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MAVEN Observations from Aerobraking Campaign: NGIMS comparison with navigation and ACC data to create the higher density profile of the neutral upper atmosphere

Meredith Elrod (1, 2), Bougher, Steve3 (3), Roeten, Kali (3), Zurek, Richard (4), Jenkins, Geoffery, (3)
(1) University of Maryland College Park, College Park, MD, USA, (2) NASA Goddard Space Flight Center, Greenbelt, MD, USA, (Meredith.k.elrod@nasa.gov), (3) University of Michigan, Ann Arbor, MI, USA, (4) Jet Propoulsion Laboratory, Pasadena, CA, USA,

Abstract

The Mars Atmosphere and Volatiles EvolutioN (MAVEN) spacecraft has been in orbit around Mars since October 2014 and science mode since November 2014. During it's normal science operation during primary and extended mission MAVEN operated with an orbit from periapsis near 150km and apoapsis near 6500km. Additionally, there were 9 deep dip campaigns over the course of the mission in which MAVEN lowered periapsis to approximately 125km in an effort to obtain in-situ observations of the homopause. Mission requirements to prolong the life of the mission and conduct relay support of 2020 and future surface missions, MAVEN needed to slightly circularize its orbit to an apoapsis of ~4500km. This maneuvering required an aerobraking campaign lowering the periapsis to ~120-125km over the course of 9 weeks. The prolonged deeper observations provided a unique observation campaign of the neutral atmosphere. Combining the Neutral Gas and Ion Mass Spectrometer (NGIMS), Accelerometer (ACC) and navigational predictions of the density observation provides a picture of the changes in the middle to upper atmosphere.

1. Introduction

By mapping the maximum measured CO_2 and Ar densities observed by NGIMS with respect to latitude and longitude we begin to look for possible patterns with peaks and spikes in densities. Additionally, since this is a plot of the maximum density, this is not a plot of periapsis density. Quite often due to waves and instrument safing protocols, the maximum densities observed by NGIMS will occur above periapsis on the inbound. Because the spacecraft was operating at much lower altitudes than previous deep-dips and for much longer, the NGIMS team instituted safety protocols for the instrument in case the atmospheric densities were too high and became a risk for the long-term operation of the spectrometer. As a result, the instrument would temporarily shut down observations at the very lowest depths when the densities became too high. In order to compensate for these gaps in data at the lower altitudes, we combine the NGIMS data with the accelerometer data that observed the total atmospheric densities at the lowest portions of the atmosphere with no safing restrictions. By combining these data sets and using the navigational observations we are able to create a map peak density profile vs longitude and latitude. This can then be overlaid with surface features and similar local time.

2. Figures

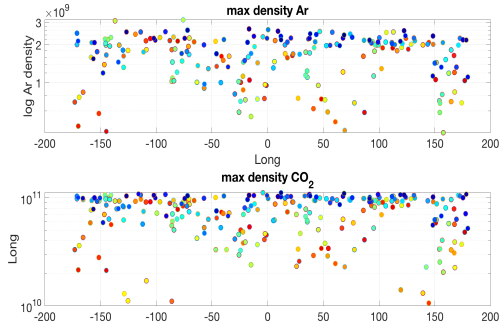

Figure 1: Maximum density observations from NGIMS log dens vs W. longitude (IAU coordinates). The color is orbit number during the aerobraking period, red is the beginning of the period, blue is the end.

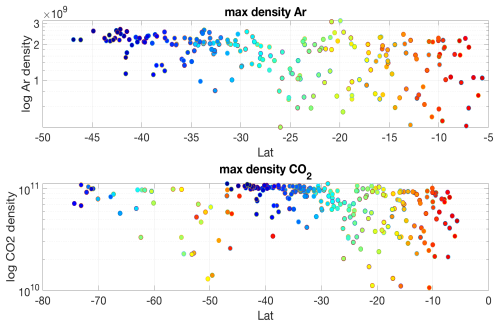

Figure 2: Maximum density observations from NGIMS vs latitude. Color indicates orbit number with red indicating the beginning of the campaign and blue the end.

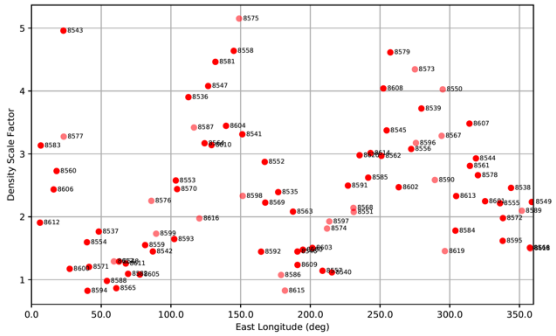

Figure 3: ACC predicts and measured of density at 150 km vs E longitude (MSO coordinates)..

3. Summary and Conclusions

The correlation of density peaks with longitude especially when NGIMS and ACC is correlated indicates that there could be a correlation with surface features. The majority of the aerobraking campaign periapsis occurred on the nightside keeping these observations at similar local times. Additional analysis will include converting all data to the same coordinates and density units. The aerobraking campaign start 12 February and ended 15 April 2019.

Acknowledgements

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