EPSC Abstracts
Vol. 10, EPSC2015-528, 2015
European Planetary Science Congress 2015

Martian ionospheric response to low solar activity as observed by multiple datasets

B. Sánchez-Cano (1), **O. Witasse** (2), M. Lester (1), S.E. Milan (1), B.E.S. Hall (1), P.-L. Blelly (3), K. Peter (4), M. Grandin (5), M. Cartacci (6) and M. Pätzold (4)

(1) Radio and Space Plasma Physics Group, Department of Physics and Astronomy, University of Leicester, University Road, Leicester LE1 7RH, United Kingdom, (2) European Space Agency, ESTEC – Scientific Support Office, Keplerlaan 1, Noordwijk 2200 AG, The Netherlands, (3) Institut de Recherche en Astrophysique et Planétologie, F-31028 Toulouse, CEDEX4, France, (4) Rheinisches Institut für Umweltforschung an der Universität zu Köln, Abt. Planetenforschung, Köln, Germany, (5) Sodankyllä Geophysical Observatory, University of Oulu, Sodankylä, Finland, (6) Istituto di Astrofisica e Planetologia Spaziali, Istituto Nazionale di Astrofisica, Rome, Italy

Abstract

Solar cycle variations in solar radiation create density changes in the Martian ionosphere. This work shows the solar cycle impact on the ionosphere of Mars, with particular attention to the different ionospheric response observed during the period of extreme low solar activity in 2008 and 2009. This unique behaviour is analysed on the basis of multiple instrument observations of the Mars Express spacecraft and with empirical and numerical models.

1. Introduction

Since the ionosphere is strongly dependent on the solar activity, a good knowledge of the behaviour of the ionospheric variability for a whole solar period is something essential. Using Mars Express data from the period 2005–2012, differences in the electron density structure of the Martian ionosphere have been observed, and seem to be linked to changes in the ionospheric temperature due to the solar cycle variation [1]. Plasma parameters such as the scale height as a function of altitude, the peak characteristics, the total electron content (TEC), the temperatures, and the ionospheric pressures are seen to have characteristic signatures during specific periods of the solar cycle. The largest variations are seen during the period of very low solar minimum, when a reduction in ionization occurs, resulting in a topside scale height decrease not predicted by modelling.

2. Ionospheric response

Mars' ionospheric response to the extreme solar minimum between end-2007 and end-2009 followed a similar pattern to the response observed in the Earth's ionosphere, despite the large differences related to internal origin of the magnetic field between both planets.

In the particular case of the topside, the ionospheric temperature was cooler, and therefore a reduction in the scale height is found on the observations. Two different scale heights were observed. From the peak altitude at about 130 km to nearby 180 km, the profile is well defined with a constant neutral scale height like the one defined by Chapman's theory. However, from this transition point, the topside behaviour is better reproduced with a neutral scale height with a linear variation in altitude, although with rate slower than the reference scale height. The solar wind-ionosphere pressure balance might be the cause since the ratio between these two pressures could be smaller than in other phases of the solar cycle, and therefore an induced magnetic field could be found at deeper/lower ionospheric altitudes than in other phases of the solar cycle [1].

Regarding the behaviour of the whole atmospheric TEC [2], an extreme reduction not predicted before is observed for that period. On average, the TEC shows a very compressed ionosphere with 30-40% less of free electrons in the atmosphere than in the preceding and the following periods. This decrease could be caused by the prolonged minimum of solar X-ray

radiation measured during that period on Earth. This radiation is the cause of the formation of the Martian ionospheric bottomside. To test this hypothesis, radio science data from Mars Express and modelling studies are presented and compared with other datasets.

6. Summary and Conclusions

Plasma parameters such as the scale height as a function of altitude, the main peak characteristics (altitude, density), the TEC, the temperatures, and the ionospheric thermal pressures show variations related to the solar cycle. Major deviations are detected during the period of very low solar minimum, when ionospheric cooling occurs.

This study is based on the comparison of multiple instrument dataset from the Mars Express Spacecraft. Empirical and numerical modelling is done to understand the peculiar behaviour of the Martian ionosphere during the latest solar minimum.

Acknowledgements

BS-C, ML and SEM acknowledge support through STFC grant ST/K001000/1. BESH acknowledges support from the STFC Ph.D. studentship ST/K502121/1. Authors acknowledge Mars Express MARSIS PIs and Mars Express MaRS PI M. Pätzold for making data accessible.

References

[1] Sánchez – Cano, B., D.D. Morgan, O. Witasse, S.M. Radicella, M. Herraiz, R. Orosei, M. Cartacci, A. Cicchetti, R. Noschese, W. Kofman, C. Grima, J. Mouginot, D.A. Gurnett, M. Lester, P.-L. Blelly, H. Opgenoorth and G. Quinsac.: Total Electron Content in the martian atmosphere: a critical assessment of the Mars Express MARSIS datasets, J. Geophys. Res. Space Physics, 120, 2166–2182, 2015, doi:10.1002/2014JA020630.

[2] Sánchez – Cano, B., M. Lester, O. Witasse, S.E. Milan, B.E.S. Hall, P.-L. Blelly, S.M. Radicella, D.D. Morgan.: Evidence of scale height variations in the Martian ionosphere over the solar cycle, *submitted to GRL*.