

From the bow shock to the magnetosphere-ionosphere coupling

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We suggest a description of magnetospheric processes in the form of a model consisting of three blocks:

1. Block of electric current generation in the bow shock where the solar wind energy converts to electric energy. This current closes through the magnetosphere in the form of the dawn-dusk current. The bow shock can be a sufficient source of power for supplying energy to substorm processes. The direction of current behind the bow shock front depends on the sign of the IMF Bz-component [Ponomarev et al., 2000, 2003]. It is this current which sets convection in motion (by an Ampere force). Any change in external current through the magnetosphere causes a convection restructuring within a time on the order of the travel time of the magnetosonic wave from the magnetopause to the center of the system, because the restructuring wave comes from both flanks.

2. Block of gas pressure relief formation.

The combined action of convection and strong pitch-angle diffusion of electrons and protons is responsible for the formation of gas pressure distribution in the magnetosphere [Kennel C.F., 1969; Ponomarev E.A., 1985], that is, steady bulk currents. The divergence of these bulk currents brings about a spatial distribution of field-aligned currents, i.e. magnetospheric sources of ionospheric current systems. The combined action leads also to the formation of particle precipitation regions in the form of an oval corresponding to the location of the auroral zone. The nonstationary solution of this problem (with time-dependent boundary conditions) reproduces the break-up.

3. Block of magnetosphere-ionosphere coupling.

The gas pressure relief determines the position of the magnetospheric MHD generators and the MHD compressor. It is shown that currents of MHD generators partially feed the ionospheric electric circuit and partially close on the magnetospheric MHD compressor. Such a structure of currents makes it possible to reconcile the operation of magnetospheric sources of power and the ionospheric consumer.

Each block is realized in the form of a system of magnetic hydrodynamic equations taking into account mass and energy losses.