Geophysical Research Abstracts
Vol. 12, EGU2010-4464, 2010
EGU General Assembly 2010

CLUSTER observations of parallel and perpendicular energization processes in polar cap boundary arcs: Implications and forcing of the ionosphere

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Recent CLUSTER observations have demonstrated that polar cap boundary arcs tend to be associated with strong monopolar electric fields at high altitude. The associated auroral current system involves both upward and downward current regions characterized by field-aligned electric potential differences. This contribution reports CLUSTER observations of both parallel and perpendicular energization of escaping ionospheric ions. Parallel energization is due to the parallel electric field in the auroral acceleration region, while perpendicular energization stems from the perpendicular electric field through the ExB drift. The impact of such polar cap boundary arcs on the ionosphere includes (1) precipitation of magnetospheric electrons that undergo parallel energization in the upward current region; (2) upward evacuation of ionospheric electrons in the downward current region poleward of the polar cap edge of the auroral zone; (3) space- and time-modulated precipitation of hot plasmasheet ions into the ionosphere throughout the auroral region, resulting in upwelling of ions that undergo the parallel energization process; (4) the ionized component of the ionosphere experiences a perpendicular energization similar to the high-altitude particles as a consequence of ExB drift, which through ion-neutral collisions will force a neutral wind along the arc; and (5) the ionospheric conductivity is enhanced wherever precipitation occurs, especially in the upward current region, while the conductivity can be depressed in the downward current region.