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# Ion-Neutral Coupling in Upper Atmospheres of Mars and Venus

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## Abstract

Over 50 years of observations have shown the upper atmosphere of Mars to have significant variability in the abundance and composition of its plasma. What drives this variability has been theoretically attributed to a multitude of plausible mechanisms that have yet to be distinguished. In this work, evidence of the strong coupling between the neutral and ionized components of the upper atmosphere of Mars are shown. The effects of neutral-driven plasma variability are demonstrated empirically by analyzing observations from the Mars Atmosphere and Volatile Evolution (MAVEN) mission as well as theoretically by using simulations from the Boston University Mars Ionosphere Model (BUMIM). The results of this analysis highlight and quantify the contributions of topside plasma variability induced by neutral density perturbations. A survey of observations from Pioneer Venus Orbiter (PVO) ion and neutral spectrometers are shown for comparison to the effects of such driving mechanisms on the topside structure of terrestrial ionospheres.

## 1. Introduction

The neutral atmospheres of terrestrial planets are photo-ionized to produce ions. At altitudes where martian ions behave as a fluid, significant structure has been observed that has predominantly been attributed to plasma-specific drivers such as plasma instabilities and magnetic field effects [1]. With the availability of MAVEN Neutral Gas and Ion Mass Spectrometer (NGIMS) data, the opportunity to observe the simultaneous neutral and ionized components of the upper atmosphere is made possible [2].

In situ measurements from thousands of orbits are analyzed to determine the correlations between variations in the density and composition of the neutral and ionized atmospheres up to four scale heights above the main ionospheric peak at Mars. In investigating the dayside observations, where ionospheric plasma is predominantly generated by photo-ionization and chemical interactions with the neutral atmosphere, strong correlations were found between neutral and plasma variations at these altitudes [3].

A 1D ionospheric model of the martian ionosphere [4] is constrained to these observations to demonstrate causation linking neutral variations to plasma structure. The consistency between simulated and observed variations quantifies the effects of ion-neutral coupling at Mars in regions where atmospheric structure is apparent [Figure 1]. A first look at similar correlations between plasma and neutral structure in the upper atmosphere of Venus is made using observations of the PVO neutral and ion mass spectrometers.

## 2. Figures

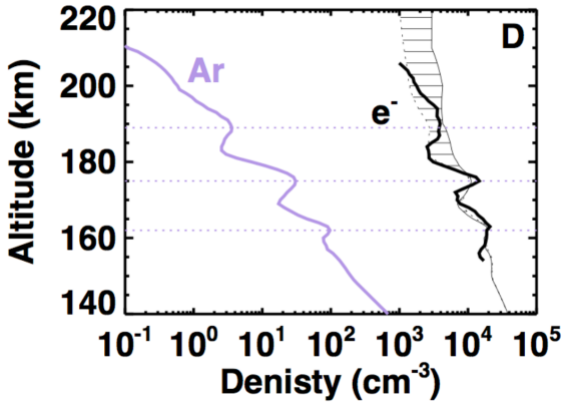


Figure 1: Simulated and observed density profiles from MAVEN 6206. The neutral density of Argon, scaled down by 5 orders of magnitude, is shown in a thick purple solid line for comparison of density variations with altitude. Between 160 and 200 km, NGIMS observations are used. Beyond those altitudes, the BUMIM model extrapolates the neutral densities. The thin dotted and thin solid black lines indicate simulation results using photo-chemistry alone, and photo-chemistry and diffusion, respectively. The shaded regions indicate the differences between the simulated densities bordered by these two simulation cases. The thick solid line represents the electron density obtained from NGIMS.

Three horizontal dotted lines indicate altitudes where the neutral density shows local peaks at 162, 175 and 189 km.

# References


[1] Mayyasi, M. et al., (2018). A sporadic layer in the Ionosphere if Mar from Analysis of MGS Radio Occultation Data, *JGR*, 10.1002/2017JA024938.

[2] Mahaffy. P. et al., (2014). The neutral gas and ion mass spectrometer on the Mars atmosphere and evolution mission, *Sp. Sc. Rev.*, 195(1-4), 49-73.

[3] Mayyasi, M. et al., (2019), Ion-neutral coupling in the upper atmosphere of Mars: a dominant driver of topside ionospheric structure, *JGR*,

[4] Matta, M. (2013). Modeling the martian ionosphere, PhD, Boston University., Boston, MA.