A Collisionless Multi-Component Model for the Martian Exosphere

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We develop a collisionless model for the Martian exosphere that consists of atomic and molecular hydrogens and oxygen atoms. Exospheric densities of each component are calculated by integrating ensemble of ballistic and escaping species from the exobase for the entire planet. Densities of hydrogen atoms and molecules at the exobase are computed from model by McElroy et al (1977) and other exobase conditions are adopted from Martian Thermospheric Global Circulation Model by Bougher et al. (1999). We find that the density distributions of hydrogen components gradually change from the pattern of density variation to that of temperature variation at the exobase as the altitude increases. Since the density variation is opposite to the temperature variation at the exobase, for the solar minimum case the variation amplitude of hydrogen atom densities over local time decreases with altitude up to 2000 km, and then increase in reverse phase to as much as 80% at the altitude of 9000 km. The density distribution of oxygen atoms is mostly affected by the diurnal variation of ionospheric O_2^+ ions which produce hot oxygen atoms by dissociative recombination. Our model shows that the density difference of hot oxygen atoms between noon and midnight is more than two orders of magnitude near the exobase, but reduces abruptly around altitudes of 2000 km due to lateral transport. The diurnal variation of hot oxygen densities remains significant up to the altitude of 10000 km. Our non-spherical multi-component model can improve models for solar wind interaction which assumed geometrically simple exospheres.