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Tomography analysis of eastward propagating auroral vortices

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We have studied characteristics of mesoscale auroral vortices observed in the Northern Scandinavia by aurora campaign observation using multi-point camera network with the EISCAT UHF radar in March, 2013. Three eastward propagating auroral vortices were observed intermittently at about 15-minute intervals in the post-midnight sector (0:00-0:40 UT; 2:30-3:10 magnetic local time) on March 9 just after the substorm onset. They were simultaneously detected by monochromatic (428nm wave length) all-sky EMCCD imagers at Tromso (69.6N, 19.2E), Norway, Kilpisjarvi (69.0N, 20.9E), Finland, and Abisko (68.4N, 18.8E), Sweden, with an exposure time of about 2 seconds and an sampling interval of about 10 seconds. We showed the difference between the eastward propagating auroral vortices and typical omega bands/torches: (1) The auroral vortices occurred during the expansion phase of the substorm, coincident with Pi 2 pulsations at the magnetic equator. The omega bands/touches are usually observed during the substorm recovery phase. (2) The drift velocity of the vortices was approximately 3 - 10 km/s at 100 km altitude, which is much faster than the typical velocity of the omega bands. (3) The ionospheric equivalent current systems derived from the magnetometer data indicated the upward FAC in the dark region inside the vortices, whereas the downward FAC is typically detected in the dark region between the torches. We speculated that the eastward propagating aurora vortices might be transient phenomena that are related to the generation process of the omega bands.

In this study, we further investigated three-dimensional (3D) structure of the auroral luminosity and energy distribution of the precipitating electrons. The generalized aurora computed tomography technique (e.g., Aso et al., 2008; Tanaka et al., 2011) was applied to the second vortex event observed at 0:15-0:18 UT. We found that the average energy of the precipitating electrons tends to be higher for thinner auroral arcs. To confirm that this tendency is common for all auroral arcs, we apply the tomography analysis to the other vortex events. In addition, we perform the numerical simulation to check if this result is not due to the analysis techniques.

Keywords: aurora, tomography analysis, vortex structure, 3D distribution, energy distribution, post-midnight