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Multiscale Simulations of the Structure and Dynamics of the Magnetopause

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Ongoing observations by the spacecraft of NASA's Magnetospheric Multiscale Mission are revealing a very complex structure and dynamics of the low-latitude magnetopause. One of the main difficulties to comprehend physical processes occurring at the magnetopause is that it requires following both the evolution of the large-scale interaction of the solar wind with the dayside magnetosphere, and the details of the kinetic processes that enable transport of energy and mass in localized regions of the magnetospheric boundary. To address this multiscale problem, we have carried out particle-in-cell (PIC) simulations of the dayside magnetopause. These simulations employ domains that are large enough to include large-scale features of the solar wind interaction with the geomagnetic field (e.g., field curvature and plasma asymmetries). The numerical challenge is dealt with by using the implicit iPic3d simulation code together with the results of global magnetohydrodynamic (MHD) simulations. We discuss the results of the PIC simulations in the context of the global MHD states that provide initial and boundary conditions, and local spacecraft observations at the magnetopause. In particular, we analyze the evolution of electromagnetic fields and particle distributions in different regions of the simulations to determine how reconnection processes affect the structure and dynamics of the magnetospheric boundary.