Variations of cosmic noise absorption (CNA) by energetic electron precipitation (EEP) and changes of the auroral morphology

*Miyamoto Taishiro[1], Shin-ichiro Oyama[1,4,5], Yasunobu Ogawa[2], Keisuke Hosokawa[3], Satoshi Kurita[1], Yoshizumi Miyoshi[1], Ryuho Kataoka[2], Hiroshi Miyaoka[2], Tero Raita[4]

1. Institute for Space-Earth Environmental Research,Nagoya University, 2. National Institute of Polar Research, 3. Department of Communication Engineering and Informatics, University of Electro-Communications, 4. Sodankylä Geophysical Observatory, University of Oulu, 5. Ionosphere Research Unit, University of Oulu

Temporal and spatial variations of aurora morphology in association with substorm have been studied for more than half a century. Various types of aurora are known, such as discrete arc emitting at relatively high intensity and elongating along the zonal direction, and diffuse aurora with darker but more widely spreading in the sky. Pulsating aurora, which is characterized by quasi-periodic oscillations in the emission intensity at periods of a few to tens seconds, and auroral patches observed embedding in the pulsating aurora tend to appear at the recovery phase of substorm, especially from midnight to dawn. It is known that these types of aurora are accompanied by energetic electron precipitation exceeding several hundreds keV. Elucidation of the causality to produce pulsating aurora and energetic electron precipitation is an important theme to understand relationships between the radiation belt and upper-middle atmosphere of the earth. Analyzing measurements from satellite observations (e.g., Arase) and ground-based optical/radio technique observations, the generation mechanism is thought to be mainly attributed to wave particle interactions due to plasma wave and electrons in the magnetosphere. In this study, we focus on relationships between auroral morphological changes, in particular spatiotemporal evolutions to patches and coinciding precipitations of the energetic electron.

Some previous studies have presented changes in morphology from pulsating aurora to patch structures [e.g., Shiokawa et al., 2014] and temporal variations of energetic electron precipitation [e.g., Hosokawa and Ogawa, 2015]. As mentioned above, the wave-particle interaction has been widely accepted with experimental evidences to support generation of pulsating aurora and energetic electron precipitation. However, our understanding has not yet reached its maturity of presenting spatiotemporal evolutions of auroral morphology and associated electron precipitation. Oyama et al. [2017] presented enhancements of CNA (cosmic noise absorption) coinciding with appearance of the patch structure but with only two events. Furthermore, due to measurements with intensive diagnostic instruments, the result was based on information of a part of the auroral ionosphere. In this study, we conducted observations to capture simultaneously time evolutions and spatial distributions of auroral morphology and energetic electron precipitation by utilizing a network of EMCCD (Electron Multiplying Charge Coupled Device) cameras and riometers deployed in Northern Europe.

This study will present three events (February 19-20, 2018, March 6-7, 2017, and March 29-30, 2017). On the way of all events, after substorm onsets twice near Northern Europe, another onset occurred again at more west side (near Iceland or Greenland area) but at dawn in the Northern Europe. In this study, we have focused on the aurora and CNA associated with the latter onset, and at that time, the aurora spatially and temporally shifted from diffuse to pulsation and patch structures. This suggests that substorm activities occurred in the distance can induce these auroral morphological changes seen in the Northern Europe. CNA at that time is characterized by gradual variations with time scale of several hours. This trend cannot be seen at substorm onset near the Northern Europe. Moreover, in the latitude distribution, the feature was confirmed that CNA increases at the latitude where patch structure is seen, and CNA keeps

constant value at the latitude where patch structure is not seen. In the presentation, based on these observations, we will discuss physical mechanisms to cause changes in the auroral morphology and energetic electron precipitation, which can be seen as increases of CNA.

Keywords: Ionosphere, Aurora, Energetic Electron Precipitation (EEP)

