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A kinetic model for runaway electrons in the ionosphere

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Thanks to satellites such as FAST or FREJA, we know that large field-aligned currents are commonly observed in the ionosphere. The aim of our work is to study the dynamic of collisionnal plasma under a parallel electric field. These kinds of issues are very important in different fields such as nuclear fusion or heating of the solar corona.

In this study, we are concentrated on the terrestrial ionosphere where large field-aligned currents were observed by satellites or radar measurements and calculated by numerical models. Different authors and kinds of studies (experimental and measurements) agree that the current density can reach up to hundreds of $\mu A.m^{-2}$. These current densities could be the cause of many phenomena such as tall red rays or triggering of unstable ion acoustic waves.

We consider the issue of electrons moving through an ionospheric gas of positive ions and neutrals under the influence of a parallel electric field. We developed a kinetic model of collisions, including electron/electron, electron/ion and electron/neutral 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 electron/electron and electron/ion collisions and the Monte-Carlo and null collision methods for electron/neutral collisions. We fixed a temporal evolution of the current density and calculated a self-consistent electric field.

We show the temporal and spatial evolution of the different characteristics (Temperature, density, mean velocity). We are particularly interested in the velocity electron distribution functions: they are non maxwellian and asymmetrical.