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A global model of meteoric metals in the atmosphere of Mars

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Here we report a global model of meteoric metals including Mg, Fe and Na in the Laboratoire de Météorologie Dynamique (LMD) Mars global circulation model (termed as LMD-Mars-Metals), following on similar work as we have done for the Earth's atmosphere. The model has been developed by combining three components: the state-of-the-art LMD-Mars model covering the whole atmosphere from the surface to the upper thermosphere (up to ~ 2 x10^{-8} Pa or 240 km), a description of the neutral and ion-molecule chemistry of Mg, Fe and Na in the Martian atmosphere (where the high CO_2 abundance produces a rather different chemistry from the terrestrial atmosphere), and a treatment of injection of the metals into the atmosphere as a result of the ablation of cosmic dust particles. The LMD-Mars model contains a detailed treatment of atmospheric physics, dynamics and chemistry from the lower atmosphere to the ionosphere. The model also includes molecular diffusion and considers the chemistry of the C, O, H and N families and major photochemical ion species in the upper atmosphere, as well as improved treatments of the day-to-day variability of the UV solar flux and 15 mm CO_2 cooling under non-local thermodynamic equilibrium conditions. So far, we have incorporated the chemistries of Mg, Fe and Na into LMD-Mars because these metals have different chemistries which control the characteristic features of their ionized and neutral layers in the Martian atmosphere. The Mg chemistry has 4 neutral and 6 ionized Mg-containing species, connected by 25 neutral and ion-molecule reactions. The corresponding Fe chemistry has 39 reactions with 14 Fe-containing species. Na chemistry has 7 neutral and only 2 ionized Na-containing species, with 32 reactions. The injection rate of these metals as a function of height is pre-calculated from the Leeds Chemical Ablation Model (CABMOD) combined with an astronomical model which predicts the dust from Jupiter Family and Long Period comets, as well as the asteroid belt, in the inner solar system. The LMD-Mars-Metals model has been run for several full Martian years under different surface dust scenarios to investigate the impact of high atmospheric dust loadings on the modelled metal layers. The model has been evaluated against Mg^+

observations from IUVS (Imaging UV Spectrometer) and NGIMS (Neutral Gas Ion Mass Spectrometer) instruments on NASA's Mars Atmosphere and Volatile Evolution Mission (MAVEN) spacecraft. We have also carried out other sensitivity experiments with different seasonality/altitude/latitudinal varying of Meteoric Input Function (MIF) of these metals in the model. These sensitivity results will be discussed.