Effect of meteoroid ablation in the chemistry of the martian ionosphere

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Comets release streams of dust particles at their perihelion distance due to the normal process of gas ejection. These particles of micron-size or larger are called micro-meteoroids and the meteoroids leave the comet nucleus at a speed of less than the orbital speed of the comets. When the planet Mars passes through such a meteoroid dust stream periodically, the meteoroids and micrometeoroids enter the martian atmosphere and encounter a suitable density of atmospheric gases, such as O_2, CO_2, CO, O, O_3, NO, N_2, to ablaze. This ablation produces ionization in the lower ionosphere at an altitude between 60-120 km. We use a coupled chemical model to calculate the density of abundant meteoric ions Mg, Fe, and Si with their neutrals and their compositions with atmospheric gases. We have observed that comets P/2003 WC7 (LINEAR Catalina) and 10P/ Tempel 2 intersected the orbit of Mars on 18 April 2004 and 11 May 2005, respectively. The meteoroids of fluxes 4.0×10^{-15} and 8.3×10^{-16} cm^{-2} s^{-1} and of masses 4.5×10^{-7} g and 1.0×10^{-3} g have produced a third ionospheric layer of electron densities, in good agreement with the electron density profiles observed by Mars Express and Mars Global Surveyor on April 18, 2004 and 11 May 11, 2005, respectively. The densities of 21 ions (CO_2+, O_2+, CO+, O+, NO+, N_2+, Mg+, Fe+, Si+, MgO+, FeO+, SiO+, $MgCO_2$+, MgO_2+, $FeCO_2$+, FeO_2+, $SiCO_2$+, SiO_2+, MgN_2+, FeN_2+, and SiN_2+) have been computed self-consistently for both days. It is observed that the lower ionosphere of Mars is strongly dependent on the incoming velocity, mass, and flux of the meteoroids. We have calculated a total ion production rate and a total ion density for meteoroids of with sizes from 10 g to 10^{-12} g entering the martian atmosphere with initial speeds of 10 km/s and 18 km/s. Micro-meteoroids with an incoming speed of 18 km/sec and mass between 10^{-5} g to 10^{-12} g ablaze and produce a significantly high total ion density between $\sim 0.5 \times 10^6$ cm^{-3} to $\sim 6 \times 10^6$ cm^{-3}. If the incoming speed of the meteoroid decreases to 10 km/s, the total ion density is between 5×10^5 cm^{-3} to 2×10^6 cm^{-3}, which indicates that the ion deposition in the Martian ionosphere depends upon the incoming speed of the meteoroids. The total ion density calculated for the meteoroids of mass between 10^{-4} g to 10 g is 2×10^1 cm^{-3} – 0.5×10^6 cm^{-3} for both incoming speeds. We have combined the chemistry of the impact of the meteoroids and the solar X-ray and EUV radiation in our model which is predicting three plasma layers in the martian ionosphere. Our effort is to balance our theoretical model of the meteoric chemistry with the observed ionospheric electron density.

Acknowledgements: The authors are grateful to the MGS/MEX science team and Planetary Data System for providing us with radio science data. The authors also acknowledge G. J. Molina-Cuberos for his encouragement in the meteoric ablation modeling.