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Sun-Earth coupling in global MHD simulations: Energy circulation and dissipation

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Currently, the global simulations based on the magnetohydrodynamic (MHD) theory provide the only self-consistent method to describe the coupled solar wind - magnetosphere - ionosphere plasma system using upstream solar wind conditions as input. We investigate both energy transfer and dissipation in the solar wind - magnetosphere - ionosphere system using our GUMICS-4 global MHD simulation. We compute the total mass and energy flux incident to the magnetopause and identify the locations on the magnetopause surface, where mass and energy transfer takes place. We identify the parameters in the solar wind that control the mass and energy entry locations and temporal variation. We find that the Poynting flux focusing controls the magnetopause energy transfer both spatially and temporally, while the mass transfer takes place along the reconnection line and is controlled by the IMF variation. We investigate the plasma sheet characteristics as a function of the magnetopause energy input and solar wind parameters. We show that the plasma sheet characteristics are sensitive functions of the IMF as well as the solar wind pressure. In the GUMICS-4 ionosphere, we determine the ionospheric energy consumption associated to two main processes consuming the solar wind energy: the Joule heating and electron precipitation. Energies related to these processes are shown to correlate with commonly used proxies based on the AE index. Finally, we investigate the energy coupling of the solar wind - magnetosphere - ionosphere system by finding a power law that best forecasts the ionospheric total energy from solar wind parameters.