Mars’ ionopause: A game of pressures

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The ionopause is a tangential discontinuity in the ionospheric thermal plasma density profile that marks the upper boundary of the ionosphere for unmagnetized planets. This interface is formed by a balance of pressures, as the ionopause is the region where the total pressure of the ionosphere (ionospheric thermal pressure plus magnetic pressure) balances the solar wind ram pressure. Since only Venus and Mars have no global “dipole” magnetic fields, ionopauses are unique to those planets. For Venus, the ionopause formation is well characterized because the thermal pressure of the ionosphere is usually larger than the solar wind dynamic pressure. For Mars, however, the maximum thermal pressure of the ionosphere is usually insufficient to balance the total pressure in the overlying magnetic pileup boundary. Therefore, the Martian ionopause is not always formed, and when it does, it is located at a large range of altitudes, varies rapidly and is highly structured. In this study, we characterise the Martian ionopause formation from the point of view of the thermal, magnetic and dynamic pressure balance. The objective of this paper is to assess under which circumstances the Martian ionopause is formed, both over and far from crustal magnetic fields. We focus on three MAVEN deep dip campaigns that occurred on the dayside of Mars, and we utilize several multi-plasma and magnetic field in-situ observations from the MAVEN mission, as well as solar wind plasma observations from the Mars Express mission.