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Observations with MEX and MAVEN in the Martian tail during late 2016

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Abstract

We investigate electron density variations in the Martian tail using Mars Express (MEX) measurements from September 2016. MARSIS (Mars Advanced Radar for Subsurface and Ionosphere Sounding), operated in Active Ionospheric Sounding (AIS) mode can determine the local plasma density, as the sounder excites oscillations at the plasma frequency and its higher harmonics. Here, we present data from five non-consecutive MEX orbits, namely 16130, 16133, 16136, 16144 and 16148. These derived electron density time series, when combined with MAVEN LPW, SWIA and MAG measurements for the same time period as the MEX orbits draw a more detailed picture of the correlation between Solar Wind activity and day-to-night transport processes. We show that the electron density well above the ionospheric peak is highly variable with three of the orbits (16130, 16133, 16148) having periods of zero electron density when MEX was located in the shadow, while in two of the orbits (16136, 16144) plasma density structures are present even for solar zenith angles as large as 180 degrees. We study also the crustal magnetic fields as an additional factor that affects the flow and behaviour of nightside ionospheric plasma.

1. Observations

The MARSIS instrument is a low frequency radar on board MEX, which measures the time delay of a transmitted pulse, that can not further propagate below the electron plasma frequency, as a function of the transmitted frequency[1]. The determination of the altitude of the ionospheric peak is feasible when MARSIS operates in AIS mode for altitudes below 1200 km[1]. However, during the orbits presented, MARSIS was operated at altitudes higher than 3000 km which gives us an insight about the local electron density in the deep magnetotail.

In Fig. 1, timeseries of the frequency for each one of the orbits of interest as well as the spatial evolution of MEX are presented. Time is plotted with respect to the periapsis passing and the duration for each orbit is $\sim 50\mathrm{min}$. The local plasma frequency can be distinguished at low frequencies, whereas the harmonics are observed at slightly higher frequencies.

2. Figures

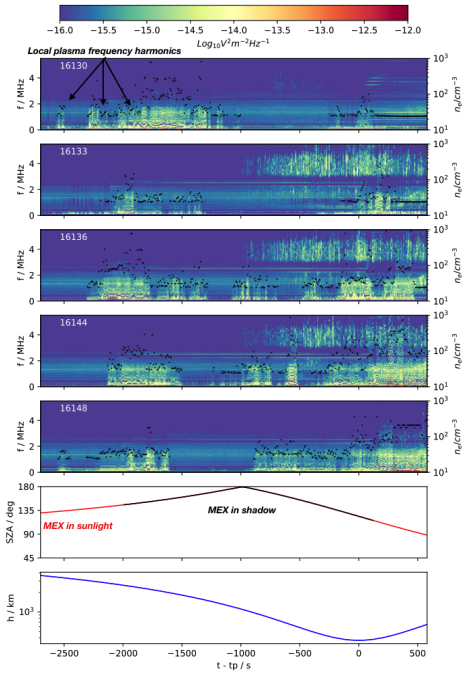

Figure 1: Timeseries of the five orbits of interest.

3. Conclusions

MEX and MAVEN measurements combined allow us to perform a thorough study of the plasma transport processes through the Martian terminator and to the nightside. Moreover, evidence of interaction between the solar wind, the crustal magnetic fields and the observable small scale plasma structures is apparent through the analysis of both MEX and MAVEN data. These observations of the upper ionosphere confirm a variability in the nightside plasma and point out the need for further investigation.

Acknowledgements

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References

[1] Gurnett D. A. et al., Science, 310, 5756 (2005).