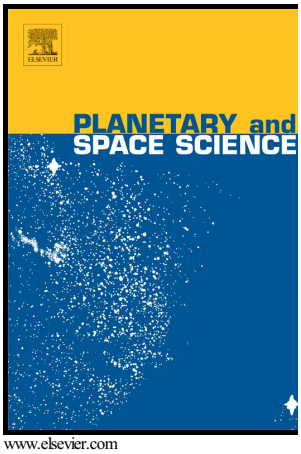

Mars atmospheric losses induced by the solar wind: Comparison of observations with models

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Mars atmospheric losses induced by the solar wind: comparison of observations with models

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Abstract

With new results from Mars-Express on plasma environment of Mars and two new Mars satellites the study Martian atmospheric losses receives new attention. Paper summarizes experimental results concentrating on configuration of Martian magnetosphere and the measurements of planetary ion escape induced by the solar wind. Several plasma populations constituting solar wind induced mass loss have been identified and studied: pick-up ions in shocked solar wind flow and induced (accretion) tail, ions accelerated in the tail current sheet, and outflow of ionospheric ions. Measured ion flux values and calculations of the total escape rate including solar cycle variations are summarized. Several types of simulation of the solar wind with Mars are considered and results of representative models are given and compared with experimental results. These computer models allowed one to much better understand solar wind-Mars interaction. However, there is significant difference between total loss rates obtained from simulation and ones from measurements on the spacecraft. Both measurements and simulation provide significant flux values that are considered as an important factor of mass loss during cosmogonic time of the planet. The origin of each solar wind induced loss component and its contribution to total amount are discussed and compared with relevant computer models. Future progress in experiments and simulation is briefly discussed.

Keywords: Mars, solar wind, solar wind interaction, atmospheric losses

1. Introduction.

Initial concept of the solar wind interaction with a comet that constitutes gaseous obstacle to the magnetized solar wind was introduced by Alfven (1957). Cometary neutrals are ionized by solar ultraviolet and load the magnetized flow. This asymmetric mass-loading leads to deceleration of the flow in the nearest vicinity of the comet that leads to the bending of magnetic flux tubes and formation of cometary tail.

Nothing was known about intrinsic magnetic field of Mars until Mariner-4 observed magnetic disturbance during fly-by of Mars in 1964. This disturbance was tentatively interpreted as crossing of the bow shock from which location Smith et al., (1965) and Dryer and Heckman (1967) estimated the upper value of intrinsic dipole moment as $2x10^{-4}$ of the Earth's magnetic moment. Existence of the Martian bow shock was confirmed from the measurements of plasma (Vaisberg et al., 1972 and Gringauz et al., 1973) and magnetic field (Dolginov et al., 1972) on Martian satellites Mars-2, -3. Using the data of magnetic field measurements Dolginov et al., (1973) concluded that Mars has magnetic moment of $2.47x10^{23}$ G cm^3. From shock crossings location obtained with plasma measurements Gringauz et al., (1974) estimated dipole magnetic moment of Mars as $2.4\ x10^{22}$ G cm^3. Comparison of the shock crossings with hydrodynamic