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Electrostatic magnetosphere-ionosphere coupling: sheared plasma flows and discrete auroral arcs

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Tangential discontinuities (TD) form in the plasma sheet boundary layer at the interface between streaming plasmas having different macroscopic parameters (density, temperature or bulk velocity). The TD is the site of a divergent perpendicular electric field. We consider a two-dimensional flux tube whose upper/magnetospheric boundary corresponds to a kinetic TD. The dynamics of charged particles coming from both ends (magnetospheric and respectively ionospheric) of the auroral flux tube is investigated. We derive the parallel flux of down-going (magnetospheric) electrons but also of up-going (ionospheric) electrons and ions. From the equation of current continuity at the top of the ionosphere we find the latitudinal profile of the field aligned potential drop, the field aligned current density, the precipitating energy flux and the Pedersen conductance. The results show auroral structures whose arc width span a broad range of values, from the large scale inverted-Vs to small scale layers. We analyze the scaling of the auroral structures as a function of the plasma temperature, density and velocity at the magnetospheric boundary, as well as of the altitude of the “generator” tangential discontinuity.