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Vlasov simulations of electron trapping on auroral field lines

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In the auroral zone, electric fields that are parallel to the earth's magnetic field are known to exist and to contribute to the acceleration of auroral electrons. Transverse electric fields at high altitude result in parallel electric fields as a consequence of the closure of the field-aligned currents through the conducting ionosphere (*L. R. Lyons*, JGR, vol. 85, 1724, 1980). These parallel electric fields can be supported by the magnetic mirror field (*Alfvén and Fälthammar*, Cosmical Electrodynamics, 2nd ed., 1963).

Stationary kinetic models have been used to study the current-voltage characteristics of the auroral current circuit (*Knight*, Planet. and Space Sci., vol. 21, 741-750, 1973). Fluid and hybrid simulations have been used to model parallel electric fields and Alfvén waves, and to study the relationship between them (*e.g., Vedin and Rönnmark*, JGR, vol. 111, 12201, 2006). *Ergun, et al.* (GRL, vol. 27, 4053-4056, 2000) found stationary Vlasov solutions over regions extending several Earth radii, and *Main, et al.* (PRL, vol. 97, 185001, 2006) performed Vlasov simulations of the auroral acceleration region. Observations have shown that field-aligned potential drops often are concentrated in electric double layers (*e.g. Ergun, et al.*, Phys. Plasmas, vol. 9, 3685-3694, 2002). In the upward current region, 20-50% of the total potential drop has been identified as localised. How the rest of the potential is spread out as function of altitude is not yet known from observations.

Gunell et al. (submitted to GRL, 2012) performed Vlasov simulations, using a model that is one-dimensional in configuration space and two-dimensional in velocity space, and found that about half of the potential drop is found in a thin double layer. The other half is in a region, which extends a few earth radii above it. The double layer itself is stationary, while there are oscillations in the longer low-field region. The current-voltage characteristic approximately follows the Knight relation. The altitude of the double layer decreases with an increasing field-aligned potential drop.

Here, we use Vlasov simulations to study how the time dependent formation of the potential drop can lead to trapping of electrons between the electric field that accelerates them downward and the magnetic mirror, which reflects them back up again. The presence of a trapped population influences the shape of the potential profile. Thus, it is important for the understanding of auroral acceleration to also understand the processes that trap and release particles.