

Formation of magnetospheric plasma regimes coupled with the dynamo process in the convection

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Based on the magnetosphere-ionosphere (M-I) coupling scheme, convection as a compound system is considered including the generation of plasma population regimes in the magnetosphere. In these considerations, primary elements that must be set to a self-consistent configuration are convection flows in the magnetosphere and the ionosphere, field aligned current (FAC) systems, ionospheric currents, energy conversion processes, and plasma population regimes. The convection is inextricably associated with FAC and generally considered to be driven by the line-tying current. The shoulder of the magnetosphere behind the cusp, where the pure Chapman-Ferraro current connected to dayside overlaps with the line-tying current, must be the primary dynamo for the region 1 current system. In the present model with negative IMF B_z , however, this Chapman-Ferraro current is not directly connected with the region-1 FAC but connected with the neutral sheet current in the dayside merging region. As a consequence, tangential Maxwell stress on the magnetopause acts to increase plasma internal energy around the cusp. This mechanism is also same to tail theta current system in which tangential Maxwell stress on the tail surface acts to increase plasma internal energy in the plasma sheet through the convection. The plasma internal energy accumulated in the cusp and plasma sheet further drives the region 1 and 2 FAC, respectively. Thus, mechanisms to drive the region 1 and region 2 current systems are the same two step process; tangential Maxwell stress on the magnetopause pumps up plasma internal energy, then plasma internal energy drives the FACs. Thus from the magnetohydrodynamic (MHD) force balance controlling the convection, plasma population regimes appears through a requirement to form dynamo in the magnetosphere, showing that plasma population regimes is indispensable to fulfill the self-consistency in the convection system. The magnetospheric model derived from this consideration enables a continuous change from the confinement state of geomagnetic field in the Chapman-Ferraro model to the convection of Dungey model for non-zero IMF B_z . Inside the lobes, nearly force-free open field lines are extending from the polar cap. Based on the convection model proposed in this paper, a suggestion is given for the substorm models in the next decade that they must develop from a modular model to a globally self-consistent model.