Ionopause-like gradients in the Martian dayside ionosphere: Comparing Mars Express MaRS and MARSIS observations. K. Peter¹, F. Chu², M. Fränz³, M. Pätzold¹, S. Shuvalov⁴ E. Thiemann¹, Z. Girazian⁵, A. Kopf², S. Tellmann¹ ¹ RIU Cologne, Aachener Strasse 209, 50931 Cologne, Germany, Kerstin.peter@uni-koeln.de, ² Department of Physics and Astronomy, University of Iowa, Iowa, USA, feng-chu@uiowa.edu, ³ MPI Göttingen, Göttingen, Germany, fraenz@mps.mpg.de, ⁴ Space Research Institute of the Russian Academy of Sciences (IKI), Moscow, Russia shuvalovsergei@gmail.com, ⁵ Laboratory for Atmospheric and Space Physics, University of Colorado at Boulder, Colorado, USA, Ed.Thiemann@lasp.colorado.edu.

The term ionopause was first applied to describe the upper boundary of the planetary ionosphere of Venus. Multiple ionopause definitions were derived from Pioneer Venus Orbiter (PVO, 1978-1992) in-situ observations, ranging from the location of pressure balance between the incoming solar wind and the Venusian ionosphere [1] to the location of a substantial decrease in ion density [2] or electron density [3] within short temporal and spatial scales. PVO in-situ observations indicate an increase in ionopause altitude for increasing solar zenith angle [4]. Two extreme magnetic states of the dayside ionosphere have been identified for PVO solar maximum conditions: the ‘unmagnetized’ and the ‘magnetized’ state. Unmagnetized ionospheres (when only small-scale magnetic fields are present) are observed when the solar wind dynamic pressure is significantly lower than the maximum thermal pressure of the ionosphere. In these cases a narrow ionopause is found above 300 km altitudes at all solar zenith angles. When the dynamic solar wind pressure reaches or exceeds the maximum subsolar thermal pressure of the ionosphere, the ionosphere can become largely magnetized and a broad ionopause region is found below 300 km altitude [5].

The interaction of Mars with the solar wind is that of an unmagnetized planet like Venus, except for the regions with strong crustal magnetic fields. Strong gradients in the Martian dayside ionosphere were identified in few Mars Express Radio Science (MaRS) observations [6, 7, 8] and in Mars Express (MEX) MARSIS observations [9]. A more detailed analysis of MARSIS observations indicates a response of the ionopause altitude to seasonal variations in solar flux and that ionopauses rarely form over strong crustal magnetic fields [10]. Simultaneous MAVEN observations of Martian plasma and magnetic field properties indicate that ion profiles with gradients in the ionospheric topsides are common on the ionospheric dayside. They are accompanied by a higher proton energy flux at high altitudes and also with stronger magnetic field at low altitude than profiles without an ionopause [11].

This work uses more than 15 years of radio science observations to study the behavior of the uppermost ionospheric region accessible to MaRS. MEX-ASPERA3 [12] and MAVEN [13] observations of the pristine solar wind and solar fluxes at the Mars position are applied to identify potential drivers of the ionospheric variability. The derived MaRS results are compared with i.) the MARSIS ionopause statistics [9] and ii.) on an orbit to orbit basis to improve our understanding of the solar wind interaction at Mars during changing space weather conditions.

References: