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Magnetospheric feedbacks in solar wind energy transfer

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The solar wind kinetic energy, fueling all dynamical processes within the near-Earth space, is extracted by a dynamo process at the magnetopause converting kinetic energy into magnetic energy. We investigate the magnetopause energy transfer both in small and large scales; using Cluster observations as well as a three-dimensional global magnetohydrodynamic (MHD) simulation GUMICS-4. In the simulation, the spatial distribution of the energy transfer exhibits a dependence on the interplanetary magnetic field (IMF) orientation, which is shown to agree with observational local estimates from Cluster spacecraft recordings. In both sythetic runs with artificial solar wind input as well as in reproductions of the observed solar wind we observe a "hysteresis" effect, where the magnetopause energy input stays enhanced longer than the traditional energy transfer proxies (e.g., epsilon) indicate. Specifically we focus in the simulation of a substorm sequence on Feb 18, 2004, during which an exceptional agreement between the simulation results and spacecraft recordings was observed on several orbits within the near-Earth space. In this event, we again observe the hysteresis effect and investigate the processes causing it at the magnetopause. We argue that since GUMICS-4 reproduces the observed signatures of the substorm sequence in question, the simulation results represent physical processes within the magnetosphere. We conclude that as the simulation energy input exhibits delays already at the magnetopause, the delays in the classical substorm loading - unloading cycle may be interpreted in a new light.