Temporal and spatial variations of pulsating auroras in fine-scale obtained from ground-based observations

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Pulsating Aurora(PA) is characterized by the periodically changing emission amplitudes with the rectangular pulses of a few seconds to a few tens of seconds [e.g., Oguti et al., 1981; Yamamoto, 1988]. PAs tend to appear in the recovery phase of substorm between postmidnight and dawn sector. The horizontal size of PAs are known to be 10-200 km, based on the optical observations. Recently, some ground-satellite coordinated observations suggested the generation mechanisms of PAs as a result of pitch angle scatterings due to whistler mode chorus waves and/or the electron cyclotron harmonics[Nishimura et al., 2010; Liang et al., 2010]. Time-varying field aligned potential was also suggested by Sato et al. [2004]. The dominant mechanisms and the origin of the periodicity remain unclear. Ground-based all-sky observations have been made for a long time, although they were not enough for a quantitative discussion about small-scale characteristics of PAs such as the shapes and dynamics due to their limited spatial resolutions. The fast temporal variations of intensity known as quasi-3Hz modulations, which was reported by a number of rocket/satellite observations about precipitating electrons[e.g., Sandahl et al., 1980], has been hardly discussed in detail using the ground instruments because of the limited temporal resolutions and sensitivities.

We have carried out ground-based observations using a suit of instruments, consisting of an EMCCD camera, an all-sky video camera, a photometer, and a search coil magnetometer covering the frequency range of ELF-VLF. We installed the instruments at Poker Flat Research Range between November 2010 and March 2011. Our EMCCD camera has narrow field of view corresponding to 100km × 100km at altitude of 110 km and high sampling rate up to 100 frames per second.

An initial analysis result of event on March 4th 2011 around 1100UT revealed two important features of PAs in small scale. One is PAs in the FOV can be categorized into three regions which showed different periods. There were 1-3Hz modulations with peak frequency of 1.5 Hz inside each patches, while there was no higher frequency modulations. In addition, simultaneous observations with the search coil demonstrated that modulations of PA ranged 1 to 3Hz correlated to ELF amplitudes integrated over frequency range of 1-10Hz. On the other hand, VLF emissions corresponding to whistler mode waves were not seen during this period.

These results demonstrate that the temporal and spatial characteristics of PA, such as periodicity, modulation and micro-shapes, varies considerably in a narrow region corresponding to about 2000km × 2000km in the magnetosphere. It means that the generation processes depend greatly on local plasma conditions and the conditions are nonuniform in the source regions.

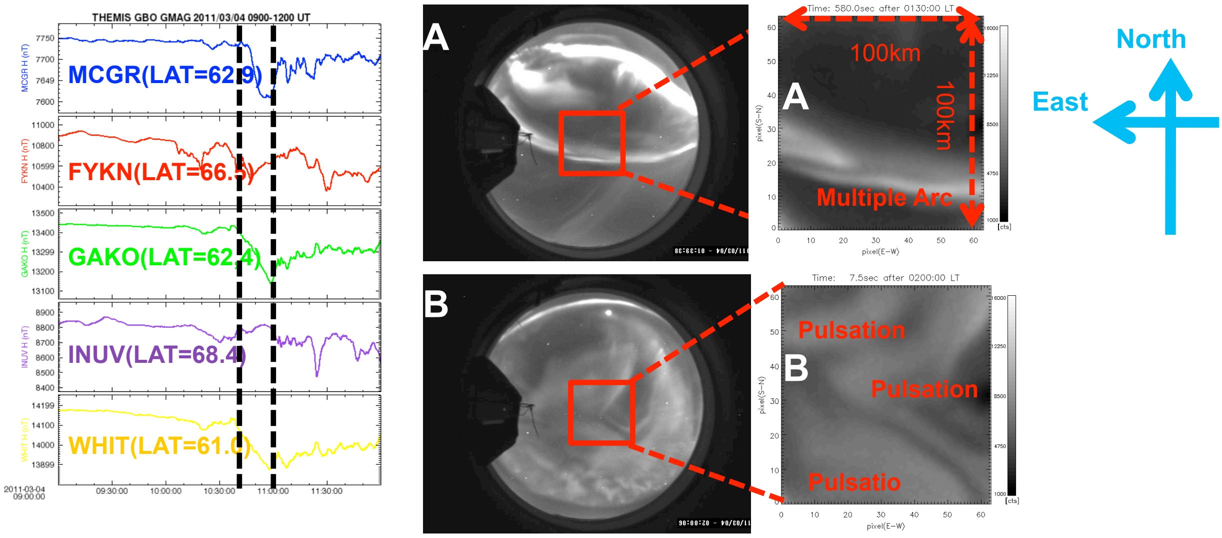

Figure 1. Summary plot of the event on Mar. 04th, 2011

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