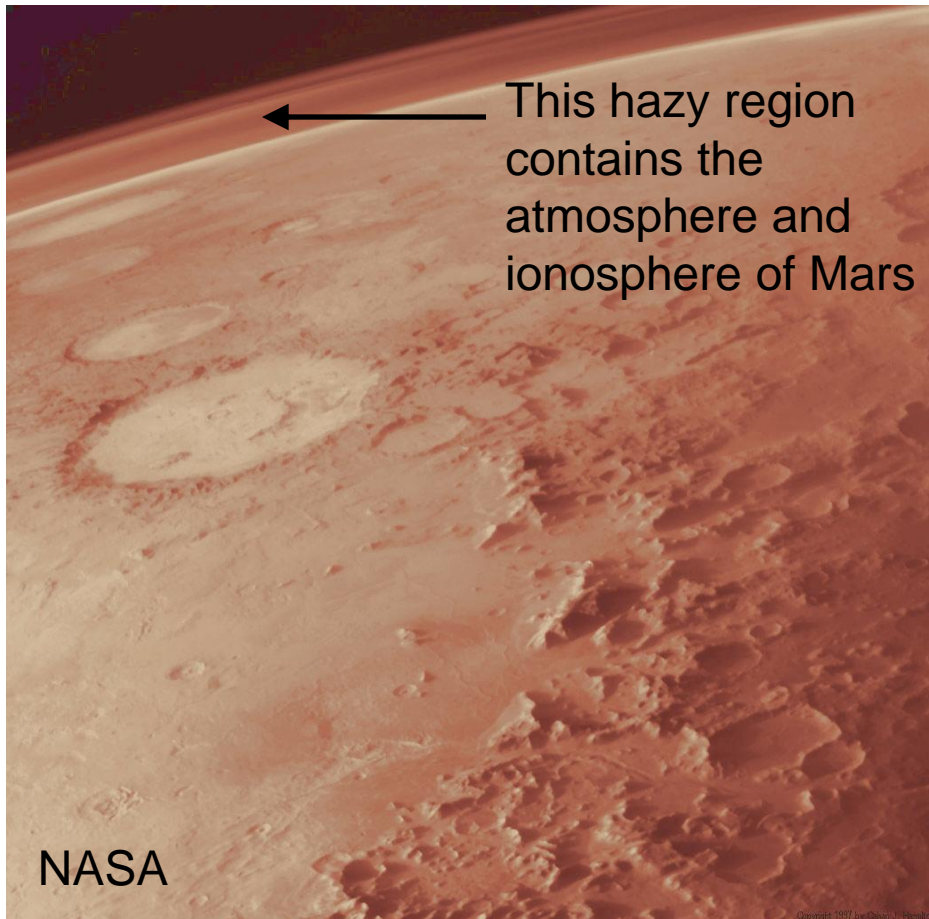


The ionosphere of Mars never looked like this before



Paul Withers
Boston University
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Space Physics
Group meeting,
University of Michigan

Wednesday 2012.03.14



One scale

This is
← Mars

0.5 x R-Earth

1.5 AU from Sun

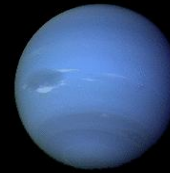
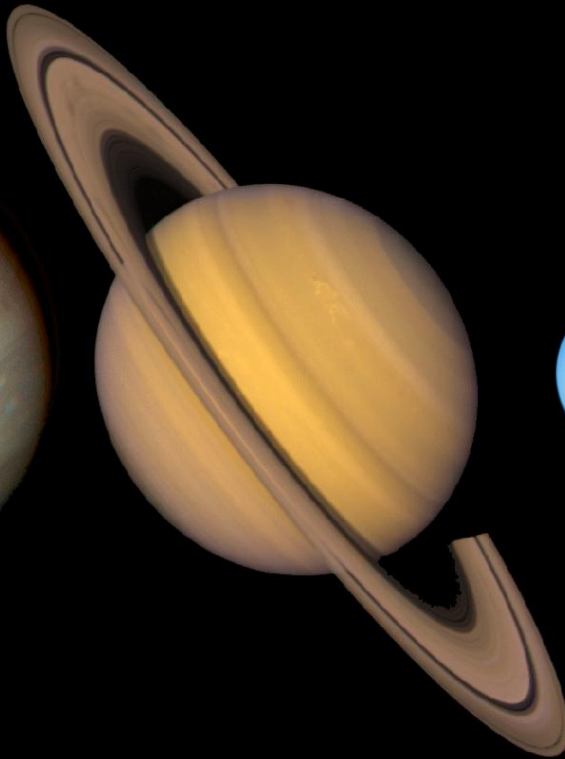
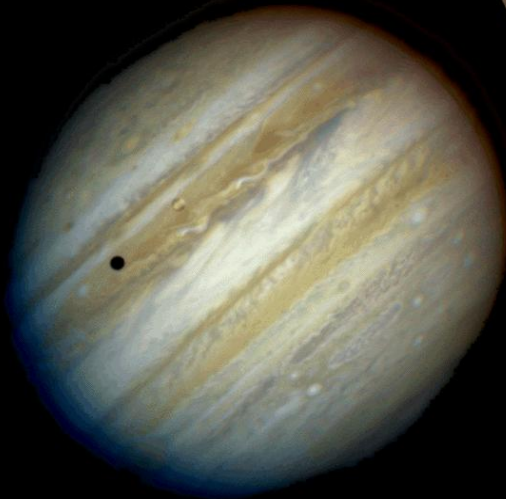
Same rotation
rate as Earth

Carbon dioxide
atmosphere

100x smaller
surface pressure













Target of many
spacecraft in last
15 years

Different scale

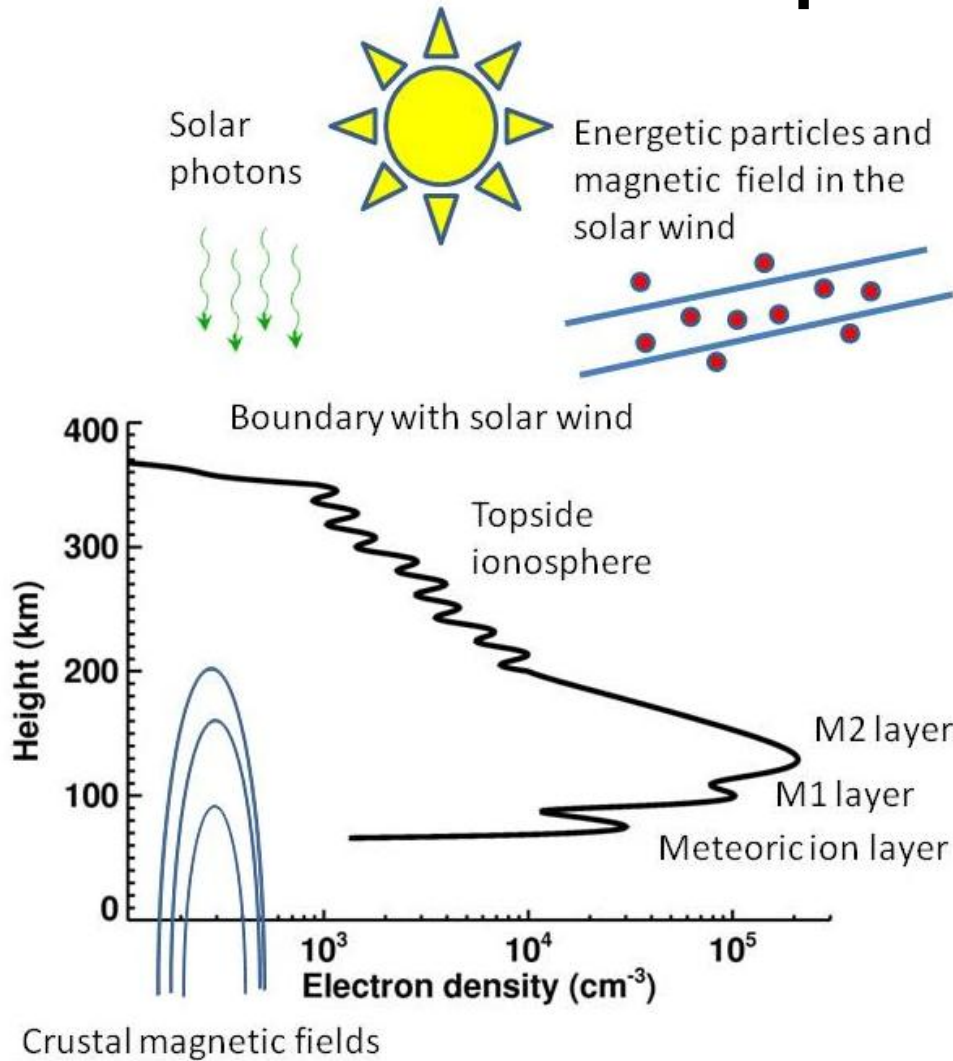


www.solarviews.com

Ionospheres are schizophrenic

	Atmosphere	Ionosphere	Space physics
Chemistry			
Gravity			
Sunlight			
Magnetic fields			
Composition	Neutrals	Ions, electrons, and neutrals	Protons and electrons

The ionosphere of Mars



Neutral atmosphere is mainly CO₂, O becomes significant at high altitudes

O₂⁺ is main ion (?) at all altitudes

EUV photons responsible for main M2 layer

Soft X-ray photons and secondary ionization responsible for lower M1 layer

Transport only important in topside ionosphere

Withers et al. (2009) Decadal Survey white paper

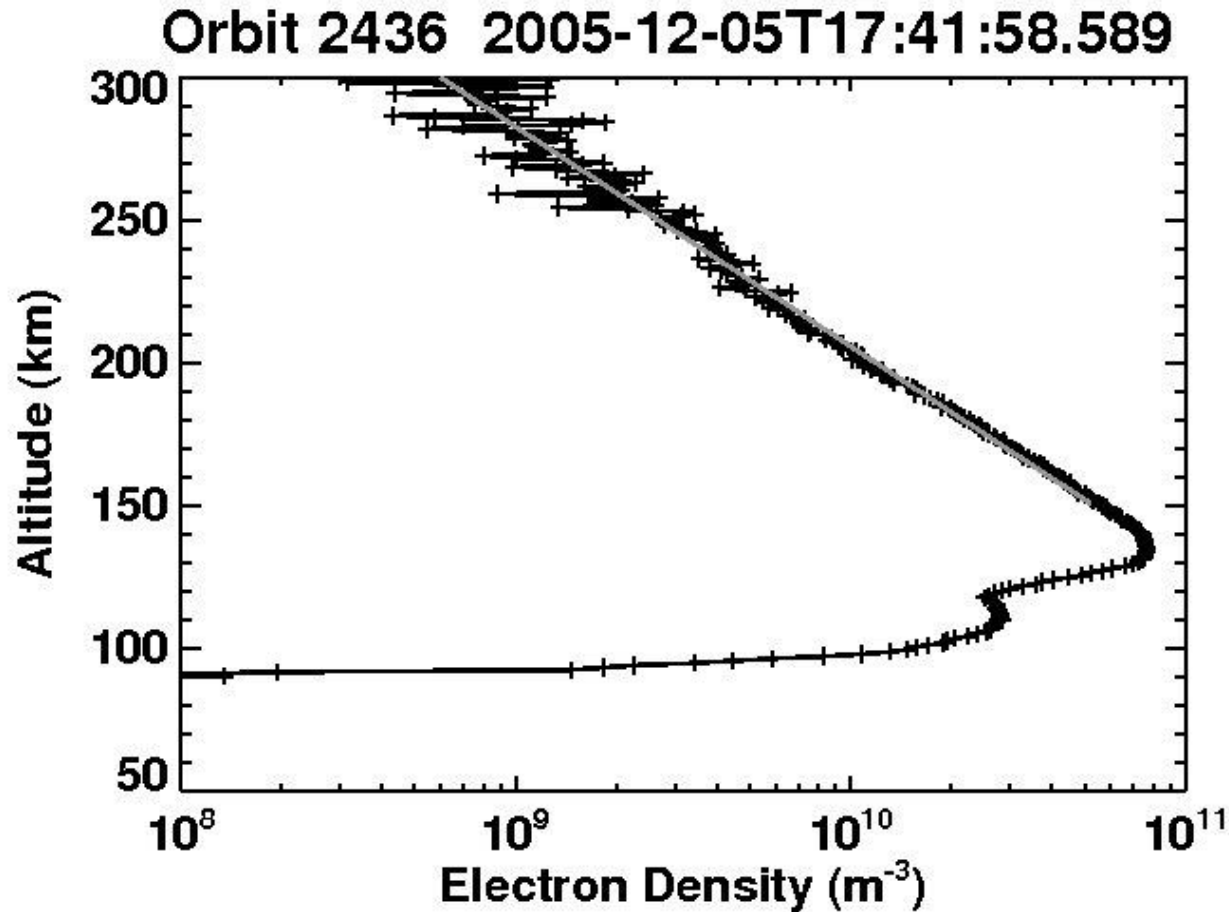


Figure 1A: Electron density profile from orbit 2436 on 5 December 2005 at solar zenith angle of 78 degrees, latitude 67°N, longitude 235°E. The grey solid line is an exponential fit to densities between 150 km and 300 km that has a scale height of 33 km.

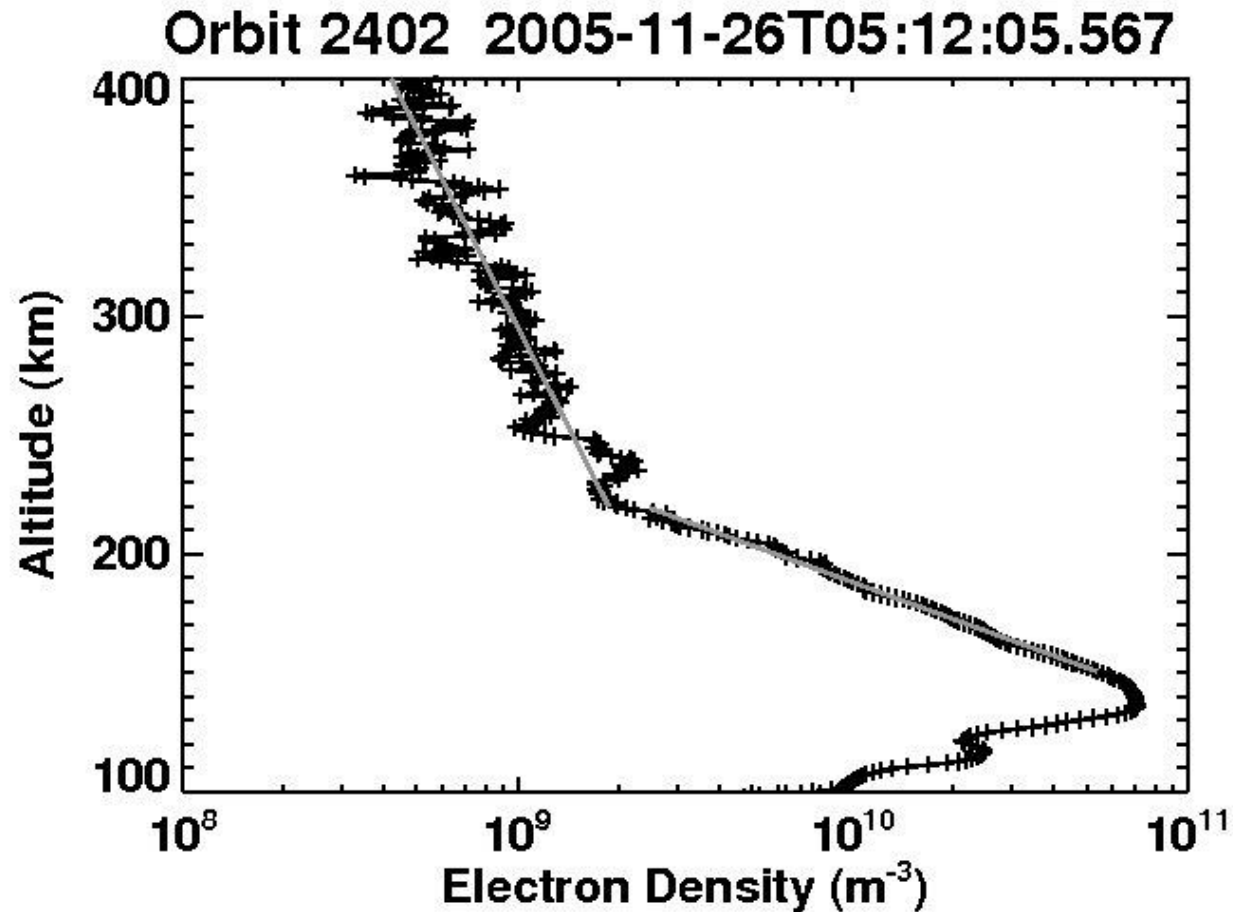


Figure 1B: Electron density profile from orbit 2402 on 26 November 2005 at solar zenith angle of 81 degrees, latitude 66°N, longitude 341°E. The lower and upper grey solid lines are exponential fits to densities at 150-220 km and 220-400 km, respectively, that have scale heights of 22 km and 120 km.

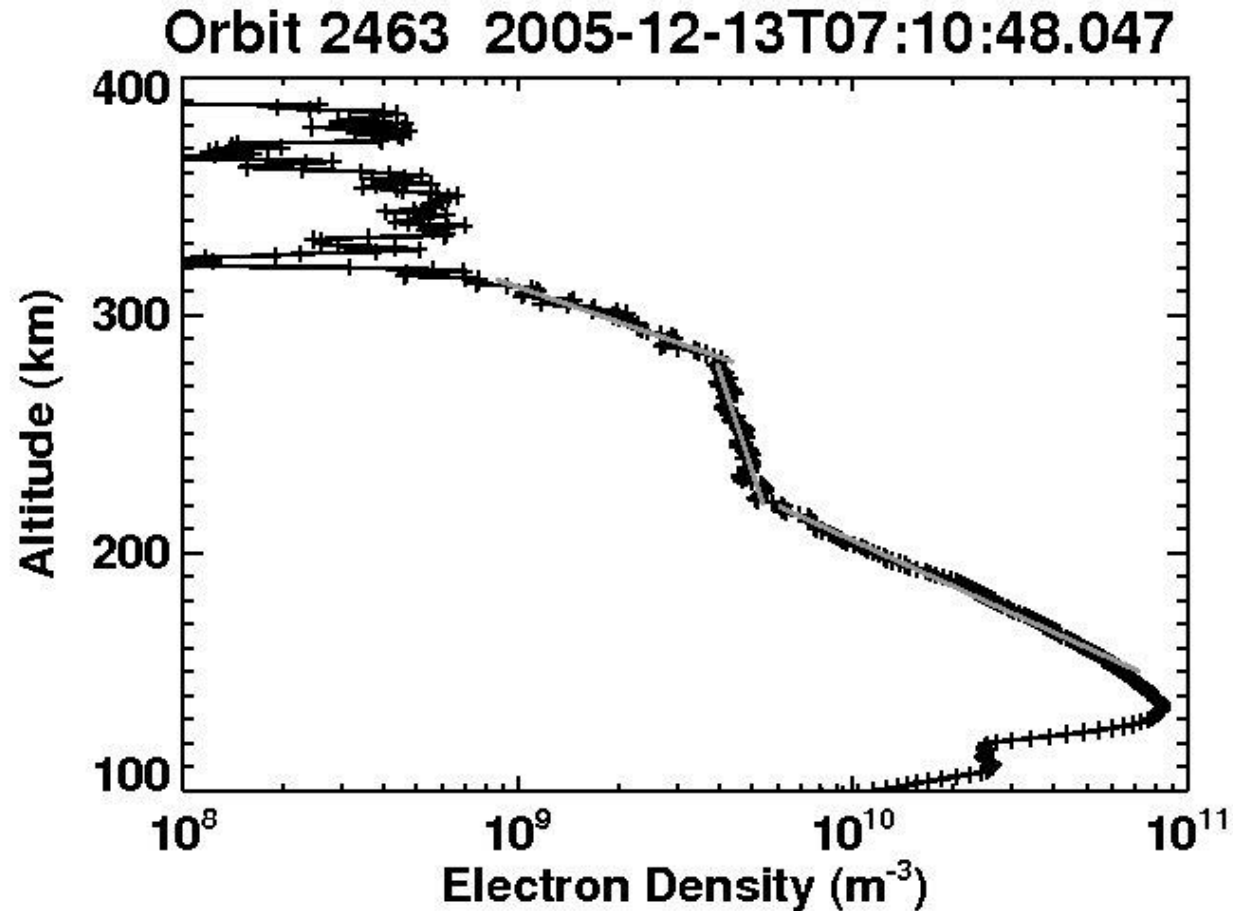


Figure 1C: Electron density profile from orbit 2463 on 13 December 2005 at solar zenith angle of 75 degrees, latitude 66°N, longitude 103°E. The lower, middle, and upper grey solid lines are exponential fits to densities at 150-220 km, 220-280 km, and 280-315 km, respectively, that have scale heights of 28 km, 190 km, and 21 km.

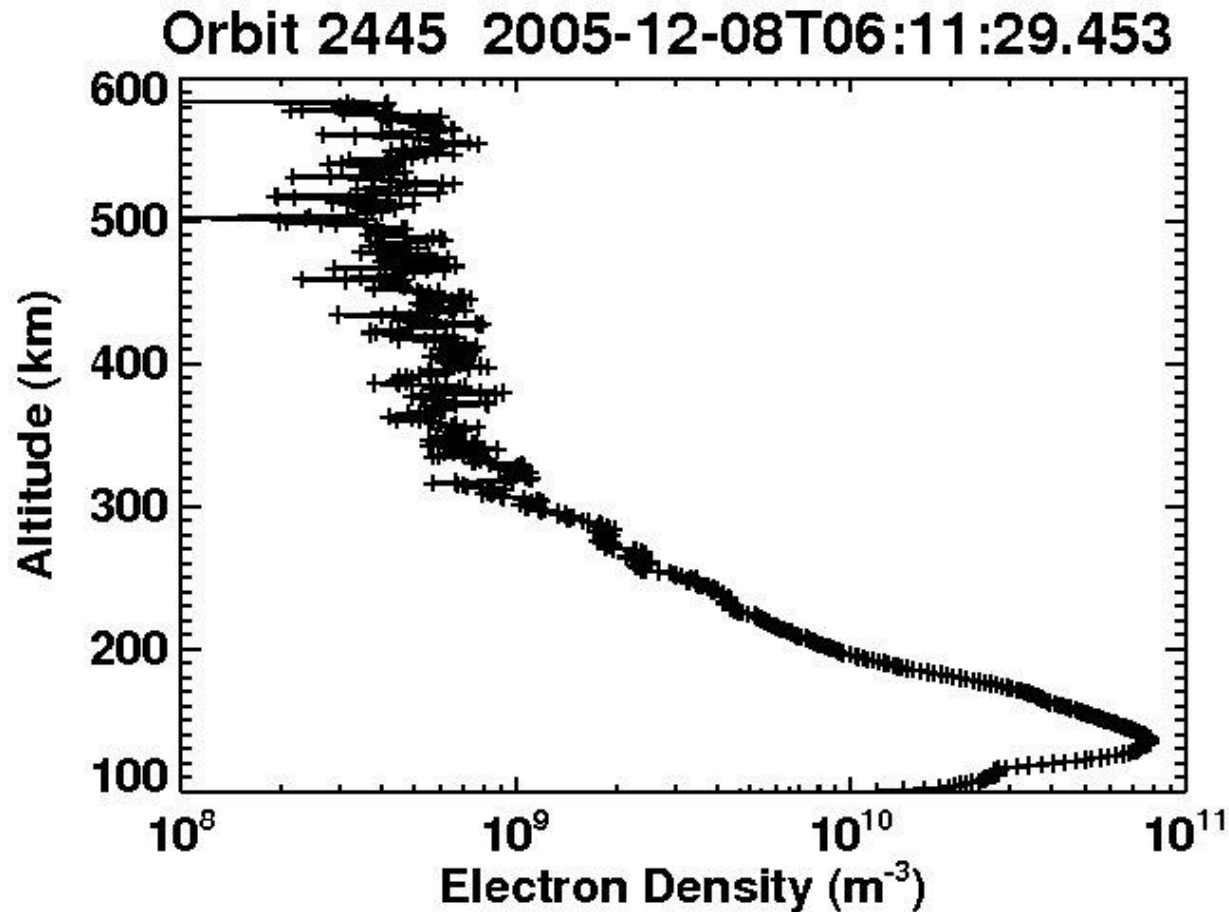


Figure 1D: Electron density profile from orbit 2445 on 8 December 2005 at solar zenith angle of 77 degrees, latitude 67°N, longitude 70°E. Electron densities are nearly uniform between 300 km and 580 km.

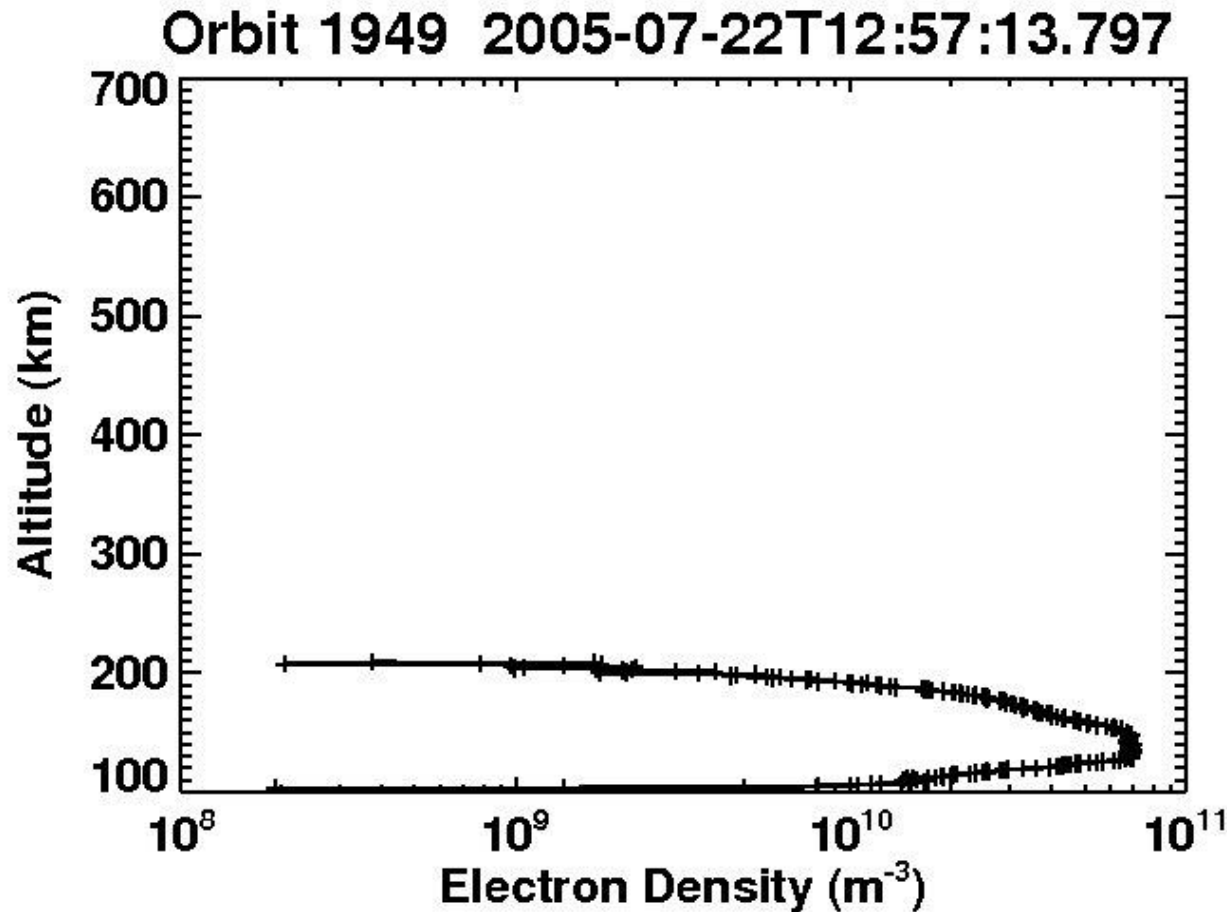


Figure 1E: Electron density profile from orbit 1949 on 22 July 2005 at solar zenith angle of 69 degrees, latitude 42°N, longitude 24°E. Electron densities drop below 10⁹ m⁻³ by 200 km altitude.

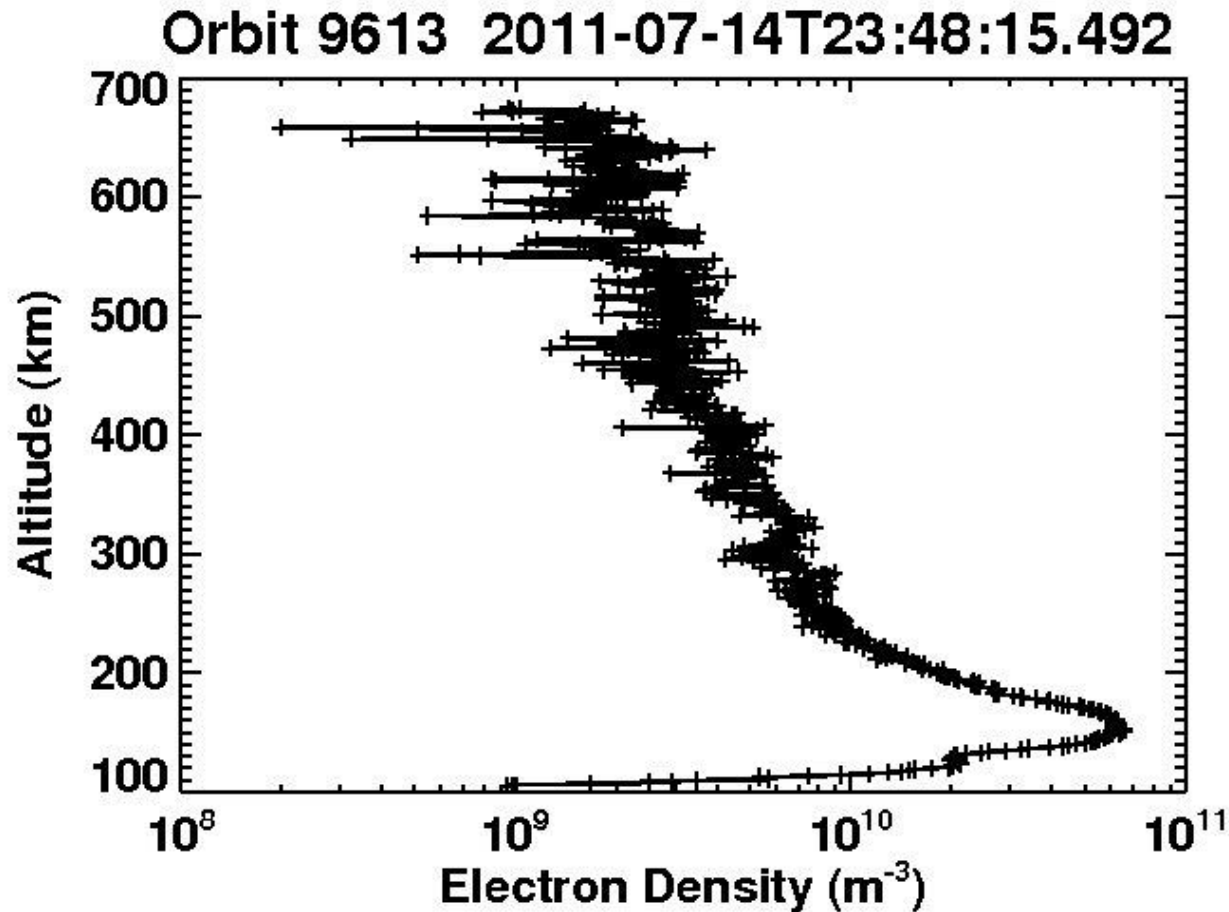


Figure 1F: Electron density profile from orbit 9613 on 14 July 2011 at solar zenith angle of 82 degrees, latitude 82°S, 180°E. Electron densities remain above 10^9 m^{-3} to 700 km altitude.

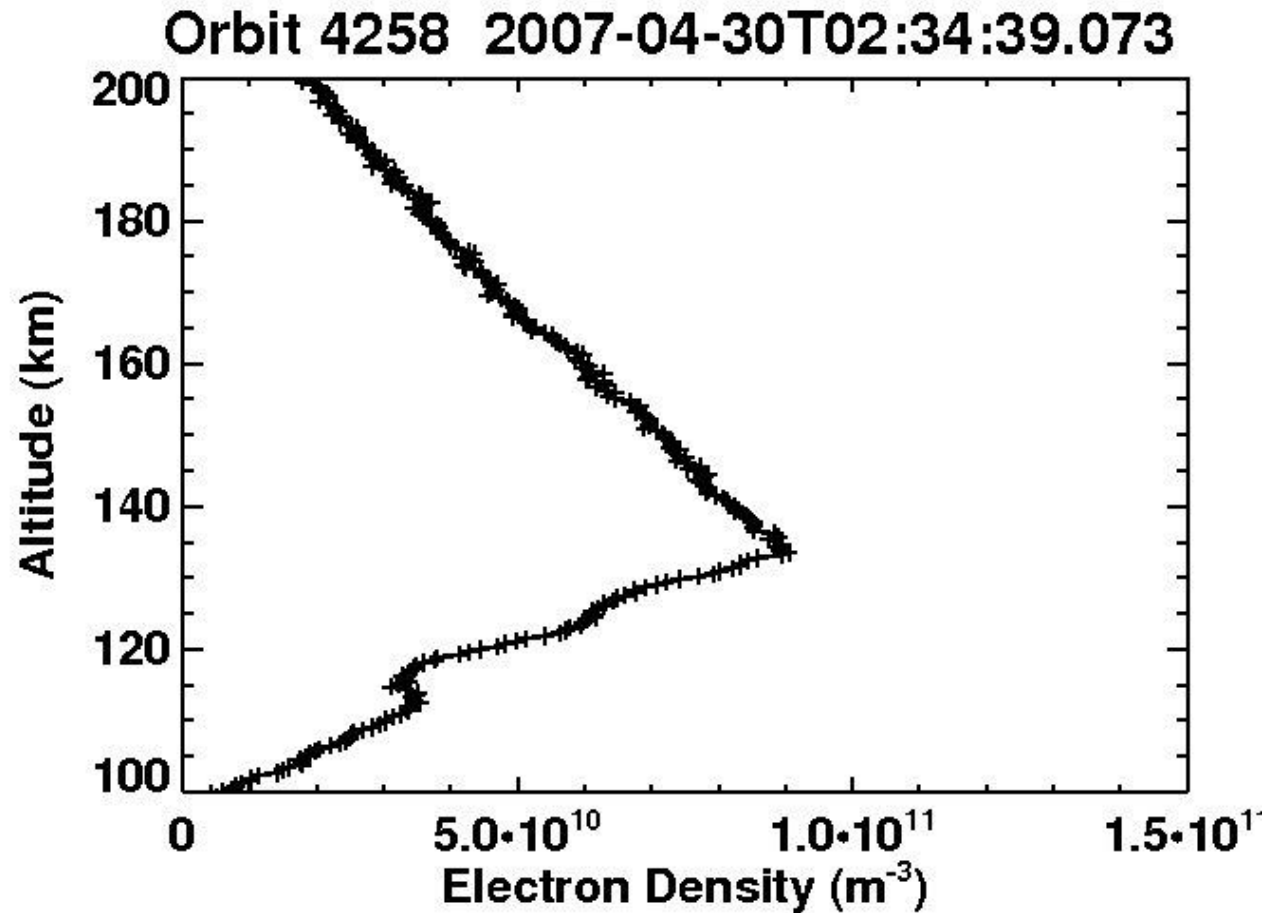


Figure 2A: Electron density profile from orbit 4258 on 30 April 2007 at solar zenith angle of 68 degrees, latitude 46°N , longitude 278°E .

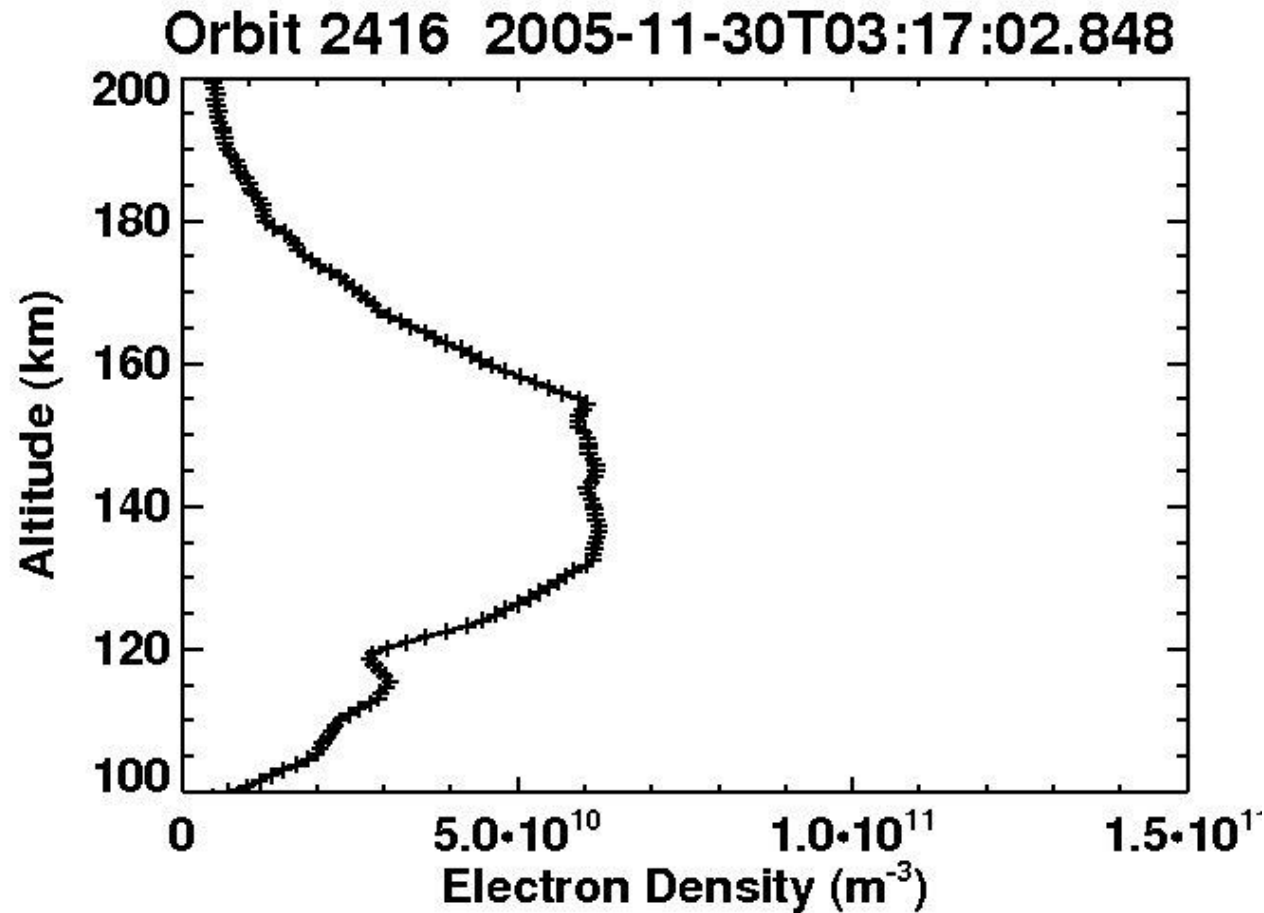


Figure 2B: Electron density profile from orbit 2416 on 30 November 2005 at solar zenith angle of 79 degrees, latitude 67°N, longitude 42°E.

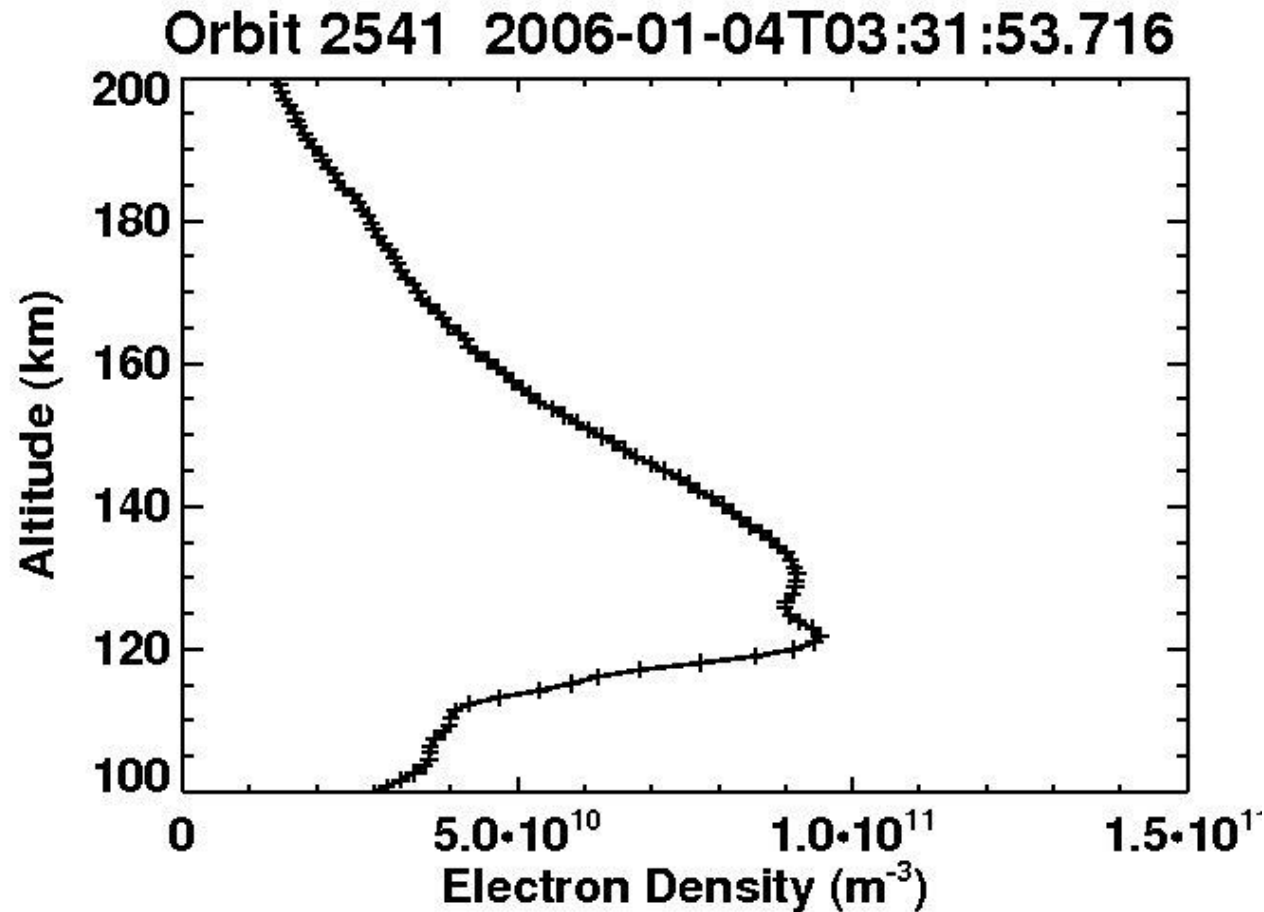


Figure 2C: Electron density profile from orbit 2541 on 4 January 2006 at solar zenith angle of 66 degrees, latitude 60°N, longitude 17°E.

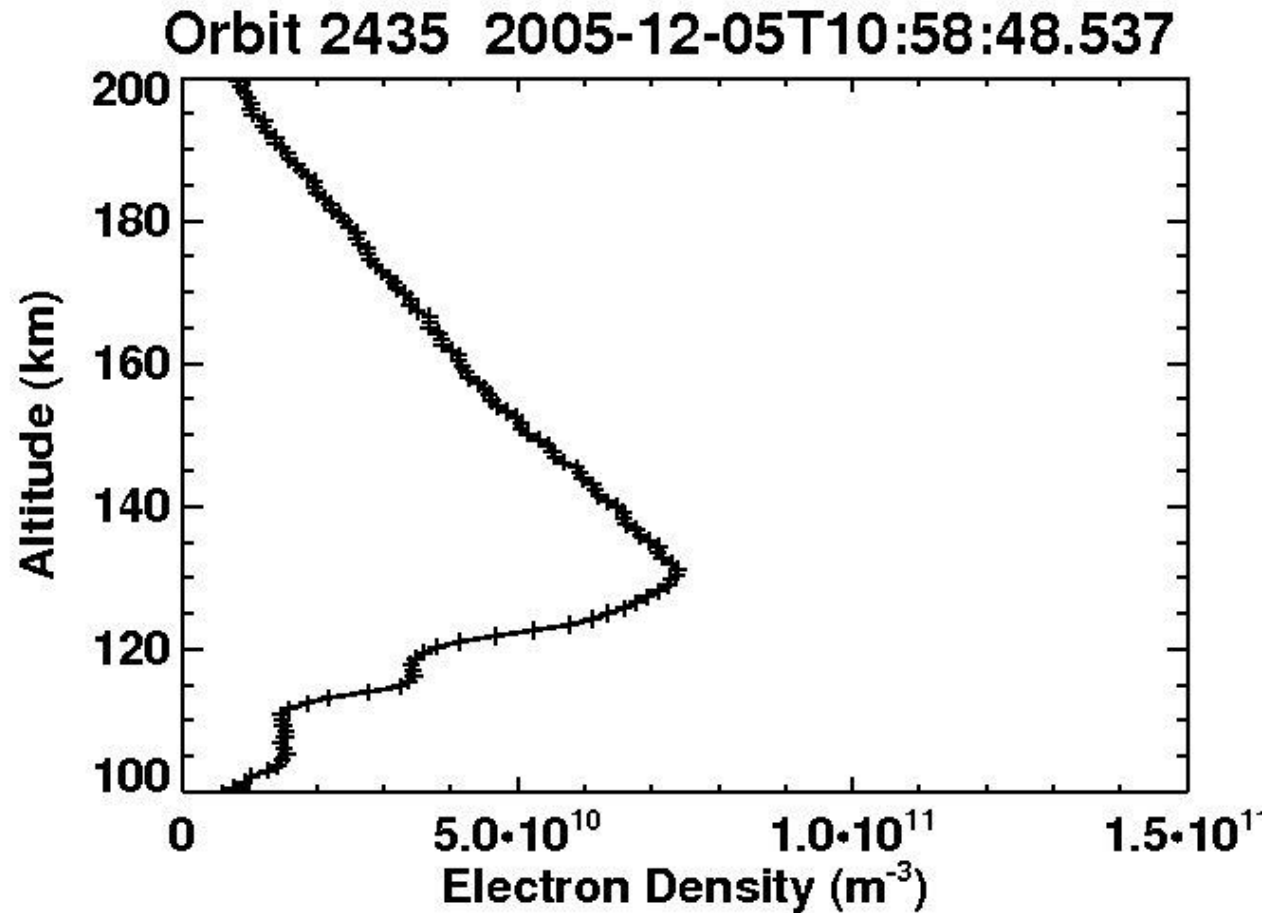


Figure 2D: Electron density profile from orbit 2435 on 5 December 2005 at solar zenith angle of 78 degrees, latitude 67°N, longitude 333°E.

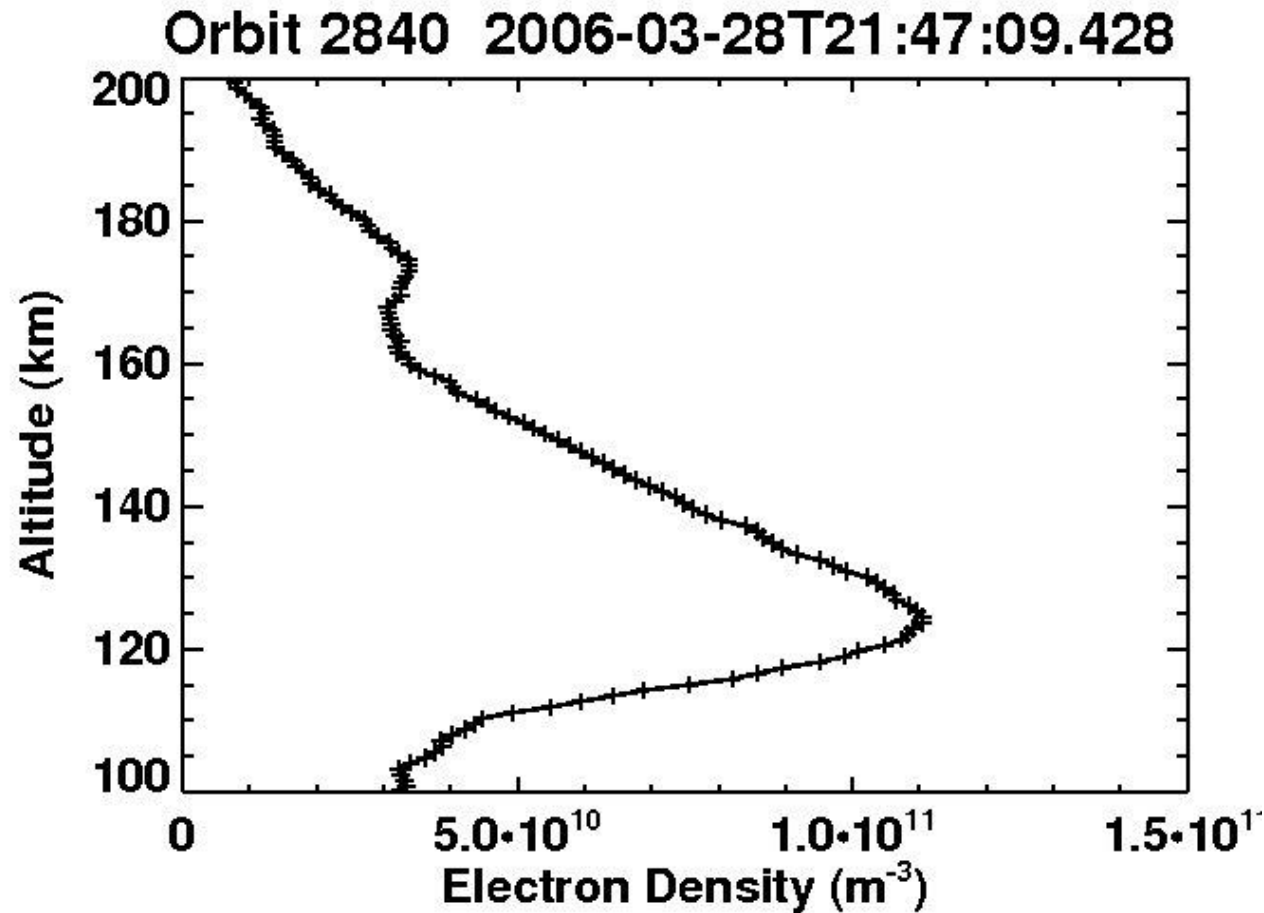


Figure 2E: Electron density profile from orbit 2840 on 28 March 2006 at solar zenith angle of 55 degrees, latitude 15°N, longitude 217°E.

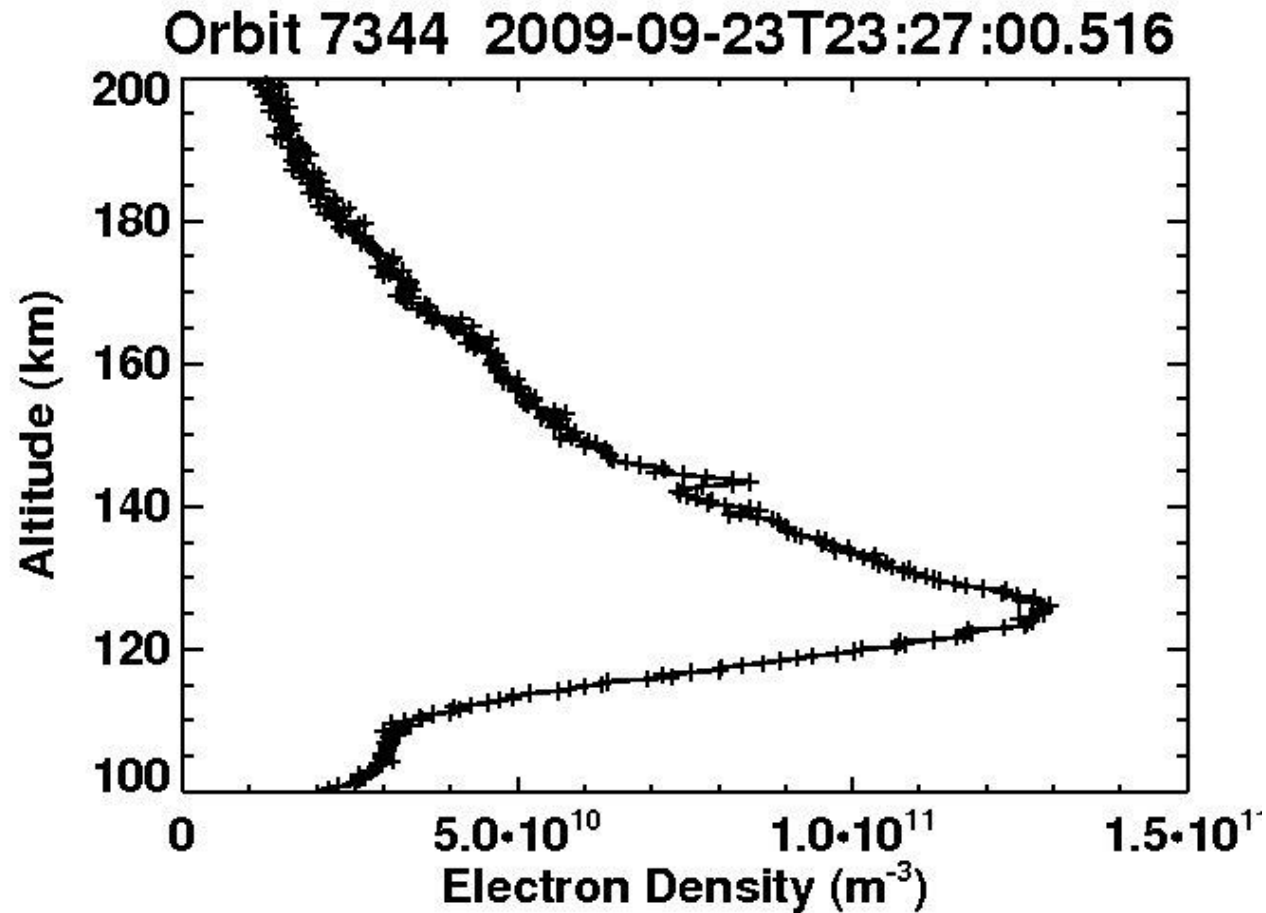
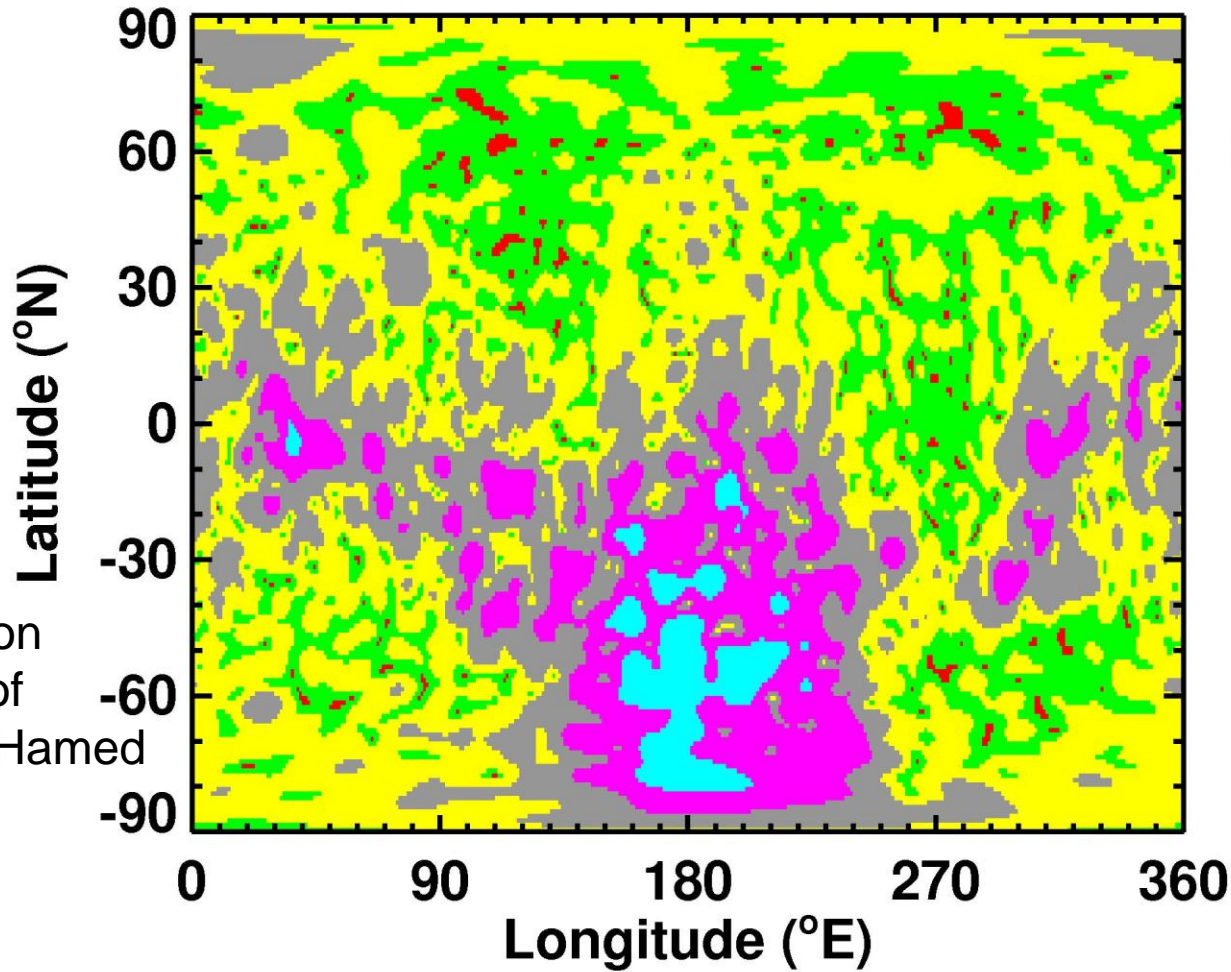


Figure 2F: Electron density profile from orbit 7344 on 23 September 2009 at solar zenith angle of 52 degrees, latitude 34°S, longitude 137°E.

Magnetic field at Mars



Based on
model of
Arkani-Hamed
(2004)

$|B|$ (nT) at 150 km