Large-scale characteristics of pulsating aurora periodicities: multi-point high-speed optical observations in Scandinavia

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It has been known that most of diffuse aurorae in the morning side are composed of luminous patches whose brightness modulates quasi-periodically. Such aurorae are termed as pulsating aurora (PsA) and have been studied extensively in the last decade. PsA patches have a scale size of a few hundreds of km and are usually observed during the late recovery phase of substorms. The entire temporal variation of PsA consists of two individual modulations: main pulsation and internal modulation. The periodicity of the main pulsation ranges from a few to a few tens of seconds and the internal modulation, showing a few Hz scintillating luminosity changes, is often embedded within the ON time of the main pulsation. Previous studies using satellites indicated one-to-one correlation between PsA and chorus wave near the equatorial plane of the magnetosphere, suggesting that ground-based observations of PsA can be used for mapping the activity of chorus in the magnetosphere in 2D fashion. In the past, the spatial characteristics of chorus wave have not visualized in detail because satellite observations only cover a single point in the magnetosphere. To overcome this limitation, we derive the spatial distribution of chorus waves by using ground-based optical observations of PsA and discuss the ambient parameters which characterize the nature of chorus.
For this purpose, we have employed data from electron multiplying charge-coupled device (EMCCD) cameras deployed at multiple sites in Scandinavia to derive the large-scale characteristics of PsA. EMCCD cameras have been operative in Kevo and Sodankyla in Finland, Tromsoe in Norway, and Tjautjas in Sweden and their temporal resolution is 100 Hz. We conducted a frequency analysis for a PsA event on March 28, 2017 (23:30 to 24:10 UT). During the event studied, there existed three different regions of PsA, regions A, B and C, showing different modulation periods. It was also found that the boundaries between these three regions were sharp. We derived the 2D frequency map by using data from all the available stations. As a result, it became clear that the higher latitude region (region C) showed faster internal modulation than the lower latitude region (region A). In addition, region B, which was sandwiched by regions A and C, did not show any internal modulations (i.e., main pulsation without internal modulation). In the presentation, we discuss why the three regions showed different modulation periods with sharp boundaries. In particular, we address what ambient conditions can control the absence of internal modulation in region B. We also derived similar frequency maps of chorus waves by tracing the PsA modulation with the Tsyganenko 04 magnetic field model, which could be used to estimate the spatial extent of chorus wave generation region.

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