Kinetic Effects due to Suprathermal Ionospheric Electrons: a Study of Auroral Arc

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A fluid model developed by Noel et al, 2000 shows that the increase of the electron density due to the auroral precipitation implies sharp horizontal gradients in the electron density. This leads to sharp horizontal gradients in the Pedersen conductivity. These gradients cause a horizontal current density. Because of the null divergence of the current density, very intense field-aligned current densities are created in the edges of auroral arcs. These currents are localized in space and imply the presence of a parallel electric field.

In order to study the possible kinetic effects of this very intense and field-aligned electric field, we developed a kinetic model, named KIMIE (KInetic Model of Ionopheric Electrons). We consider the issue of electrons moving through an ionospheric gas of positive ions and neutrals under the influence of a dynamic electric field. The kinetic model includes electrons/electrons, electrons/ions and electrons/neutrals collisions. We solve the Langevin equation in which we find terms of friction and diffusion. We also include the interaction with the local electric field. In order to take into account the evolution of the current density, we introduce a feedback on the electric field.

First of all, we observe that the electron distribution functions are non Maxwellian. We can show that suprathermal electrons are created. These electrons are the core of the issue as they carry the current. They represent around 10% of the total current density. The electrical conductivity can also be calculated. The comparison between the classical and modeled conductivity show that the modeled one is always larger of 30%.

This work applied to the study of auroral arcs could be developed to understand the energy transfer from the troposphere to the ionosphere due to relativistic electron beams coming from TGFs.