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Energy Transfer and Flow in the Solar Wind-Magnetosphere-Ionosphere System: A New Coupling Function

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A fundamental question in space physics is to understand how the flow of energy is transported and distributed in the solar wind-magnetosphere-ionosphere system. There is no direct method of measuring the energy transfer from the solar wind to the magnetosphere, but it is well accepted that the rate of transfer is strongly related to the magnitude of the southward component ($B_z < 0$) of the Interplanetary Magnetic Field (IMF). During such conditions, energy is transferred to the magnetosphere as a consequence of a large-scale reconnection process on the dayside. Eventually, reconnection in the neutral sheet of the magnetotail deposits the accumulated energy to the inner magnetosphere and ionosphere. Joule heating, particle precipitation and ring current injection are the three major energy sinks in the magnetosphere-ionosphere system. The deposited energy into these sinks can be estimated using ground-based magnetometer data. In this paper we determine the functional dependence on solar wind parameters of the rate of energy transfer from the solar wind into the magnetosphere using a correlation analysis between the general formula by *Vasyliunas et al.* [1982] and estimated energy sinks. Using a superposed epoch analysis for 45 geomagnetic storms, we have obtained a new energy coupling function describing direct energy transfer. We find that the effective area of interaction is dynamic, and depends to the first order on the magnitude of B_z. We also find that for longer time periods this area must be increased compared to the area used for geomagnetic storms. We quantify the relative importance of the different energy dissipation processes during substorms, geomagnetic storms and long time series, and present the coupling efficiency of the solar wind. Our energy coupling functions is compared with the ϵ parameter by *Akasofu and Perreault* [1978] and is found to perform better for almost every event.