Effects of geomagnetic field and cold plasma on the generation of isolated proton aurora at sub-auroral latitudes

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Electromagnetic ion cyclotron (EMIC) waves in the magnetosphere cause pitch angle scattering of high-energy (several keV ˜tens of keV) ions via wave-particle interactions. Then, isolated proton aurora (IPA) is observed on the ground. EMIC waves propagate along the magnetic fields line from the source region and are observed as Pc1 waves on the ground. In order to understand the effects of geomagnetic field and cold plasma on the wave-particle interactions, we investigated the curvature effects of background magnetic field and cold plasma density on the generation of EMIC waves.

In this study, we calculated the curvature of magnetic field line near the magnetic equator to estimate the curvature effects on the generation of the IPA. The IPA and related Pc1 waves were observed at Athabasca, Canada, using an all-sky EMCCD camera (110 Hz sampling) and an induction magnetometer (64 Hz sampling) at 05:30-06:00 UT on 17 February, 2017. The spectral characteristics of Pc1 waves changed from discrete elements to broadband waves when the IPA moved from higher latitudes to lower latitudes. Then, the gradient of magnetic field line near the magnetic equator, which is calculated by Tsyganenko 2002 model, became 15% smaller. The observation results support the importance of curvature characteristics for spectrum characteristics of EMIC waves.

Next, we compare the IPA observed at 01:30-02:00 UT on 2 January, 2016 at The Pas, Canada, with the differential total electron content (TEC) to investigate the relationship between cold plasma density and IPA. The TEC distribution can be equivalent to the cold plasma density in the plasmasphere. We observed two IPAs showing a clearly spatial gap between them. In the gap region of IPAs, we observed the increase of differential TEC value related to the spatial gap of IPAs. The gap region of IPAs was seen at 63.4 degrees in the invariant latitude and the observed local maximum in the distribution of differential TEC near the gap region of IPAs was seen in the vicinity of the gap at 64.7 degrees. Since the resonant energy of ions becomes small in the case of high plasma density, the IPA is not generated. Therefore, the existence of local maximum in the differential TEC indicates the importance of cold plasma density at the boundary of plasmapause for the generation of IPA.

These observations suggest that the curvature characteristics and cold plasma density are important in the generation of IPA. In this presentation, we will discuss the analysis results of the curvature characteristics and cold plasma density for the generation of IPA in detail.