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Solar wind driven magnetosphere: Are we asking the right questions?

H. Koskinen
(Hannu.E.Koskinen@helsinki.fi)

High solar wind speed together with a southward component of the interplanetary magnetic field are key elements in energy, momentum, and plasma transfer processes from the solar wind to the magnetosphere. The product of these, the rectified dawn-to-dusk electric field Ey, is the simplest coupling function, which highlights the role of dayside reconnection as the primary solar wind – magnetosphere coupling process. Reconnection opens the magnetopause and produces a normal component of the Poynting vector across the magnetopause. The energy input takes place in regions where the Poynting vector has a positive divergence in the inward direction. The positive divergence rises from a dynamo process converting solar wind kinetic energy to magnetospheric magnetic energy. Some plasma simulations suggest that the dayside reconnection and magnetopause energy transfer rates may not have the same dependence on the solar wind parameters. In addition to Ey, several other combinations of upstream plasma parameters, including also solar wind density, have been correlated with various parameters determined inside the magnetosphere and ionosphere. While positive correlations are normally found, the correlation coefficients usually are not particularly high and different coupling functions correlate best with different internal parameters. Furthermore, the role of solar wind fluctuations and turbulence, the issue of solar wind triggering of magnetospheric activity, and the origin of typical activity time scales remain insufficiently understood after several decades of research. We discuss these problems and claim that more emphasis should be given to investigating the actual plasma properties near the magnetopause in the magnetosheath region. After all, it is the magnetosheath flow that interacts with the magnetopause. Its characteristics are determined by the solar wind but only after passing the spatially variable bow shock structure and being perturbed between the shock and the magnetopause. This approach is challenging because there are much less observations from the magnetosheath than from the upstream solar wind and due to lack of long-term homogeneous data sets.