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Magnetospheric response to interplanetary shocks: summary of MHD simulations and observations

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We study interaction of interplanetary (fast forward) shocks with the Earth's magnetosphere using results of global MHD simulations. Collision of interplanetary shock with the bow shock results in a transmitted fast shock and several new discontinuities moving Earthward through the magnetosheath. After interaction with the magnetopause, a weak fast shock goes into the magnetosphere. According to the global simulation results, fast shock reflects from the inner numerical boundary. The reflected (reversed) fast shock moves sunward and interacts successively with the magnetopause and bow shock. Both the bow shock and magnetopause move at first earthward because of interaction with the forward shock and then sunward because of interaction with the reversed shock. Such inward-outward bow shock motion has been observed in situ in several events. Magnetospheric pulsations follow sometimes the shock passage. The pulsations can be explained assuming that fast waves (or weak shocks) oscillate during several periods between the inner and outer boundaries. Considering periods of the pulsations, we conclude that these boundaries are probably the ionosphere and magnetopause. The global MHD simulations predict intensification of two high-latitude ionospheric currents, i.e. the NBZ and Region 1 currents, caused by shock impact during a northward IMF Bz interval. This prediction agrees with the well-known two-pulse structure of sudden impulse in ground data.