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The Zodiacal Cloud Model applied to the Martian atmosphere. Diurnal variations in Meteoric ion layers

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Sporadic metal layers have been detected in the Martian atmosphere by radio occultation measurements using the Mars Express Orbiter and Mars Global Surveyor spacecraft. More recently, metallic ion layers produced by the meteor storm event following the close encounter between Comet Siding Spring (C/2013 A1) and Mars were identified by the Imaging UltraViolet Spectrograph (IUVS) aboard the Mars Atmosphere and Volatile EvolutioN (MAVEN) spacecraft. However, the background metal layers produced by the influx of sporadic meteors have not yet been detected at Mars (contrary to the permanent metal layers identified in the Earth's atmosphere). The Zodiacal Dust Cloud (ZDC) model for particle populations released by asteroids (AST), and dust grains from Jupiter Family Comets (JFC) and Halley-Type Comets (HTC) has been combined with a Monte Carlo sampling method and the Chemical ABlation MODel (CABMOD) to predict the ablation rates of Na, K, Fe, Si, Mg, Ca and Al above 40 km altitude in the Martian atmosphere. CABMOD considers the standard treatment of meteor physics, including the balance of frictional heating by radiative losses and the absorption of heat energy through temperature increases, melting phase transitions and vaporization, as well as sputtering by inelastic collisions with the air molecules. These vertical profiles are input into the Leeds 1-D Mars atmospheric model which includes photo-ionization, and gas-phase ion-molecule and neutral chemistry, in order to explore the evolution of the resulting metallic ions and atoms. We conclude that the formation of the sporadic ion layers observed below 100 km with a plasma density exceeding 104 cm-3 requires the combination of the three different influx sources considered by the ZDC model, with a significant asteroidal contribution. Finally, we explore the changes of the neutral and ionized Mg and Fe layers over a diurnal cycle.