Multiscale observations of the structure and motion of field-aligned cusp currents

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Field-aligned cusp currents are the mechanism by which momentum and energy are transferred from the solar wind to the ionosphere during reconnection. On 25 August 2001, the Cluster spacecraft flew through the northern polar cusp and observed large-scale deflections of the magnetospheric field (FGM) and field-aligned electrons (PEACE) indicative of strong field-aligned currents, together with dispersed cusp-ion signatures (CIS) that are associated with pulsed reconnection. This occurred during periods of weak southward IMF accompanied by strong IMF $B_Y > 0$ and $B_X < 0$. Similar observations of reconnection pulses have been made in the past and linked to poleward-moving auroral forms (PMAFs), which appear to occur on open field lines. Successive reconnection pulses during these type of events can contribute almost all of the voltage across the magnetosphere. However, these single spacecraft observations in the mid-altitude cusp were constrained by assumptions about the cusp structure and the relative spacecraft and boundary motions - this could easily lead to large errors in the analysis. With multi-spacecraft observations we can better constrain these parameters and make better estimates of the field-aligned currents. The formation of the Cluster spacecraft during this interval also allows us to study in-situ the evolution of the cusp on timescales of minutes to tens of minutes.