On the role of discrete auroral arcs for the transport of plasma in the magnetosphere

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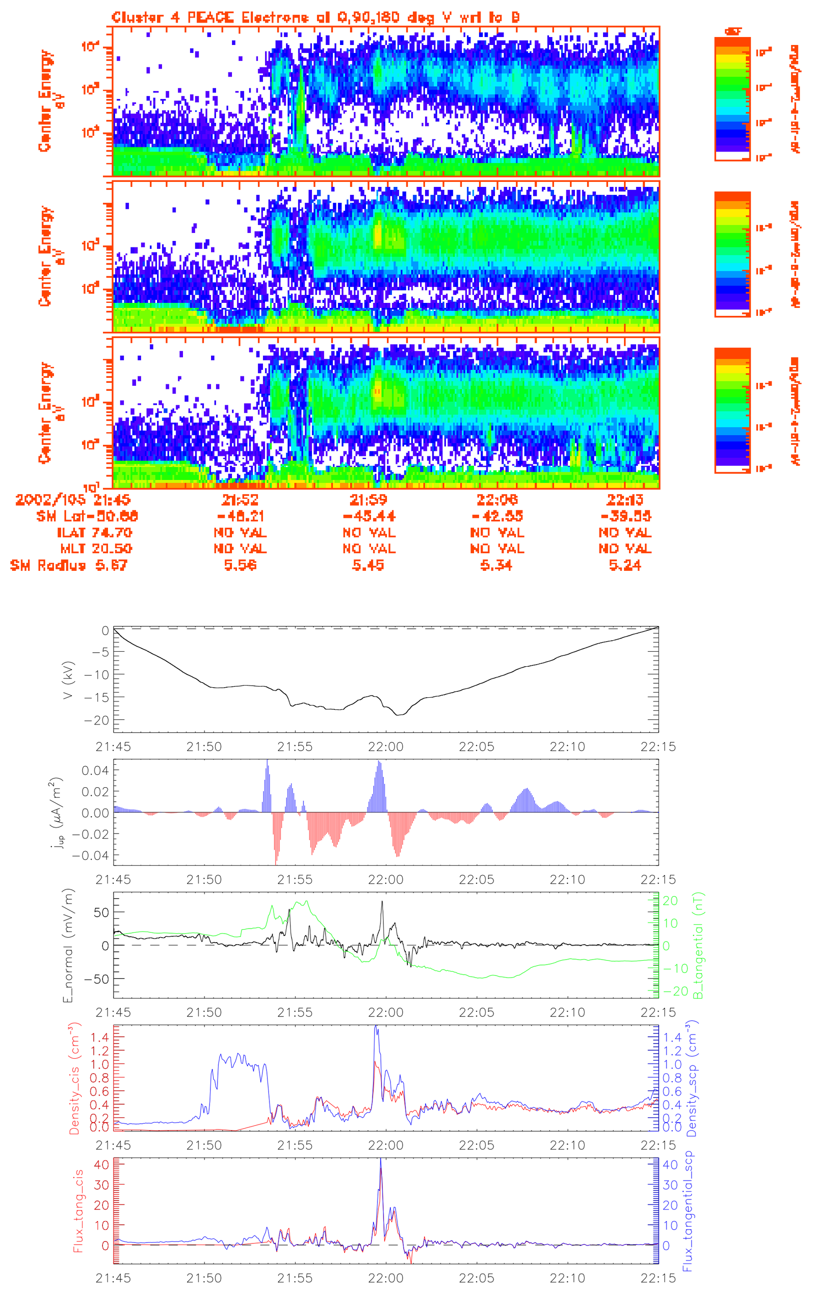
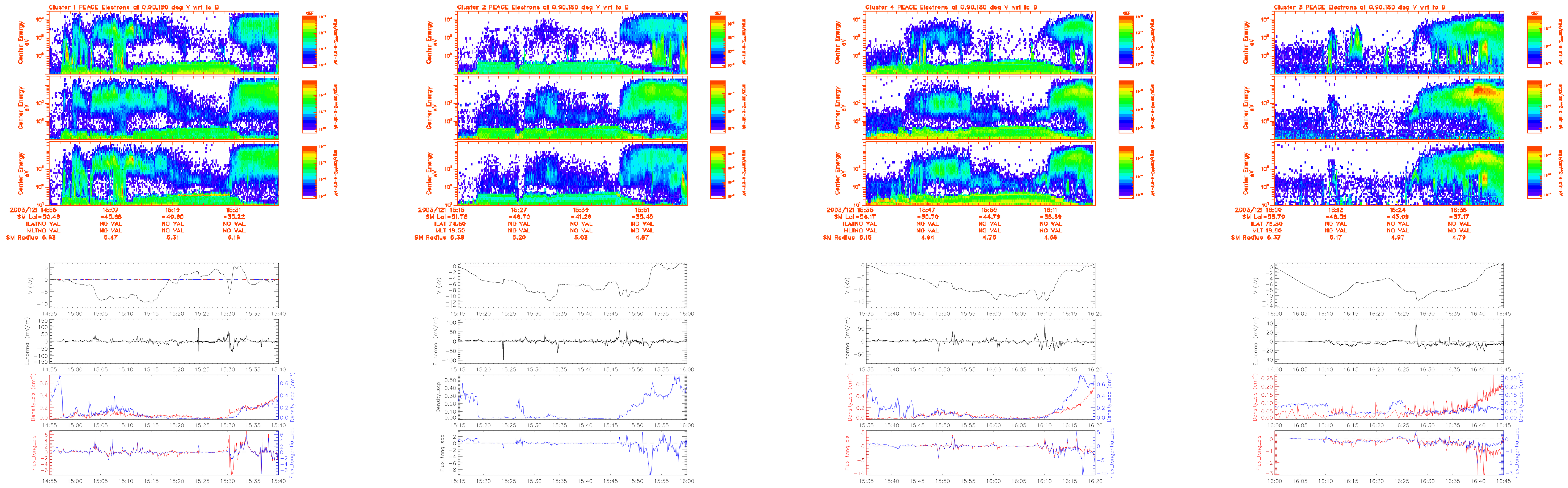
Case 1



Case 2



Introduction

☞ "standard" features of discrete auroral arcs (DAAs): field-aligned potential drop + strong perpendicular electric field above;

☞ plasma flow across B is a very elongated vortex → no net mass transport for homogeneous density;

☞ E field signatures of DAAs are often observed at steep density gradients → plasma is transported along arcs.

☞ How much plasma is transported? From where to where? Context with global convection?

In this study we investigate two cases of DAA E field signatures seen by Cluster at the poleward boundaries of the duskside oval.

Figures

Top 3 panels: PEACE electron data for 0, 90 and 180 degrees.

4th panel: From E-field calculated electric potential.

5th panel: Currents (calculated from rot B, after substraction of the background B-field). Blue means upward (primary) current, red means downward (return) current.

6th panel: E-field component normal to the arc, and B-field component tangential to the arc (derived with the minimum analysis).

7th panel: Plasma density, as measured by CIS (sum of all particle types) and derived from the spacecraft potential.

8th panel: Plasma flux tangential to the arc. Positive values mean antisunward flow and negative values sunward flow.

Observations Case 1 (May 1, 2003) and Case 2 (April 15, 2002) in comparison

A strong dipolar E-field structure appears at the poleward boundary of the CPS. It is connected to strong sunward and antisunward transport of plasma. However, the antisunward part dominates over the sunward part, as long as a strong, dipolar E-field peak is visible (case 1, c1 and case 2). As soon as the E-field weakens and gets less sharp, the general sunward transport along the CPS prevails (Case 2, c2-c4).

With time, the E-field becomes weaker until it nearly disappears. The antisunward plasma transport decreases as well. In the last plot, only antisunward plasma transport in the CPS is observed.

Summary

Strong, converging E-fields, that arise due to discrete arcs along plasma boundaries,give a major contribution to the plasma transport.

Having a discrete arc (connected to a converging E-field structure) at the boundary between polar cap and auroral oval, one would expect a net contribution to the sunward plasma flow in the magnetosphere, as the higher density should be connected to the dawnward directed E-field. However, these two examples show that it is more complicated than that, and that additional density maxima after the boundary lead even to a net flow in antisunward direction.

Further work is necessary to find out whether the strong antisunward mass transport, caused by a DAA near the oval boundary is a typical or not.