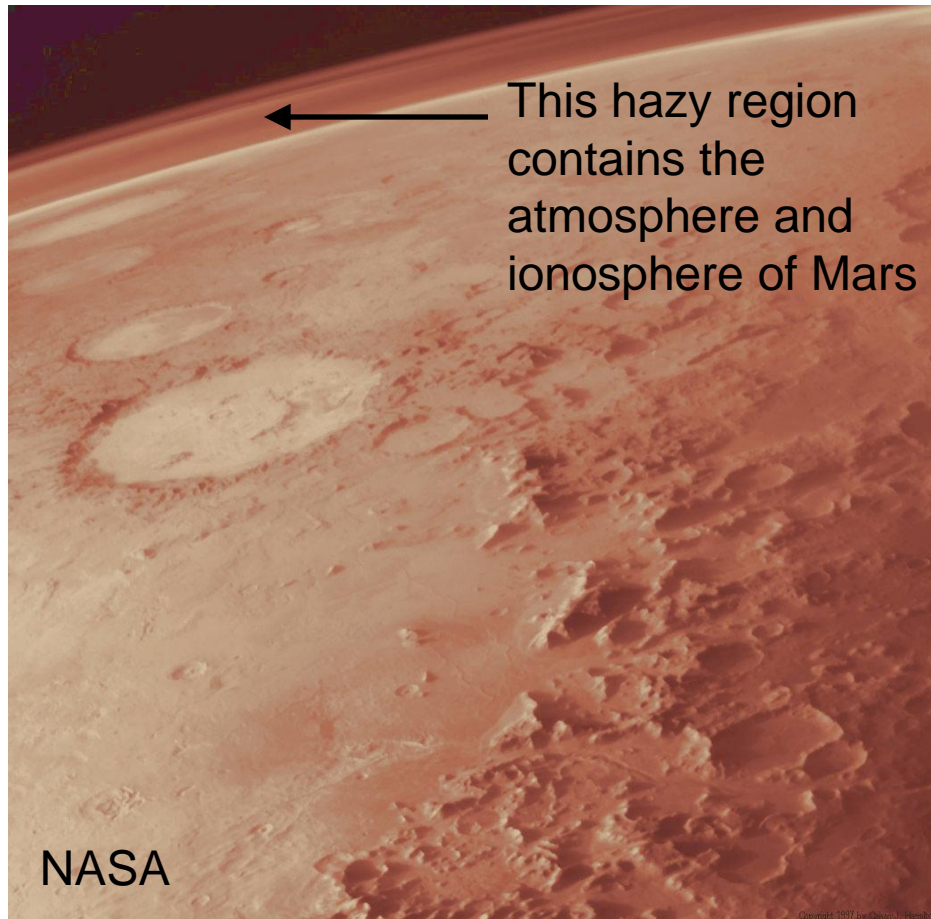


Exploring the ionosphere of Mars

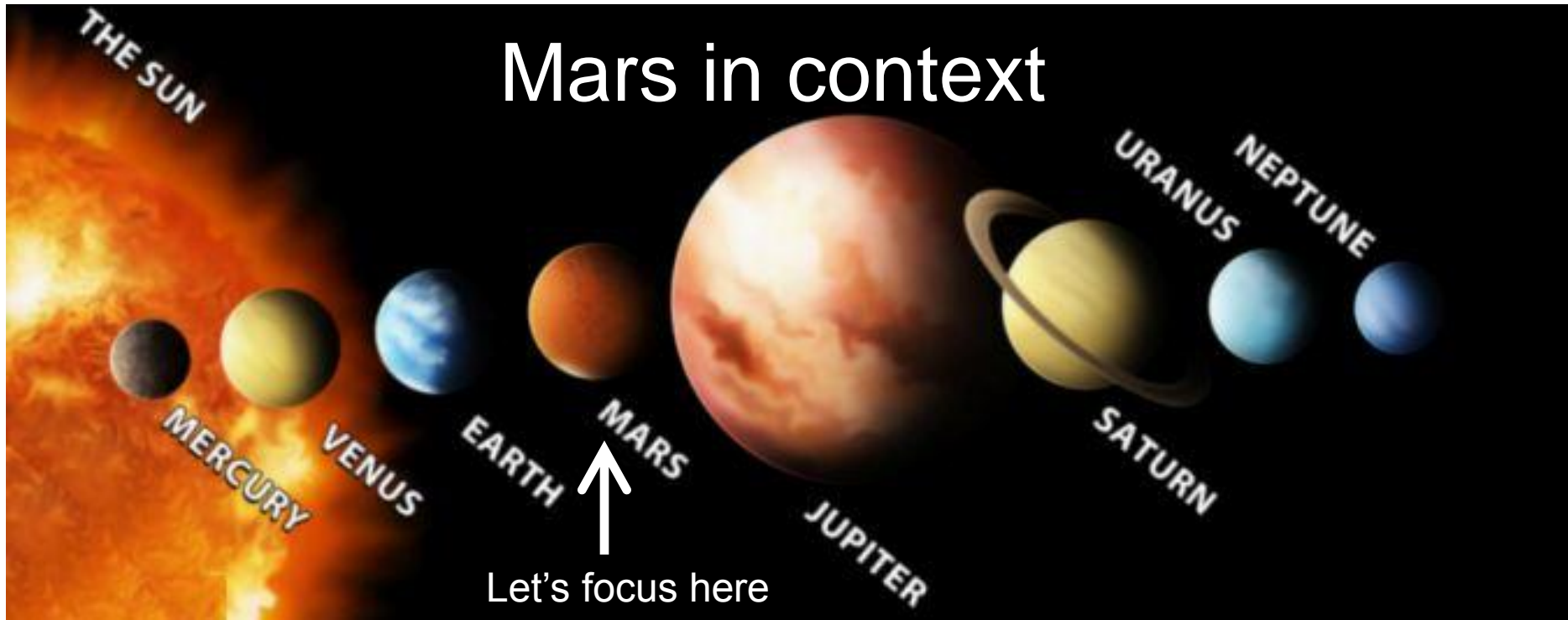


Paul Withers
Boston University
(withers@bu.edu)

UK NAM
St. Andrews, Scotland
Thursday 2013.07.04
10.12-10.24

Happy Fourth of July!

Mars in context



0.5 x R-Earth

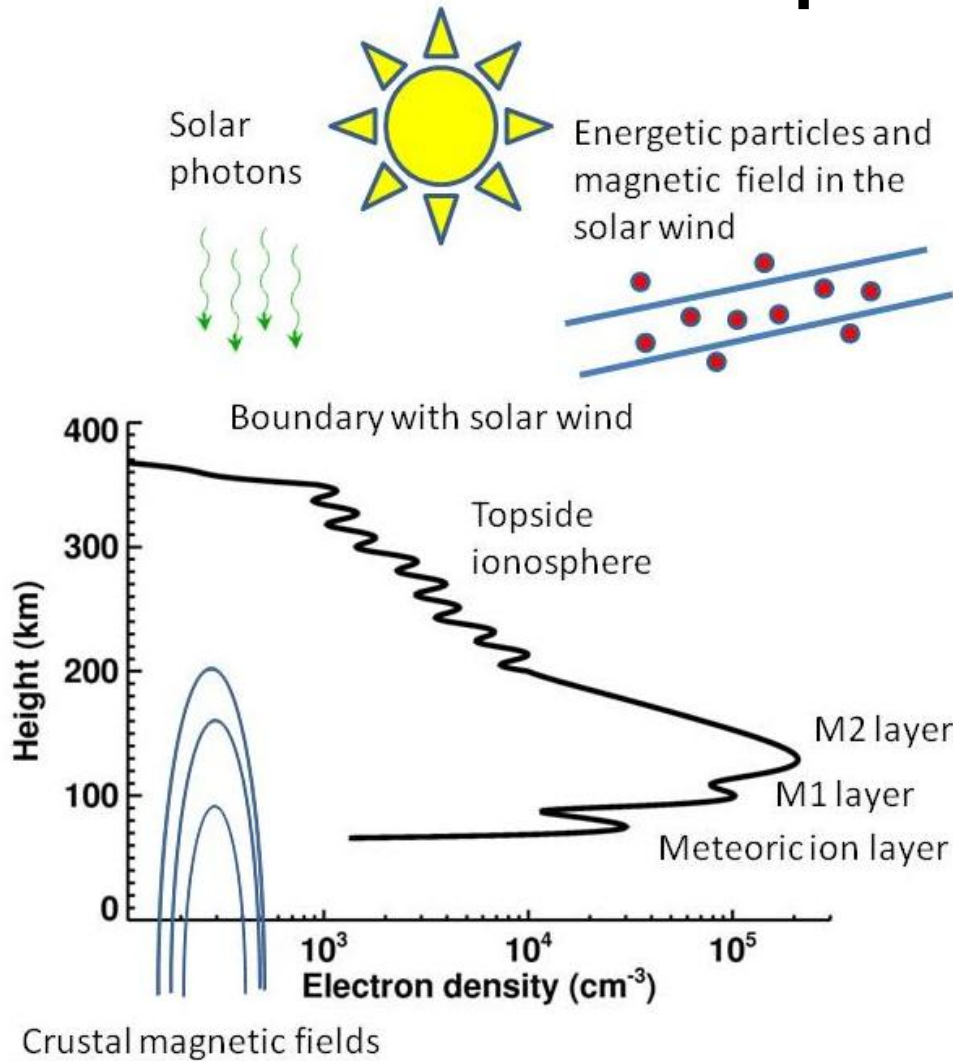
Carbon dioxide atmosphere

1.5 AU from Sun

100x smaller surface pressure

Same rotation rate as Earth and target of many spacecraft in last 15 years

The ionosphere of Mars



Neutral atmosphere is mainly CO_2 , O becomes significant at high altitudes

O_2^+ is main ion at all altitudes

EUV photons (10-100 nm) responsible for main M2 layer

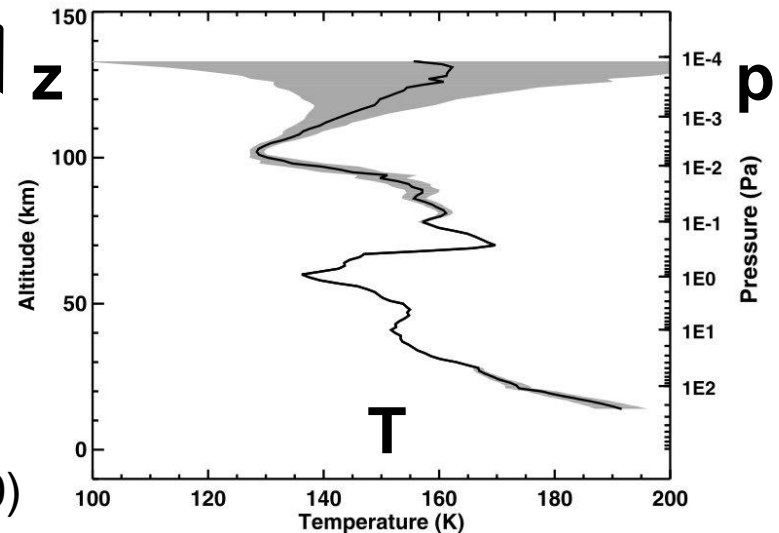
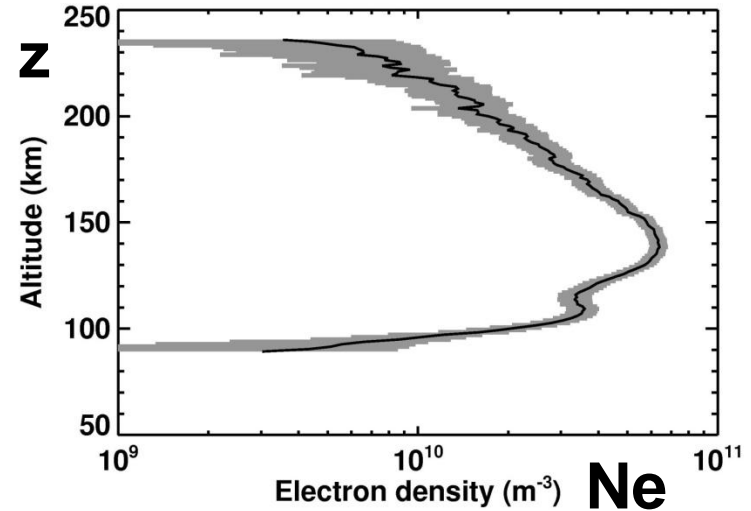
Soft X-ray photons (1-10 nm) and secondary ionization responsible for lower M1 layer

Transport only important in topside ionosphere

How does the system work?

Chemistry, dynamics, energetics

- Lots of data:
 - Plasma vertical structure
 - Neutral vertical structure
- Limited data:
 - Ion and neutral composition, dynamics, and energetics
 - Solar photon, charged particle, magnetic inputs



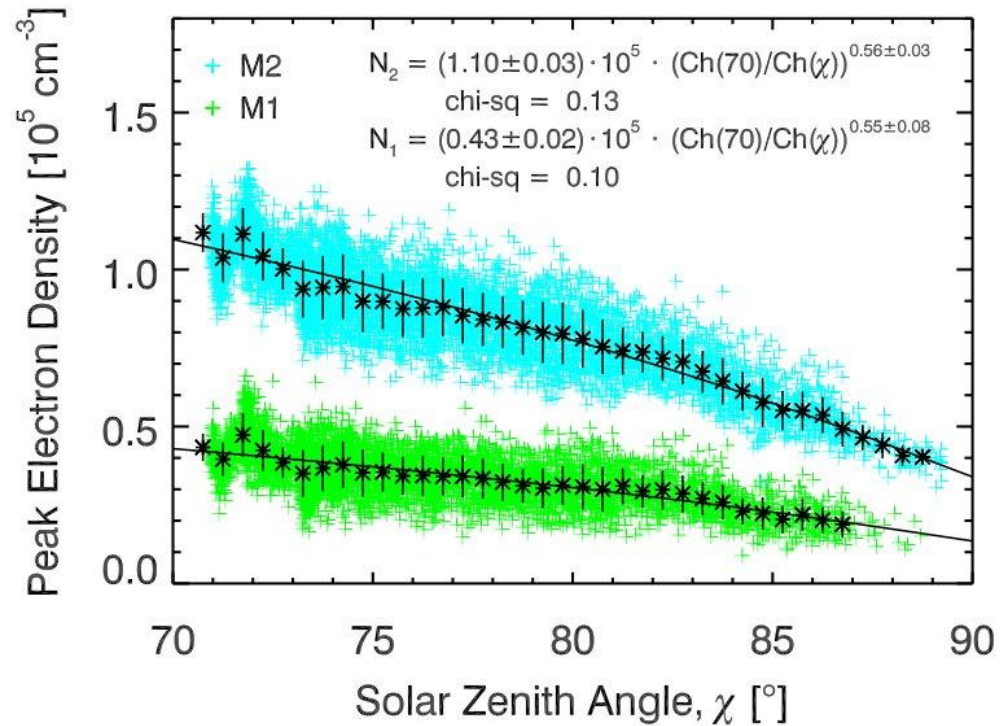
Withers et al. (2008); Withers and Catling (2010)

Solar control

- Solar zenith angle dependence

- $N \propto \cos(\text{SZA})^{-0.5}$
- Both layers

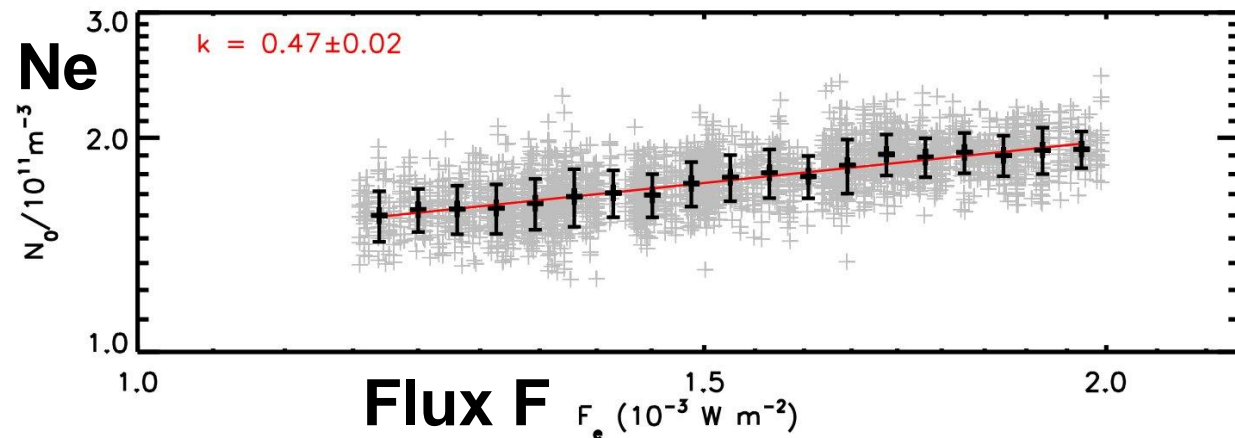
Fallows and Withers (2013, sub)



- Solar flux dependence

- $N \propto F^{0.5}$
- Needs good F

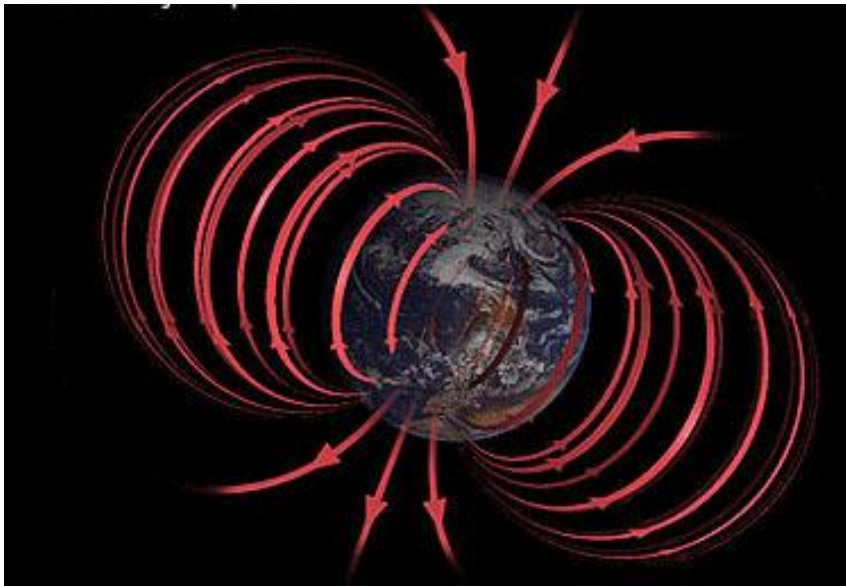
Girazian and Withers (2013)



Mars is magnetically crazy

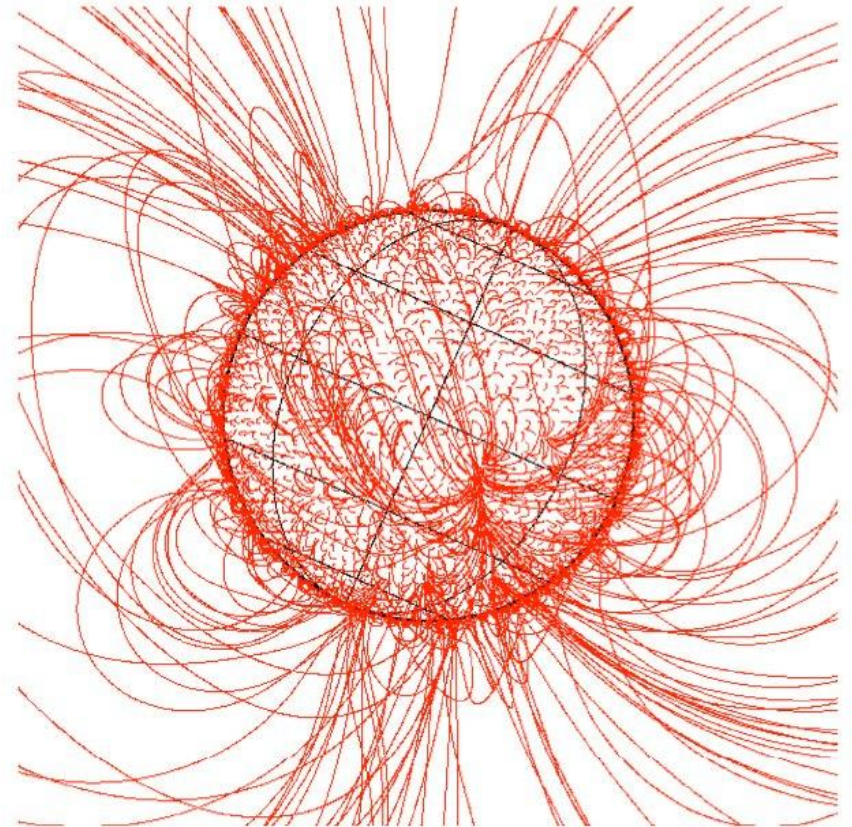
How does this affect ionosphere?

Earth magnetic field



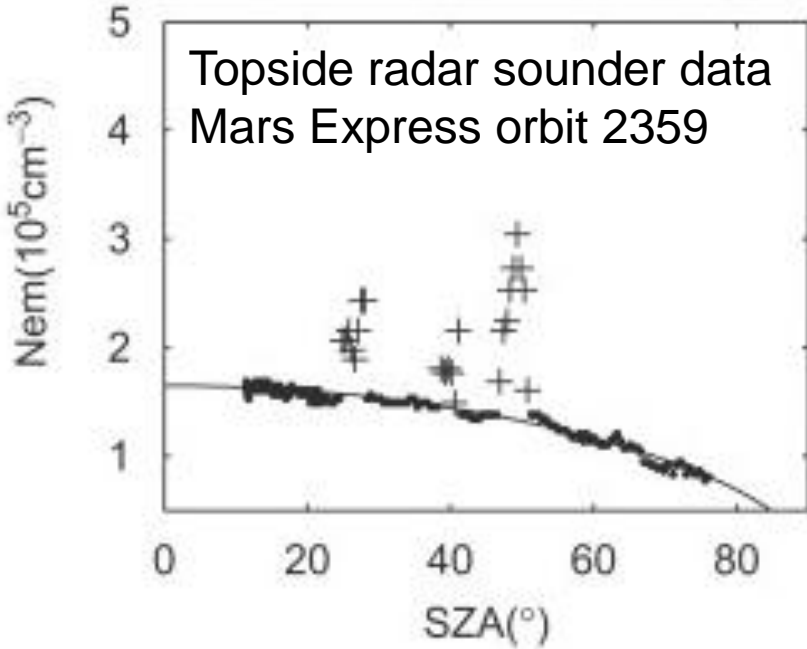
www.windows2universe.org

Mars magnetic field



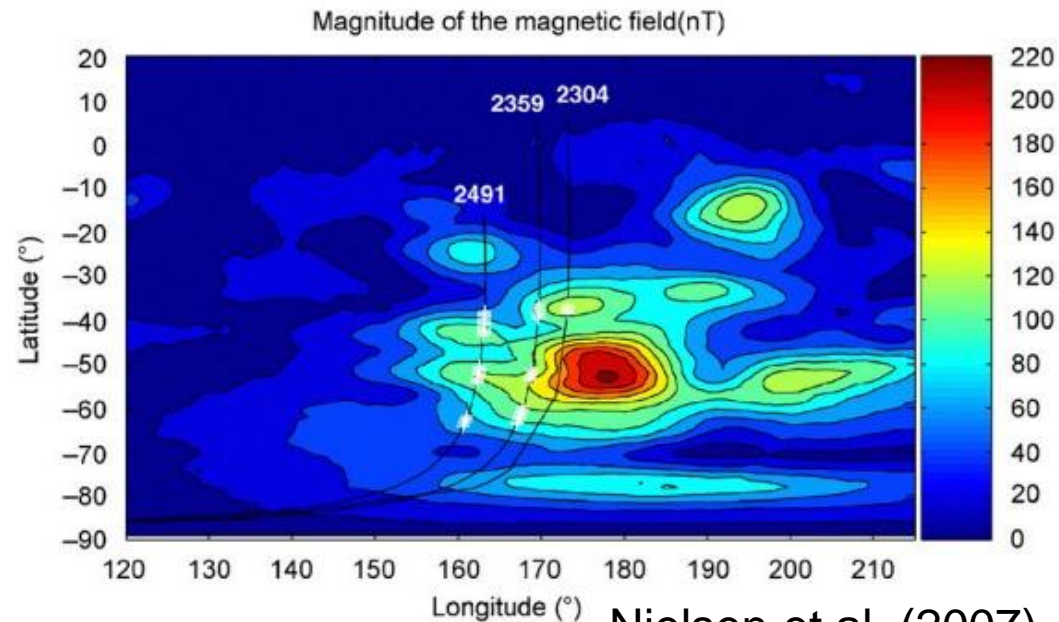
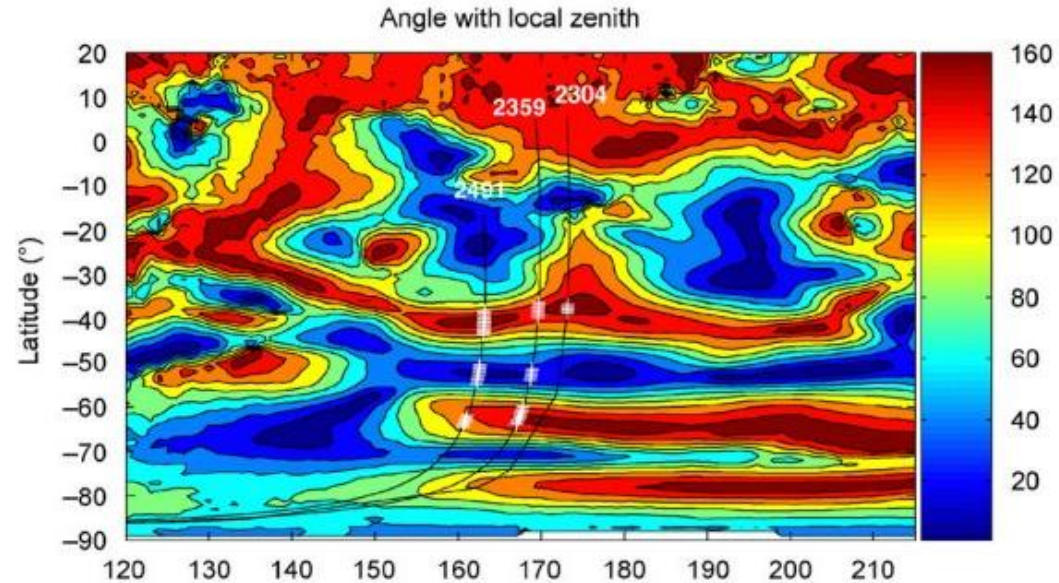
Brain (2002)

Magnetic effects



Strong and vertical field
means large densities

Why?



Nielsen et al. (2007)

Future is bright – MAVEN



Launch in <6 months, reach Mars in September 2014

MAVEN carries:

- Particles and fields package
- UV spectrometer
- Mass spectrometer

to measure:

- Solar forcing
- Conditions in magnetosphere, neutral atmosphere, and ionosphere