



Field-aligned currents in the morning high-latitude auroral arcs

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In January 19-27, 2004, the Swedish-Finnish EISCAT measurement campaign has been performed in Svalbard (around 75 deg. geomagnetic latitude) to investigate the ionospheric plasma flow associated with morning auroral arcs in the 7-11 MLT sector. The radar antenna was directed to west along the local L-shell at an elevation of 45 deg. to horizon. There were cases when rayed auroral arcs occurred in the immediate vicinity of the radar beam allowing for observations of the plasma flow simultaneously at different distances from the arc. All the arcs were associated with a plasma flow shear, which indicate sheets of field-aligned current (FAC) over the arcs. In some cases the data indicate sheets of downward FAC (i.e., upward going electrons) over the rayed arcs. We suggest an explanation to this result, which is based on the current sheet (Kelvin-Helmholtz) instability operating in the magnetospheric regions where plasma pressure gradients exist. As a result filaments of upward FAC and corresponding auroral rays can be embedded in a downward FAC. This mechanism is important in the morning sector where the large-scale Region 1 (R1) FAC occurs. On the other hand, the R1 FAC region is favorable for the magnetospheric interchange instability, which in combination with the current sheet instability can explain the sheets of downward FAC with embedded filaments of upward FAC causing rayed auroral arcs.