Auroral Flux Tube Simulations Yielding a Linear Current-Voltage Relation

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Large scale numerical simulations of auroral flux tubes have been hampered by the inability of fluid models to properly describe the generation of field-aligned electric fields and the associated electron acceleration. In particular, it has not been possible to derive a linear current-voltage (C-V) relation from the collisionless fluid models describing Alfvén waves.

Most fluid models of auroral electron acceleration have been based on the assumption that temperature variations can be neglected. However, stationary kinetic theory shows that the electron temperature variations, caused by the auroral current, are of the same order as the electrostatic potential. The temperature gradients play a decisive role in the electron momentum equation, and the proper inclusion of these gradients is essential for obtaining a linear C-V relation from collisionless fluid theory.

We have developed a numerical model in which the fluid description of the electrons is supplemented by a kinetic calculation of the electron temperatures. The first results from this numerical model are presented and compared with recent satellite observations.