APPLICATION OF 3D HYDROGEN CORONA DISTRIBUTION MODEL TO RETRIVE ATOMIC HYDROGEN FROM EMUS/EMM OBSERVATIONS.

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Introduction

Hydrogen is essentially produced from the dissociation of H_2O and via odd-hydrogen reactions in the Martian atmosphere. A fraction of H_2 transported to the upper atmosphere is dissociated by solar ultraviolet photons that leads to fast moving hydrogen atoms. The scale height of atomic hydrogen is larger than any other species due to its smaller mass, which makes hydrogen a dominant species in the Martian exosphere. The study of atomic hydrogen distribution and its loss rate from the Martian atmosphere can help us to understand the history of water presence on Mars. Previous observations have shown that atomic hydrogen density is highly variable in the Martian exosphere but its spatial and temporal variability over a large period is not yet well-understood [*Chaffin et al.*, 2014; *Clarke et al.*, 2014; *Halekas*, 2017; *Stone et al.*, 2020, and several other works]. Characterizing the hydrogen variability in the Martian exosphere is one of the primary goals of the Emirates Ultraviolet Spectrometer (EMUS) onboard Emirates Mars Mission (EMM). A global hydrogen distribution model for atomic hydrogen is essential while retrieving the density and temperature of hydrogen from the EMUS/EMM observations.

Model

Following the theoretical approach of *Vidal-Madjar and Bertaux* [1972], we developed a 3-D hydrogen corona distribution model which is characterized by the conditions of exobase such as number density and temperature. Unlike the classical *Chamberlain* [1963] model, which assumes a uniform temperature and number density at the exobase, this model can account for inhomogeneous distribution of temperature and number density at the critical level.

Application of the model for MCD exobase condition

The developed model has been applied under different exobase conditions of Mars obtained from Mars Climate Data (MCD) base model [*Forget et al.*, 1999] and the calculated hydrogen distribution profiles are compared with *Chamberlain* [1963] model (See Figure 1). A significant difference between the modelled hydrogen distribution profiles has been noticed. Along with the EMUS/EMM observations, this model will be used to constrain the density and temperature of hydrogen in the Martian exosphere. This approach allows us to study the global distribution of atomic hydrogen and its variability at different Martian seasons and also under different space weather conditions.

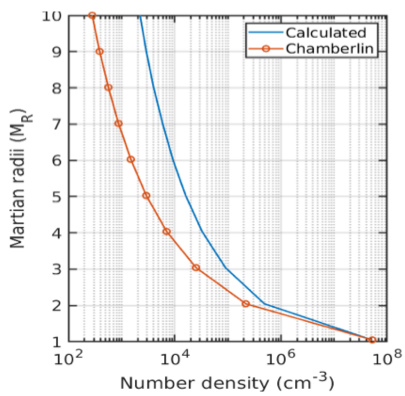

Figure 1: A comparison of modelled atomic hydrogen density profile calculated using MCD exobase condition with Chamberlin (1963) calculation.

References

Chaffin, M. S., J.-Y. Chaufray, I. Stewart, F. Montmessin, N. M. Schneider, and J.-L. Bertaux, Unexpected variability of Martian hydrogen escape, Geophys. Res. Lett., *41*(2), 314–320, doi: 10.1002/2013GL058578, 2014.

Chamberlain, J. W., Planetary coronae and atmospheric evaporation, Planet. Space Sci., *11*(8), 901–960, doi: 10.1016/0032-0633(63)90122-3, 1963.

Clarke, J. T., J. L. Bertaux, J. Y. Chaufray, G. R. Gladstone, E. Quemerais, J. K. Wilson, and D. Bhattacharyya, A rapid decrease of the hydrogen corona of Mars, Geophys. Res. Lett., *41*(22), 8013–8020, doi: 10.1002/2014GL061803, 2014.

Forget, F., F. Hourdin, R. Fournier, C. Hourdin, O. Talagrand, M. Collins, S. R. Lewis, P. L. Read, and J.-P. Huot, Improved general circulation models of the Martian atmosphere from the surface to above 80 km, J. Geophys. Res., *104*(E10), 24,155–24,176, doi:10.1029/1999JE001025, 1999.

Halekas, J. S., Seasonal variability of the hydrogen exosphere of Mars, *Journal of Geophysical Research (Planets)*, *122*(5), 901–911, doi:10.1002/2017JE005306, 2017.

Stone, S. W., R. V. Yelle, M. Benna, D. Y. Lo, M. K. Elrod, and P. R. Mahaffy, Hydrogen escape from Mars is driven by seasonal and dust storm transport of water, *Science*, *370*(6518), 824–831, doi: 10.1126/science.aba5229, 2020.

Vidal-Madjar, A., and J. L. Bertaux, A calculated hydrogen distribution in the exosphere, Planet. Space Sci., *20*(8), 1147–1162, doi: 10.1016/0032-0633(72)90004-9, 1972.