Wide energy electron precipitation associated with pulsating aurorae: Arase-EISCAT conjugate observations and computer simulations

Y. Obayashi[1], Y. Miyoshi[1], S. Saito[2], K. Hosokawa[3], Y. Ogawa[4], S.-I. Oyama[1], K. Asamura[5], Y. Kazama[6], S.-Y. Wang[6], S. Kasahara[7], S. Yokota[8], T. Mitani[5], T. Takashima[5], I. Shinohara[5], C.-W. Jun[1], T. Hori[1], K. Keika[7], Y. Kasahara[9], S. Matsuda[9], F. Tsuchiya[10], A. Kumamoto[10], S. Nakamura[1], A. Matsuoka[11], A. Kero[12], P. T. Verronen[12, 13], and E. Turunen[12]

[1]*ISEE, Nagoya University*

[2]*NICT*

[3]*UEC*

[4]*NIPR*

[5]*ISAS, JAXA*

[6]*Academia Sinica, Taiwan*

[7]*Tokyo University*

[8]*Osaka University*

[9]*Kanazawa University*

[10]*Tohoku University*

[11]*Kyoto University*

[12]*Sodankyla Geophysical Observatory, Finland*

[13]*Finnish Meteorological Institute, Helsinki, Finland*

Wave-particle interactions with lower-band whistler-mode chorus (LBC) waves near the magnetic equator result in electron precipitation with energies from a few to a few tens of keV, leading to the diffuse and pulsating aurora (PsA). In addition to the low-energy electron precipitation, recent studies have shown that relativistic electrons with energies from several hundreds of keV to several MeV are scattered by LBC waves propagating at higher latitudes along field lines, and these electrons precipitate into the thermosphere as well as the mesosphere in association with PsA (Miyoshi et al., 2015, 2020, 2021). However, there are still many unknowns, such as the maximum energy of the precipitating electrons, the dominant factors that change the precipitating electron flux, and the effects on the atmosphere. To understand electron precipitation over a wide energy range associated with PsA, we investigate an energetic electron precipitation event observed at Tromsoe, Norway, on March, 2022, by analyzing data from the Arase satellite and the European Incoherent Scatter (EISCAT) radar. First, we used the inversion method to estimate an energy spectrum of precipitating electrons from the height profile of electron density obtained by the EISCAT radar. The result shows precipitation of electrons over a wide energy range, and particularly strong precipitation is observed for low-energy (< several tens of keV) electrons. Next, we examined the pitch-angle diffusion coefficients of electrons using the Arase observations, and we estimate the equilibrium energy spectrum of precipitating electrons based on the quasi-linear theory. The estimated energy spectrum shows a good agreement with the energy spectrum taken from the EISCAT observation if we assume that the chorus waves propagate to the high latitudes. We also conducted the GEMSIS-RBW test-particle simulation (Saito et al., 2012) with physical parameters close to those observed by the Arase satellite in this event. The simulation results in intermittent precipitation of wide energy electrons is obtained. Our integrated study combining with the data analysis and data-driven simulations showed that chorus waves propagating to the high latitudes cause precipitation of electrons over a wide energy range.