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Three-dimensional Multiscale Simulation of Magnetic Reconnection in Earth's Magnetotail

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We have used a combination of a global magnetohydrodynamic (MHD) simulation and a three-dimensional implicit particle-in-cell simulation to investigate magnetic reconnection in the plasma sheet during a magnetospheric substorm on February 15, 2008. In this simulation we first calculate the changes in the overall magnetospheric simulation by driving the MHD code with solar wind observations. Just after reconnection begins on closed field lines in the tail we load parameters based on the MHD values into a large-scale particle-in-cell code (iPIC3D). Both the initial conditions and the boundary conditions in the north-south and east-west directions are set to values derived from the MHD model. During the substorm two processes are found in the tail. On the dawn side the tail develops kinks in the magnetic field, while on the dusk side the tail reconnects. The interplay produces a vortical pattern in the near-Earth part of the simulation. Reconnection in this environment is highly variable and produces a series of earthward propagating dipolarization fronts. Ions from the reconnection form large-scale earthward jets (several RE) while electron jets are much more localized. The electron jets are highly time dependent. They are observed to move duskward rapidly and frequently completely reform. Two regions of enhanced reconnection electric field are found. One is associated with the ion jetting while the other is associated with the electron jetting. We discuss the implications of these results in the context of the dynamics of the magnetotail.