Geophysical Research Abstracts
Vol. 18, EGU2016-3196, 2016
EGU General Assembly 2016
© Author(s) 2016. CC Attribution 3.0 License.

Study of the Total Electron Content in Mars ionosphere from MARSIS data set

Nicolas Bergeot (1), Olivier Witasse (2), Wlodek Kofman (3,4), Cyril Grima (5), Jeremie Mouginot (6), Kerstin Peter (7), Martin Pätzold (7), and Véronique Dehant (1)

(1) Royal Observatory of Belgium, Brussels, Belgium (nicolas.bergeot@oma.be; veronique.dehant@oma.be), (2) Research and Scientific Support, Department of ESA, ESTEC, Noordwijk, the Netherlands (owitasse@cosmos.esa.int), (3) UJF-Grenoble CNRS-INSU, Institut de Planétologie et d'Astrophysique de Grenoble UMR 5274 Grenoble, France (wlodek.kofman@obs.ujf-grenoble.fr), (4) Space Research Center, PAS, Warsaw, Poland (wlodek.kofman@obs.ujf-grenoble.fr), (5) Institute for Geophysics, University of Texas, Austin, USA (cgrima@ig.utexas.edu), (6) University of California - Irvine, Department of Earth System Science, Irvine, USA (jmougino@uci.edu), (7) Rheinisches Institut für Umweltforschung, Abt. Planetenforschung, Aachener Straße 209, 50931 Cologne, Germany (peterk@uni-koeln.de; mpaetzol@uni-koeln.de)

Centimeter level accuracy on the signal delay will be required on X-band radio link for future Mars landers such as InSIGHT, aiming at better determining the interior structure of Mars. One of the main error sources in the estimated signal delay is directly linked to the Total Electron Content (TEC) values at Earth and Mars ionosphere level. While the Earth ionosphere is now well modeled and monitored at regional and global scales, this is not the case concerning the Mars' upper atmosphere.

The present paper aims at establishing the basis to model the climatological behavior of the TEC on a global scale in the Mars' ionosphere. For that we analyzed ~8.5 years of data (mid-2005 to 2014) of the vertical Total Electron Content (vTEC) expressed in TEC units (1 TECu = $10^{16}e^{-}.m^{-2}$) from the Mars Advanced Radar for Subsurface and Ionospheric Sounding (MARSIS) radar. Our study takes advantage of the double data set of EUV solar index and Mars vTEC data to develop an empirical Model of Mars Ionosphere (MoMo). The finality of this model is to predict the vTEC at a given latitude, solar zenith angle and season taking only F10.7P solar index as input.

To minimize the differences during the least-square adjustment between the modeled and observed vTEC, we considered (1) a 4th-order polynomial function to describe the vTEC diurnal behavior (2) a discretization with respect to Mars seasons (depending on Ls) and (3) two latitudinal sectors (North and South hemispheres). The mean of the differences between the model and the observations is 0.00±0.07 TECu with an error of the model around 0.1 TECu depending on the Solar Zenith Angle (SZA), season and hemisphere of interest (e.g. rms 0.12 TECu for SZA equal to 50°±5° in the Northern hemisphere during the spring season). Additionally, comparison with 250 Mars Express radio occultation data shows differences with MoMo predictions of 0.02±0.06 TECu for solar zenith angles below 50 degrees.

Using the model we (1) highlighted different behaviors of Mars ionosphere depending on seasons, solar activity level, and latitudes; (2) estimated a maximum effect on X-Band signal delay (up plus down links) of ~3 cm during the autumn season and high solar activity at the future InSIGHT lander location.