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On the vertical transport of Mg+ ions of comet Siding Spring origin in the Martian upper atmosphere

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On 19 October 2014, comet Siding Spring (CSS) flew extremely closely by planet Mars at 18:29 UT with a closest approach distance of ~134,000 km and a relative velocity of 56 km s^{-1}. The arrival time of the cometary dust is ~ 90 min after closest approach. It dumped appreciable amounts of material into the Martian atmosphere, and the effects from this material persisted in the atmosphere for several days. During the CSS event, there were five spacecraft orbiting Mars, namely, Mars Reconnaissance Orbiter (MRO), Mars Express (MEX), Mars Atmospheric Volatile EvolutioN (MAVEN) mission, Mars Odyssey, and Mars Orbiter Mission. These spacecraft are equipped with instruments that are capable of observing the atmospheric effects of the cometary dust.

Many of these instruments detected the presence of a dense ionization layer composed of metallic ions. The Imaging Ultraviolet Spectrograph (IUVS) instrument on MAVEN spacecraft detected the metallic ion layer composed of Mg+ and Fe+ ions with peak density at an altitude of ~115 km. It detected these ions in its first pass 4 h after the peak dust deposition. These ions were also detected at subsequent passes. In these passes, the ion layer was observed over several longitude sectors that are located in the region that was initially exposed to dust and also outside this region. The Neutral Gas and Ion mass spectrometer (NGIMS) instrument made its first detection of metallic ions 9.5 h after the peak dust deposition and the ions are observed at an altitude of 185 km. It detected the presence of several metal ions such as Na^+, Mg^+, Al^+, K^+, Ti^+, Cr^+, Mn^+, Fe^+, Co^+, Ni^+, Cu^+, and Zn^+. The highest recorded abundances occurred at 19 h following the peak dust flux and were observed until 2.5 days at these altitudes.

In this work, we investigate the vertical profiles of Mg^+ ions measured by IUVS instrument on orbits from 118 to 121 which were observed much later in time after the closest approach of CSS. We derived the densities of Mg^+ ions from the measured intensities by assuming that the emissions are optically thin. The results of the present study clearly show that the depletion/vertical transport of metallic ions have a strong latitudinal dependence with the smaller values at higher latitudes and larger values near the equator. This feature is apparent in the peak density of the layer and in the slopes of the density profiles above the main peak. Furthermore, the present results clearly showed that the vertical transport of the metallic ions is greater in regions of strong crustal magnetic anomalies. These results were interpreted considering the enhanced transport of ions along open magnetic field lines and the confinement of ions in regions of horizontal magnetic fields.