3-D MHD Studies of the night side structure of Mars

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Three-dimensional global studies of the solar wind interaction with Mars have been carried out in the past using semikainetec [Brecht, 1997; Kallio and Janhunen, 2002], and multispecies MHD [Liu et al., 1999, 2001; Ma et al.,2002, 2004]. To calculate the structure of Martian ionoshere high resolution is necessary. Ma et al. [2004] developed a high resolution MHD model, which has an altitude resolution of about 10 km in the ionosphere. They reproduce the bow shock positions, the ion densities observed by Viking 1 and radio occultation electron densities obtained by Mars Global Surveyor which agree reasonably well with the observed values.

We study the interaction between the solar wind and Mars using a high-resolution 3-D MHD simulation, which has an altitude resolution of about 5 km in the ionosphere. Our simulation takes into account collision of ions with neutral atmosphere, gravity, magnetic diffusion, and include three ion species H+, O+, and O+2 representing the solar wind and two major ionospheric ion species. We report on the result of the night side structure affected by magnetic tension force and plasma flow.

The obtained destribution of O+ density and interplanetary mangetic field lines are shown in Figures 1. The solar wind flows from right to left. The upstream IMF is palallel to the plane of the figure. On the day side O+ ions are produsd by photoionaization and photochemical reactions and form an ionosphere. The O+ density saturates the colar contour in the ionosphere. While on the night side a ray of O+ ions is formed and O+ ions escape from the ionoshere tailward. On the terminator region the O+ ions escape from the ionosphere tailward, too. After passing the bow shock the IMF is bended with the flow around the planet. On the day side the IMF penetrates into the ionoshere. The IMF caputured by the ionosphere decreases the velocity and magnetic field lines are strongly bended. Magnetic tension force accelerates the ionosheric plasma flows on the night side. Lundin et al. [1989] reported that cooler and denser plasmas flow out the terminator region and the central tail region is characterized by a highly variable outflow of O+ ion beams according to the Phobos 2 observation. Our simulation results suggest central O+ ion beams are accelerated by the magnetic tension force which is caused by the field line draping around the Martian ionosphere.

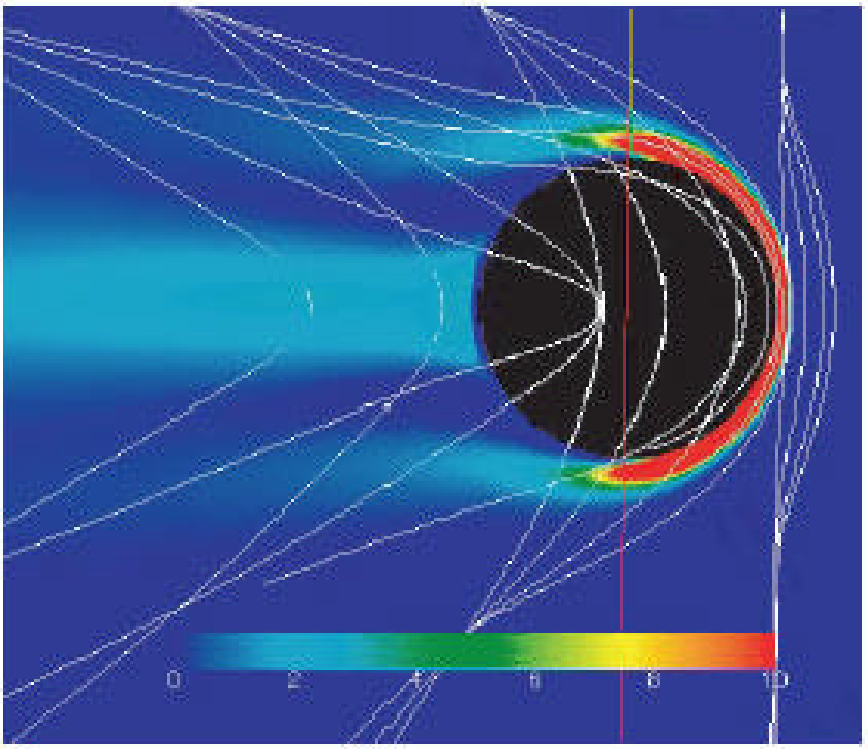

Fig. 1. Distribution of O^+ densities and interplanetary magnetic field lines around Mars. Color contours show O^+ density. White curved lines correspond to field lines.