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Martian Meteoric Mg⁺: an intercomparison of MAVEN/IUVS observations with simulations using the LMD Mars GCM

Daniel Marsh et al.

The Imaging Ultraviolet Spectrograph (IUVS) on the Mars Atmosphere and Volatile Evolution (MAVEN) mission has been used to observe the Mg⁺ in the upper atmosphere of Mars since 2015. These observations reveal significant diurnal, seasonal and latitudinal variations. For example, a factor of two change in Mg⁺ occurs during the day at the equator and Mg⁺ above 100 km decreases across the globe during the Southern Hemisphere summertime. Possible causes include the influence of photo-chemistry, atmospheric dynamics and the injection rate of meteoric material. To delineate these sources of variability, a 3-dimensional model of the Martian Mg has been developed. The model is based on the Laboratoire de Météorologie Dynamique (LMD) Mars global circulation model (GCM), which is capable of simulating the seasonal cycles in the Martian atmosphere arising from changes in heating rates from orbital geometry and the distribution of dust in the lower atmosphere. The model solves for the dynamics and primary constituents of the atmosphere from the surface to the thermosphere. For this study, the chemistry has been augmented with neutral and ion chemistry for meteoric metals within a CO₂ atmosphere, incorporating 7 neutral and 8 ionized Mg-containing species and an additional 42 neutral and ion-molecule reactions. The atmospheric input of meteoric material is specified from seasonal and latitudinal fits to new estimates of the deposition of the ablated metals in the atmosphere. Here we present the first detailed intercomparison of the MAVEN IUV Mg⁺ observations with simulated Mg⁺ from the LMD Mars GCM. Model variability is consistent with observations and indicates tropical variability is caused by a combination of photochemistry and vertical transport by atmospheric tides. Comparisons of simulations performed with variable and fixed meteoric input show that the high latitude variations are caused by both seasonal variation in ablation rates and the residual circulation. Finally, we show how Mg⁺ varies in relation to neutral Mg and the remaining Mg-containing species to determine how Mg⁺ may be used as a proxy for total Mg variability.

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Discussion

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