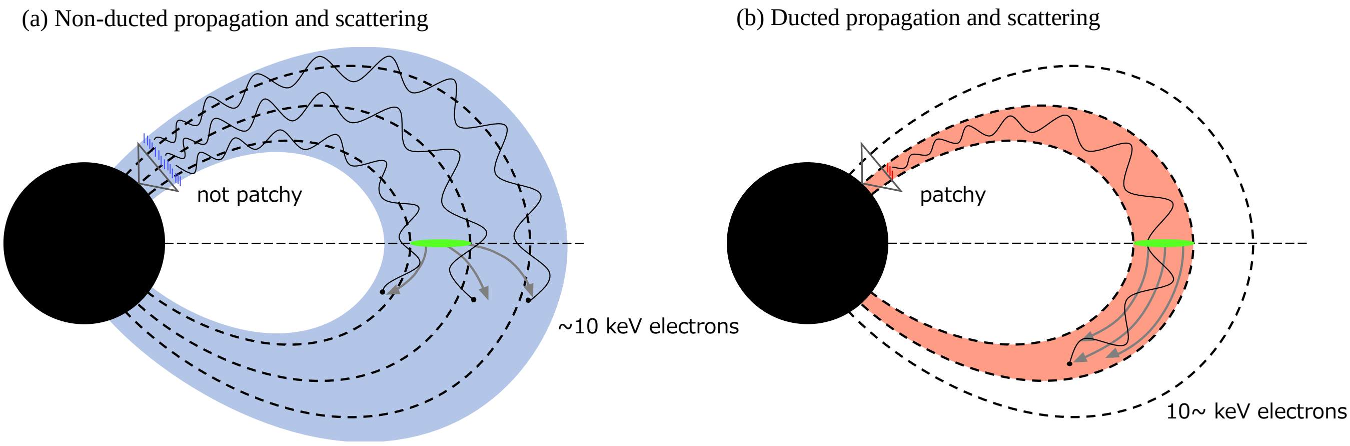

Figure 1. Schematic diagram showing the relationship between pulsating aurora, ducts, and chorus wave propagation. (a): In the case of non-ducted propagation and scattering, resonance energy is low and PsA structure is not patchy. (b): In the case of ducted propagation and scattering, resonance energy is high and PsA structure is patchy.

References

Brekke, A., C. Hall, and T. L. Hansen, Auroral ionospheric conductance during disturbed condition, Ann. Geophys., 7, 269-280, 1989.