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Fine-scale electrodynamic structure behind auroral vortex street

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One of the primary scientific objectives of the planned EISCAT_3D system would be “3D imaging of aurora”, especially 3D imaging of dynamically moving auroral arcs at the time of substorm expansion phase onset. In order to discuss the specification of the EISCAT_3D system in detail, we have to know how such an effort of multi-dimensional imaging of aurora has been made by using currently-working radar systems in the high-latitude region. For this purpose, I present a fine-scale electrodynamic structure behind an auroral vortex street observed immediately before substorm expansion phase onset, as inferred from high spatial and temporal resolution measurements of auroral breakup with an all-sky TV camera (ATV) and a coherent HF radar of Super Dual Auroral Radar Network (SuperDARN) in Iceland. During the interval of interest, the ATV observed eastward propagating auroral vortices in the initial brightening arc of a substorm just prior to the poleward expansion. During the sequential passage of the vortices across the radar beams, the radar detected large velocity flow shears whose magnitude was in excess of 1.5 km/s. The observations suggest that flow shears were located very close to the center of the vortices; thus, they corresponded to electric fields converging toward the vortices, which is consistent with the existence of upward field-aligned currents (FACs) flowing out of the vortices. The temporal and spatial resolutions of the current radar measurement were still insufficient for fully resolving the detailed electrodynamic structure behind the fast moving auroral vortices. At least, however, the observations suggest the existence of highly localized filamentary FAC structures behind the auroral vortex street. Such a fine-scale structuring process of an auroral arc would be one of the possible targets of the 3D imaging observations of the planned EISCAT_3D system.

Keywords: Aurora, Radar, Electric Field