Excitation of substorm-FAC by slow mode disturbances in the near-earth plasma sheet

Aoi Nakamizo[1]

[1] Earth and Planetary Sci., Kyushu Univ.

The magnetospheric substorm is the fundamental but unsolved problem in the solar-terrestrial physics. In our previous study, we proposed the new concepts that will be applied in global MHD simulations, toward the complete understanding of the mechanics and energetics of substorm processes in the context of the Magnetosphere-Ionosphere coupling system.

Also in our previous studies, by using the GOTAIL/MGF, LEP and EPIC data, we have presented the fundamental structure of convection in the near-earth magnetotail and have suggested a scenario for the behavior of near-earth plasma sheet during substorm. Observational facts obtained from these studies are summarized as follows:

(1) The stress balance is primarily achieved by -grad P and JxB. This basic condition remains unchanged even in the magnetotail disturbances. (2) The diamagnetic property pertains to variation of all time scales. (3) In relatively near-earth magnetotail, -grad P is intensified for a few tens of minutes prior to the onset of magnetotail disturbances. The enhancement subsides in accordance with the development of disturbances.

As for the interval of substorms, (i) during the growth phase, plasma pressure is intensified in the near-earth plasma sheet and additional earthward pressure gradient is superimposed to the background gradient. The plasma pressure peak is formed in the region less than the radial distance of 8 RE. (ii) After the onset, enhanced pressure gradient is reduced in accordance with the development of slow mode disturbances. Consequentially, the plasma stress and the Maxwell stress are reduced in the near-earth tail where they have been intensified during the growth phase.

The role of slow mode motion is to resolve the pressure gradient and magnetic tension along the background magnetic filed. The slow mode disturbance is crucial for the redistribution of plasma fluid along the magnetic field and the reconfiguration of magnetic field. The diamagnetic property is the manifestation of this redistribution process. It is suggested that the slow mode is the primary process as the non-Alfvenic (non-convective) motion in the earth's magnetotail.

The excitation of the substorm-FAC must be explained by the energy and stress balance consistent with the above observational facts. We refine the data analysis and examined in detail some substorm events. In this paper, we will show the obtained results and propose its implication for the excitation of substorm-FAC. Also we will discuss our results in association with the above mentioned new ideas for the global MHD simulations.