Simultaneous observations of pulsating aurora with multi-point high-speed optical measurements and ARASE/ERG satellite

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Pulsating aurora (PsA) is one of the major types of aurora often seen in the lower latitude part of the auroral region in the morning side. The period of the main optical pulsation ranges from a few to a few tens of seconds, and PsA is almost always observed during the recovery phase of substorm. Recent coordinated satellite-ground observations of PsA indicated that the temporal variation of the main optical pulsation is closely associated with the intensity modulation of whistler mode chorus waves in the morning side magnetosphere because the intensities of the chorus waves and optical pulsation show similar temporal variation [e.g., Nishimura et al., 2010]. However, it is still under debate what process causes the precipitation of PsA electrons and what factor controls the period of optical pulsation.

To further associate the chorus intensity variation in the magnetosphere and optical pulsation in the ionosphere, we need to conduct simultaneous ground/satellite observations of PsA. For this purpose, we have installed 3 identical all-sky cameras (ASI) in the northern Scandinavia to observe PsA in a wide area. The cameras were installed into Tromso in Norway, Sodankyla and Kevo in Finland. By employing highly-sensitive EMCCD cameras (Hamamatsu C9100-23B), we succeeded in capturing PsA with a temporal resolution of 100 Hz. The temporal resolution of the camera is sufficient for resolving the temporal variation of both the main pulsation (a few to a few tens of second) and internal modulation (~3 Hz).

During the first coordinated campaign observations of PsA with the ARASE/ERG satellite in March 2017, we obtained several case examples of simultaneous observations of PsA and chorus by the ASIs and ARASE. In particular, on the night of March 28/29, intense PsA appeared for almost 2 hours when the footprint of ARASE was located within the field-of-view of one of the ASIs in Sodankyla. During this 2-h interval, we identified a good agreement between the overall characteristics of the main pulsation of PsA and the chorus burst. For example, when the ASI observed PsA with a constant pulsating frequency, the satellite detected very periodic bursts of chorus. When the satellite observed irregular occurrence of chorus bursts, the main pulsation seen on the ground was rather sporadic.

Most of the past studies [e.g., Nishimura et al., 2010] investigated the relationship between PsA and chorus in relatively short time period, for instance a few minutes. In contrast, an overall good agreement was obtained for 2 hours during the current interval. This again proves the causal relationship between the activities of chorus and PsA. In the presentation, we focus on the event on March 28/29, 2017 and introduce on-going analysis on the fine-scale correlation between the main modulation of PsA and chorus bursts.

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