MULTI-SCALE MODELING OF MAGNETOSPHERIC DYNAMICS

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Magnetic reconnection is a key element in many phenomena in space plasma, e.g. Coronal mass Ejections, Magnetosphere substorms. One of the major challenges in modeling the dynamics of large-scale systems involving magnetic reconnection is to quantify the interaction between global evolution of the magnetosphere and microphysical kinetic processes in diffusion regions near reconnection sites. Recent advances in small-scale kinetic modeling of magnetic reconnection significantly improved our understanding of physical mechanisms controlling the dissipation in the vicinity of the reconnection site in collisionless plasma. However the progress in studies of small-scale geometries was not very helpful for large scale simulations. Global magnetosphere simulations usually include non-ideal processes in terms of numerical dissipation and/or ad hoc anomalous resistivity. Comparative studies of magnetic reconnection in small scale geometries demonstrated that MHD simulations that included non-ideal processes in terms of a resistive term ηJ did not produce fast reconnection rates observed in kinetic simulations. In collisionless magnetospheric plasma, the primary mechanism controlling the dissipation in the vicinity of the reconnection site is non-gyrotropic pressure effects with spatial scales comparable with the particle Larmor radius. We utilize the global MHD code BATSRUS and replace ad hoc parameters such as "critical current density" and "anomalous resistivity" with a physically motivated model of dissipation. The primary mechanism controlling the dissipation in the vicinity of the reconnection site in incorporated into MHD description in terms of non-gyrotropic corrections to the induction equation. We will demonstrate that kinetic nongyrotropic effects can significantly alter the global magnetosphere evolution. Our approach allowed for the first time to model loading/unloading cycle in response to steady southward IMF driving. The role of solar wind parameters and ionospheric conductance on the dynamics of the loading/unloading cycle will be discussed.