A word of caution on the interpretation of auroral electric field observations

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Auroral acceleration is to a large extent due to parallel electric fields. These parallel electric fields are produced by perpendicular electric fields and the associated potential variations across magnetospheric plasma boundaries at high altitude. We show by means of an example that CLUSTER observations of auroral electric fields above the auroral acceleration region must be interpreted with caution. The example demonstrates that part of the observed electric field may be due to the motion of such boundaries. This has a number of implications: (1) One has to be very careful with the application of minimum variance analysis to establish the orientation of the magnetospheric interface. (2) The observed electric field is not necessarily an intrinsic property of the boundary as part of it is simply due to motion. (3) The motion of the boundary is not necessarily monotonic. (4) The popular method of integrating the observed electric field along the orbit in order to obtain the electric potential profile across the structure may be seriously in error since it ignores non-monotonic boundary motion. (5) The popular single-spacecraft method of using derivatives of the magnetic field in order to obtain the field-aligned currents may be seriously in error as well, since it also ignores non-monotonic boundary motion.

We demonstrate an alternative (single-spacecraft, multi-point) approach that allows translating time profiles into spatial structure at the auroral boundary. This approach is essentially the empirical reconstruction method, which has previously been used for understanding the structure of the moving magnetopause. The use of such a method is essential for obtaining the proper value for the accelerating potential.