Field-aligned potential drop in the ionosphere and cusp dynamics

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An open-field line particle precipitation model was developed. The model open-field line low latitude boundary layer (LLB), cusp, mantle, and polar rain compare well with DMSP observations. When the interplanetary magnetic field By is dominant, the model predicts each hemisphere can have two cusps (double cusp) that are separated in latitude resulting from nearly simultaneous reconnections at high and low latitude magnetopause. The low and high latitude cusp plasma originate from low and high latitude reconnection sites, respectively. The double cusp is a spatial rather than a temporal feature. Electrons have higher thermal speeds than ions and can enter the magnetosphere in greater quantities. As a result, a retarding field-aligned potential drop develops in order to limit the electron entries to maintain charge-quasi neutrality. In the model, the potential drops are small in the cusp, intermediate in the mantle, and high in the polar rain and open-field LLBL. The model potential drops compare well with those obtained from the fits of the DMSP electron spectra. Furthermore, the polar rain potential drop is also obtained from shifting the phase space densities of the DMSP electrons to match those of the suprathermal component (strahl) of the solar wind electrons. The model potential drop in the polar rain agrees qualitatively with those obtained using this method. However, using this method, it is found that near the open-closed boundary at dusk, the polar rain electrons appear to have gone through accelerating potential drop. At the dusk flank of the magnetopause boundary, the velocity shear between the solar wind and magnetospheric plasma can generate an upward field-aligned (region-1) current. When the electron density at the boundary layer is too low to provide enough electron current carriers, a potential drop develops to draw more electrons downward. The open-field line particle precipitation model does not take these processes into account. However, a boundary layer model that takes into account these processes was developed. The potential drops from the boundary layer model compare well with those from the DMSP observations.

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