Multi-event analysis for chorus waves and pulsating aurora at sub-auroral latitudes

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Pulsating aurora is a kind of luminous phenomena, which shows a luminous modulation on timescales from several hundred milliseconds to tens of seconds. It is generated by interaction between high-energy electrons and chorus waves. It is expected that spatial and temporal variations of pulsating aurora show a close relationship with those for chorus waves. In order to investigate their relationships, we have been analyzing simultaneous ground observations of pulsating aurora and chorus waves at Athabasca in Canada (L=4.3). VLF waveform is sampled at 100 kHz and all-sky EMCCD camera for pulsating aurora is sampled at 110 Hz. In this study, we analyzed 11 events of simultaneously observed pulsating aurora and chorus waves from Dec., 2014 to May, 2015. In each event, the auroral luminosity had a correlation with the chorus intensity, which also showed a correlation with AE index. These results show that high-energy electrons resonate efficiently with the chorus waves during a high auroral activity. Next, we have performed a statistical analysis of internal modulations of the pulsating aurora observed at different latitudes in the FOV of the all-sky EMCCD camera. The occurrence distributions of the internal modulation showed different trends above and below a modulation frequency of 4 Hz. In the case of less than 4 Hz, the internal modulation frequency had a correlation with its luminosity. This is the same result reported by Nishiyama et al. [2014] based on the nonlinear wave growth theory. Pulsating aurora having the internal modulation below 4 Hz frequently appeared at low latitudes. This would be caused by the effect of a small geomagnetic inhomogeneity at the equatorial region based on the nonlinear wave growth theory. On the other hand, pulsating aurora exhibiting internal modulations above 4 Hz had a weak intensity in comparison with that with less than 4 Hz. This would suggest that the flux of energetic electrons causing the high modulation frequency was low, or the internal modulation above 4 Hz was generated by high-energy electrons, which could not contribute to the auroral emissions. The occurrence of pulsating aurora showing a high modulation frequency (4~10 Hz) was mainly distributed at high latitudes. This would be caused by the effect of hiss-like emissions generated with a high ratio of plasma frequency and electron cyclotron frequency. Thus, the spatial and temporal features of pulsating aurora can be expected to vary with the conditions of chorus generation depending on the L-value.
In this presentation, we will discuss the relationship between high-energy electrons causing pulsating aurora and chorus waves in detail.

Keywords: Pulsating aurora, Chorus waves, A few Hz modulation

