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A kinetic model for runaway electrons in the ionosphere

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Electrodynamic models and measurements with satellites and incoherent scatter radars predict large field aligned current densities on one side of the auroral arcs. Different authors and different kinds of studies (experimental or modeling) agree that the current density can reach up to hundreds of $\mu A/m^2$. This large current density could be the cause of many phenomena such as tall red rays or triggering of unstable ion acoustic waves. We consider the problem of electrons moving through a ionospheric gas of positive ions and neutrals under the influence of a static electric field. We develop a kinetic model of collisions including electrons/electrons, electrons/ions and electrons/neutrals collisions. We use a Fokker-Planck approach to describe binary collisions between charged particles with a long-range interaction. We present the essential elements of this collision operator : the Langevin equation for electrons/ions and electrons/electrons collisions and the Monte-Carlo and null collision methods for electrons/neutrals collisions. Computational example is given illustrating the approach to equilibrium and the impact of the different terms (electrons/electrons and electrons/ions collisions on one hand and electrons/neutrals collisions on the other hand). Then, a parallel electric field is applied in a new sample run. In this run, the electrons move in the z direction, parallel to the electric field. The first results show that all the electron distribution functions are non-Maxwellian. Furthermore, runaway electrons can carry a significant part of the total current density, up to 20% of the total current density.