MULTI-SCALE MODELING OF MAGNETOSPHERIC 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 magnetospheric dynamics and microphysical processes in diffusion regions near reconnection sites. 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 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. To incorporate nongyritropic effects in diffusion regions 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. The BATSRUS adaptive grid structure allows performing global simulations with spatial resolution near reconnection sites comparable with ion kinetic scales. 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. The 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 continually dynamic 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.