Connection between the convection and plasma population regimes

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Based on the magnetosphere-ionosphere (M-I) coupling scheme, convection as a complex system is considered in relevance with the generation of plasma population regimes in the magnetosphere. In these considerations, the primary elements that must be set to a self-consistent configuration are convection flows in the magnetosphere and the ionosphere, filed aligned current (FAC) systems, ionospheric currents, energy conversion processes, and plasma population regimes. Then, the global current systems and plasma population regimes are derived from the magnetohydrodynamic (MHD) force balance controlling the convection. The magnetospheric model derived from this consideration is the closed magnetosphere with the open cusp.

It is also shown in this paper that under the requirement of self-consistent configuration, the substorm can be understood naturally on the production of enhanced convection for the southward IMF. The plasma sheet thins during the growth phase as a natural response of the convection system to the southward turning of IMF, because both the compressional magnetospheric flow and the incompressional ionospheric flow must respond self-consistently to an enhanced driving force under an imbalance between the subsolar and tail reconnections. The approach in this paper can improve the weak point of present substorm models that they are lacking in global self-consistency under the framework of global convection. In this view, the onset that follows the growth phase corresponds to the criticality in the convection system rather than to the local instability.

In the convection system, the MHD processes primarily determine the position of criticality, since the initial and destination states controlling the criticality and transition are slowly varying convection states although the kinetic effects may control the pathway between the states. Consequently, this paper gives a suggestion for the substorm models in the next decade that they must develop from a modular model to a globally self-consistent model.