Geophysical Research Abstracts
Vol. 12, EGU2010-6597, 2010
EGU General Assembly 2010

Observations of reversed flow channels in the winter cusp ionosphere by EISCAT Svalbard Radar

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A new category of flow channels, named Reversed Flow Events (RFEs), has been discovered by EISCAT Svalbard Radar. An RFE is a longitudinally elongated, 100-200 km wide channel, in which the flow direction is opposite to the background convection, persisting for 10-20 min. In this paper we study RFEs that seem regulated by Birkeland current arcs in the winter cusp ionosphere above Svalbard. The RFE onset occurs with brightening of a discrete arc near the open closed boundary. The auroral arc is situated exactly at a sharp clockwise flow reversal, consistent with a converging electric field and an upward field-aligned current. One category of RFEs propagates into the polar cap in tandem with poleward moving auroral forms, while another category of RFEs moves with the equatorward cusp boundary. The RFE phenomenon is addressed to a region void of electron precipitation, and in lack of direct sunlight the E-region conductivity will be very low. We propose two possible explanations: i) The RFE channel may be a region where two MI current loops, forced by independent voltage generators, couple through a poorly conducting ionosphere. ii) The reversed flow channel may be the ionospheric footprint of an inverted V- type coupling region. Electron beams of $<$1 keV will not give rise to significant conductivity gradients and the form of a discontinuity in the magnetospheric electric field will be conserved when mapped down to the ionosphere, although reduced in amplitude. These two explanations may be related in the sense that the boundary discontinuity in the magnetospheric electric field in i) may be the driver for the inverted V in ii).