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Fine scale structures of pulsating auroras in early recovery phase of substorm

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We have carried out ground-based observations optimized to temporal and spatial characteristics of pulsating auroras (PAs) in micro-meso scale, using an Electron Multiplying Charge Coupled Device (EMCCD) camera with a narrow field of view corresponding to 100km x 100km at altitude of 110 km and high sampling rate up to 100 frames per second. Transient pulsating auroras propagating southward around 1100 UT, in early recovery phase of the substorm, on 4 March 2011 are focused on in this paper. Three independent PAs (PA1-3) with each different periods between 4 and 7s were observed by our EMCCD camera, which means that the periodicity was not bounce motion and strongly depended on local plasma conditions in the magnetosphere, corresponding to 2300 km x 2300 km, or the ionosphere. One more insight is that only PA1 had also a sharp peak of modulations around 1.5 Hz, with a narrow frequency width of 0.30 Hz. In addition, the strong modulations existed as a small spot in the center of PA1, and the spatial distributions of modulations were presented for the first time in this work. We also conducted cross spectrum analysis and obtained coherence and phase maps for auroral variations between 0.1 and 3.0 Hz in order to investigate and quantify the dynamics inside pulsating auroras. The results indicated that low frequency variations from 0.2 to 0.5 Hz inside PA1-3 propagated as a group of flows in the particular directions. The estimated flow velocities were ranged from 80 to 150 km/s at the auroral altitude, corresponding to between 1800 and 3500 km/s at the magnetic equator.

Keywords: Inner magnetosphere, Aurora, Substorm, Wave-particle interactions, Ground observations