Shape characteristics analysis of proton aurora by using the level set method

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Electromagnetic ion cyclotron (EMIC) waves are generated by ion temperature anisotropy at the magnetic equator. EMIC waves propagate along the magnetic field line from the source region and are observed as Pc1 geomagnetic pulsations on the ground. The EMIC waves cause the pitch angle scattering of high-energy (several keV ~ tens of keV) ions via wave-particle interaction. A part of precipitated ions travel to the ionospheric altitude along the magnetic field lines. Then, proton aurora is observed. The variation of proton aurora would show a time and spatial evolution of wave-particle interaction region in the magnetosphere. We have been observing HB emission of proton aurora by using an all-sky EMCCD camera (486.1nm) with a low time resolution (60seconds), secondary electron aurora using another all-sky EMCCD camera with a high time resolution (110 Hz sampling) and the geomagnetic pulsations by an induction magnetometer (64 Hz sampling) on the ground at Athabasca in Canada (L value=4.3). In this study, in order to reveal a time and spatial evolution of wave-particle interaction region, we have analyzed proton aurora related to Pc1 geomagnetic pulsations. Proton aurora and Pc1 geomagnetic pulsations were simultaneously observed on the ground at 7:40-8:40 UT on 12 November 2015 at Athabasca. The Pc1 geomagnetic pulsations showed a rising tone structure in the frequency domain and a left-hand circular polarization. The intensity variations of proton aurora and the Pc1 geomagnetic pulsations showed one-to-one correspondence with each other in this event. This result suggests that the observed Pc1 geomagnetic pulsations and proton aurora are generated by the EMIC instability in the magnetosphere. Both intensity variations have a clear period of about 1 minute. Moreover, the proton aurora showed a fast modulation of about 10 seconds with the main fluctuations of about 1 minute. Next, to investigate a relationship between the intensity and luminous area of the proton aurora, we use the level set method, which is a kind of optimization methods for modeling dynamic objects. The analysis result shows that the luminous area has a strong correlation with the intensity. This would be caused by the effects of charge exchange interaction for energetic protons (below 200 keV). On the other hand, the strong correlation may be caused by the effects of variations of flux tube in the magnetosphere modulated by the Pc1 pulsations.
In this presentation, we will discuss the analysis results of the proton aurora and the Pc1 geomagnetic pulsations at Athabasca in detail.

Keywords: Proton aurora, Level set method

