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Auroral electric field and potential structures observed by Cluster

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Characteristics and dynamics of auroral electric fields and associated potentials in the upward and downward field-aligned current (FAC) regions are presented based on Cluster field and particle data from six events. Two events were characterized by converging electric fields associated with upward ion beams and upward FACs, and four events by diverging or unipolar electric fields, upward electron beams and downward FACs. Common for both types of acceleration structures are (all values are projected to 100 km altitude): peak amplitudes of $\approx$ 1 V/m, perpendicular scale sizes of 10 km or less, occurrence at auroral plasma boundaries associated with plasma density gradients, and FAC densities up to 20 μA/m2. Apart from the trivial difference between the converging and the diverging electric field structures, the former are typically associated with higher acceleration potentials (with peak energies of upward ion beams of 10 keV as compared to a few keV for the upward electron beams) and larger scale sizes. The temporal evolution of the acceleration potentials in the upward and downward current branches of a FAC circuit reveals for one event an energy decay of inverted-V ions in the upward FAC region, followed by an acceleration potential increase in the adjacent downward FAC region, indicating a possible potential redistribution between the two current branches. The observed location of divergent electric field structures at the poleward boundary of the central plasma sheet, and of unipolar electric field structures at the polar cap boundary, suggests that the return current electric field profile depends on whether sufficiently dense plasma regions, capable of supporting intense FACs, exist on both sides, or one side only, of the boundary.