The morphology of the topside ionosphere of Mars under different solar wind conditions: Results of a multi-instrument observing campaign by Mars Express in 2010

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Solar wind

http://lasp.colorado.edu/home/science/space-physics/space-plasma
(SOHO EIT and LASCO composite)

Fig 1b of Russell et al. (2000)
(WIND data from 4 May 1998)
Fig 4 of Brain et al. (2010)
H⁺ (left) and O⁺ (right) densities from Ma MHD model
“Typical” solar wind conditions, no crustal fields
Ionosphere

Fig 2 of Withers et al. (2012)
Variations in the vertical extent of the ionosphere
Observational study of solar wind, magnetosphere, and ionosphere coupling using Mars Express

- March/April 2010
  - Earth and Mars on same branch of Parker spiral
- Solar wind data
  - WIND extrapolation, ASPERA
- Magnetospheric data
  - ASPERA
- Ionospheric data
  - Radio occultations, MARSIS local densities
Solar wind data
Magnetospheric data

8051 Protons

8058 Protons

8051 Electrons

8058 Electrons
Ionospheric data

Orbit 8051
Blue – unsmoothed
Red – smoothed
Relatively small topside densities

Orbit 8058
Blue – unsmoothed
Red – smoothed
Relatively large topside densities
Electron density (cm$^{-3}$)
Summary

**Orbit 8051 – Compression**
- Solar wind dynamic pressure relatively high
- Magnetosphere relatively compressed and magnetosheath densities relatively enhanced
- Ionopause detected by MARSIS
- Relatively low densities in topside ionosphere

**Orbit 8058 – Relaxation**
- Solar wind dynamic pressure relatively low
- Magnetosphere relatively relaxed and magnetosheath densities relatively diminished
- Ionopause not detected by MARSIS (orbits 8056, 8059)
- Relatively high densities in topside ionosphere
Backup
Fig 17 of Brain (2006)
Halloween 2003 solar events
Strong ionospheric attenuation seen by MARSIS topside radar sounder in SEP events
Implication – enhanced plasma densities at “low”(?) altitudes during SEP events