Fast flickering aurora within traveling current vortices

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Flickering auroras have typical frequencies of 5-15 Hz which correspond to oxygen ion cyclotron frequency. The formation mechanism has been therefore assumed as Landau resonance between electrons and electromagnetic ion cyclotron waves in the auroral acceleration region located over the altitude range of ~2000 to 5000 km. However, many fast flickering auroras have recently been found at much higher frequency of up to 50 Hz, which may be contradictory to the standard theory. The purpose of this study is to investigate the formation mechanism of the fast flickering aurora. Two identical imaging systems were installed at Poker Flat Research Range (PFRR) in Alaska since February 2014 and conducted observations during two winter seasons. 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. The sampling rate of the one system is 50 frames per second (fps), while another system uses a sub-array option to enhance the sampling rate up to 200 fps. We used RG665 sharp cut filter only for the sub-array imaging. During a magnetic storm event on February 19, 2014, we found interesting variations in ground-based magnetometer observations nearby PFRR associated with the appearance of fast flickering auroras. It is found that the fast flickering auroras repeatedly appear when the magnetic field show impulsive variations (5-10 min, 100-200 nT amplitude) in the pre-midnight sector. From the phase difference of the impulsive variations of Bx, By, and Bz components, traveling Hall current vortices with the upward field-aligned current can be identified. We discuss the formation mechanism of the fast flickering aurora associated with the traveling current vortices.