Extremely fast auroral morphology beyond the ULF range: new ground-based experiment using sCMOS cameras

Yoko Fukuda[1]; Ryuho Kataoka[2]; Yoshizumi Miyoshi[3]; Naoki Sunagawa[4]; Kazuo Shiokawa[3]; Ayumi Hashimoto[3]; Yusuke Ebihara[5]; Donald Hampton[6]; Naomoto Iwagami[7]
[1] Dept. Earth & Planet. Sci, Univ. Tokyo; [2] NIPR; [3] STEL, Nagoya Univ.; [4] STEL, Nagoya Univ.; [5] RISH, Kyoto Univ.; [6] GI, Univ. of Alaska Fairbanks; [7] U Tokyo

Small-scale and high-speed auroral morphology is important because fundamental physical processes behind the wave-particle interaction can be visualized. The smallest and fastest spatiotemporal variation of auroras is tens of meters and a fraction of a second, which appears especially during intense auroral activities, and is potentially useful to diagnose the plasma environment of magnetosphere-ionosphere coupled system. The purpose of this study is to find the fastest aurora and to understand the formation mechanism of the small-scale and high-speed auroral morphology. Two identical imaging systems were installed at Poker Flat Research Range (PFRR) in Alaska from February to April 2014. A highly sensitive sCMOS camera with the imaging sensor of 2048 x 2048 pixels and the narrow field of view of 15 x 15 degree enable us to identify the smallest auroral structure. The field of view approximately corresponds to 26 km x 26 km at 100 km altitude, and the spatial resolution is ˜52 m when 4 by 4 binning is used. One system uses a sub-array option to enhance the sampling rate up to 1000 frames per second. We used RG665 sharp cut filter only for the sub-array imaging. A major criterion to select the events for this study is more than 15 KR auroral emissions of 557.7 nm at the magnetic zenith. We found a total of 16 nights satisfying the above criterion. About a half of the events are associated with moderate or intense magnetic storms. As the most distinctive examples, it is found that flickering auroras show ˜30 Hz oscillations on February 20, 2014 during storm-time substorms, which are beyond the ULF range (<5-10 Hz). The minimum Dst index was -86 nT at ˜13 UT (˜1.5 MLT), and the AE index exceeded 1000 nT. Pulsating auroras with ˜20 Hz modulations were also captured in the postmidnight sector. Based on such initial results from February to April 2014 data sets, we are developing a new camera system with two major improvements. One is to improve the recording synchronism between two sCMOS cameras by using a GPS clock. The second is the ”active burst mode” to store huge amounts of data observed only when intense auroras appeared overhead, applying an automatic detection technique by using a Nikon DSLR camera with fish-eye lens. The new combined system of the sCMOS camera and the Nikon DSLR camera will be installed at PFRR in the next winter season to statistically investigate the occurrence distribution of the small-scale and high-speed auroras for the first time.