

All substorm problems are solved by discarding the current wedge

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It has been widely believed that the substorm onset is caused by the formation of the current wedge. Apparently it is argued as the non-MHD process. The purpose of this paper is to show that this is a misleading and that we can understand the substorm quite reasonably by discarding the current wedge. In recent years, the global M-I coupling simulation reproduces almost all substorm signatures both in the magnetosphere and in the ionosphere just like the observation. According to this study, the substorm is understood as the development and transition of the M-I convection system. The substorm reproduced there is generated based on four natural principles governing in the convection system. They are (1) force balance must be maintained in the convection system among gradient P force, $J \times B$ force, and acceleration force (2) energy conversion process to form a dynamo must work in the magnetosphere to supply the energy consumed by the ionospheric convection through the field aligned current (FAC) (3) shear motion must co-exist with the FAC to twist the magnetic field (4) electric field equivalent to the magnetospheric convection must coincide with electric field that promotes the ionospheric closure of FAC. All of these principles are another representation of the MHD and coupling ionospheric boundary condition.

The substorm models estimated by reorganizing the observations not always satisfy all of these four principles self-consistently. This point has been the limit of substorm research made until now. The most intrinsic element of the substorm, the onset, is caused in this paper by the state transition in the convection system. This process describes the change of global force balance which is hard to investigate from the observational study. Once the current wedge is accepted, the substorm must result in an appearance of the global breakdown of MHD in magnetospheric plasma. Afterward, it brings about the study of the local kinetic process without the hope of success. It is desirable to avoid such direction.