MICROPHYSICS IN LARGE-SCALE MHD RECONNECTION

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One of the major challenges in modeling the magnetospheric magnetic reconnection is to quantify the interaction between large-scale global dynamics and microphysical processes in diffusion regions near reconnection sites. There is still considerable debate as to what degree microphysical processes on kinetic scales affect the global evolution and how important it is to substitute numerical dissipation and/or ad hoc anomalous resistivity by a physically motivated model of dissipation. 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 the fast reconnection rates observed in kinetic simulations. For a broad range of physical parameters in collisionless magnetospheric plasma, the primary mechanism controlling the dissipation in the vicinity of the reconnection site is non-gyrotropic effects with spatial scales comparable with the particle Larmor radius. We will demonstrate that reconnection electric field can be estimated as a convection electric field v x B at the edge of the non-MHD diffusion region and can be incorporated into the MHD description. In collisionless plasma the spatial scale of the diffusion region d can be estimated from the condition $d = \rho_i(d)$, where $\rho_i(d)$ is the ion Larmor radius at the edge of the diffusion region. We utilize the global MHD code BATSRUS and incorporate nongyrotropic effects in diffusion regions in terms of corrections to the induction equation. We developed an algorithm to search for magnetotail reconnection sites, specifically where the magnetic field components perpendicular to the local current direction approaches zero and form an X-type configuration. Spatial scales of the diffusion region and magnitude of the reconnection electric field are calculated self-consistently using MHD plasma and field parameters in the vicinity of the reconnection site. The location of the reconnection sites is updated during the simulations. To clarify the role of nongyrotropic effects in diffusion region on the global magnetospheric dynamic we perform simulations with steady southward IMF driving of the magnetosphere. Ideal MHD simulations with magnetic reconnection supported by numerical resistivity produce steady configuration with almost stationary near-earth neutral line (NENL). Simulations with non-gyrotropic corrections demonstrate dynamic quasi-periodic response to the steady driving condition. The loading/unloading cycle in non-gyrotropic MHD results has a non-stationary reconnection site in the magnetotail, with the retreating during the stretching phase and then a new NENL forming in the resulting thin plasma sheet.