MARTIAN CRUSTAL MAGNETIC FIELDS: INFLUENCES ON THE IONOSPHERE

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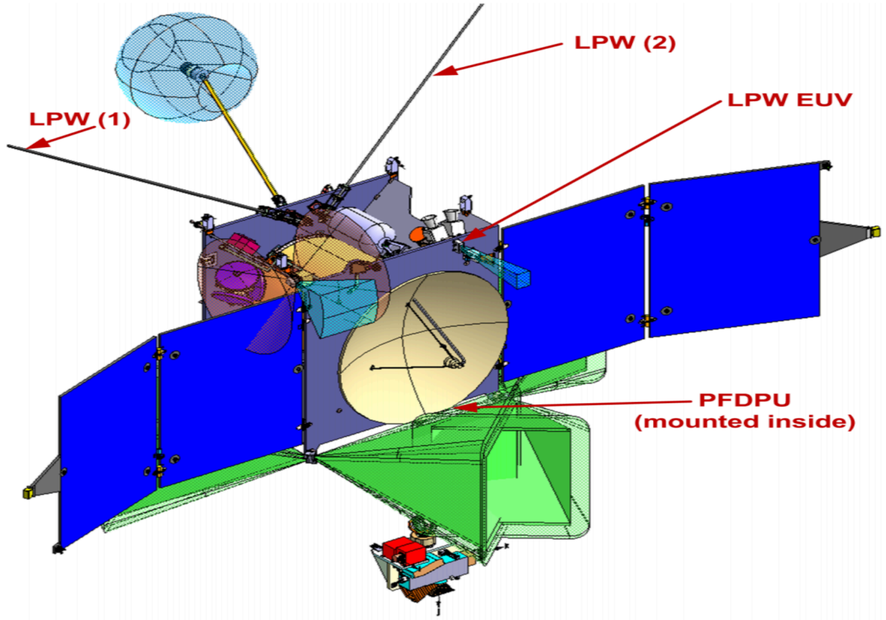

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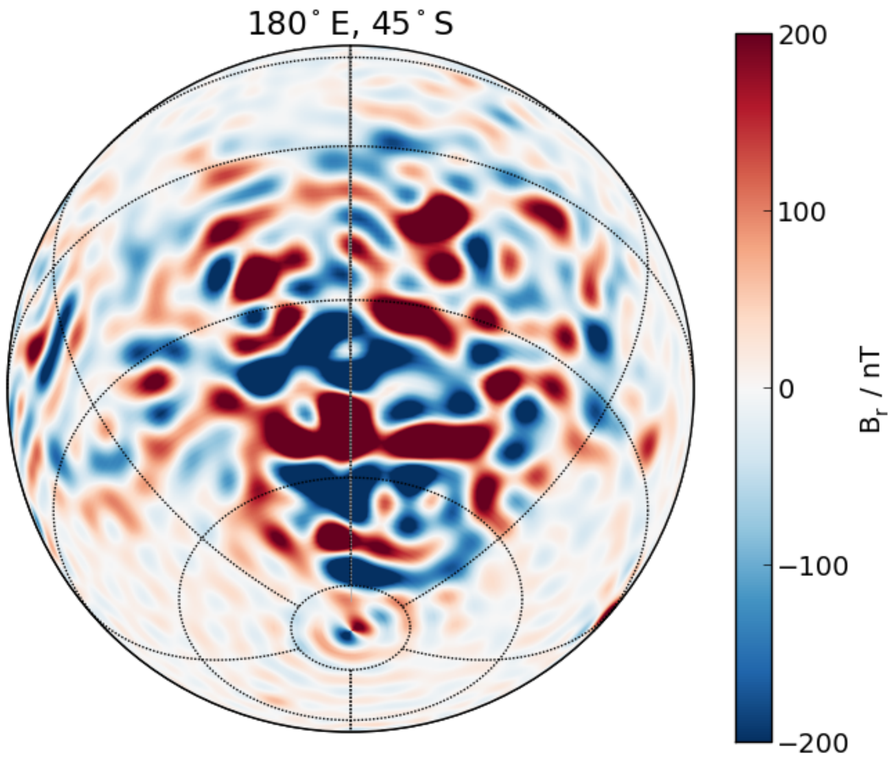
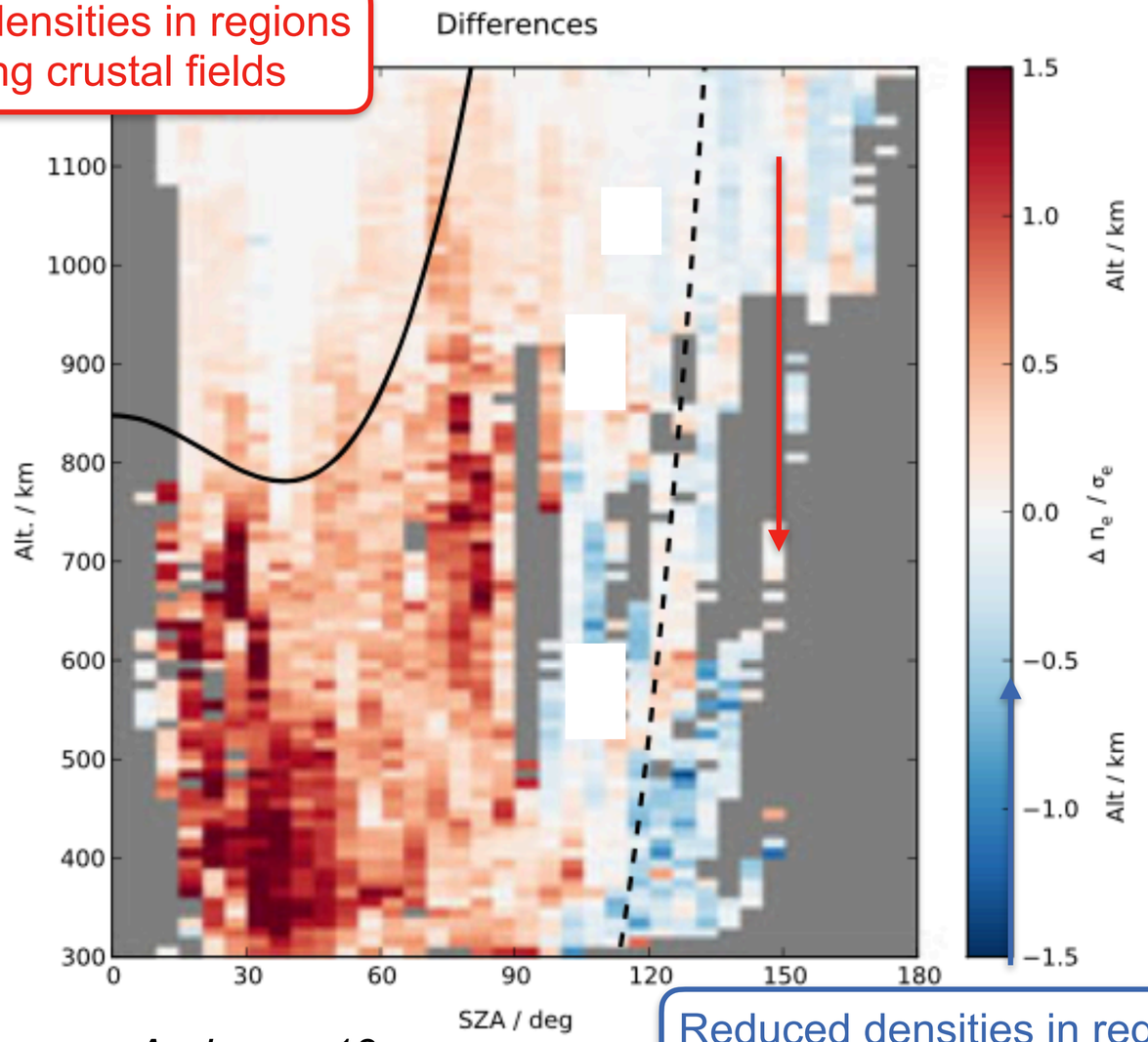
Mars's crustal fields and the ionosphere

Elevated densities in regions of strong crustal fields



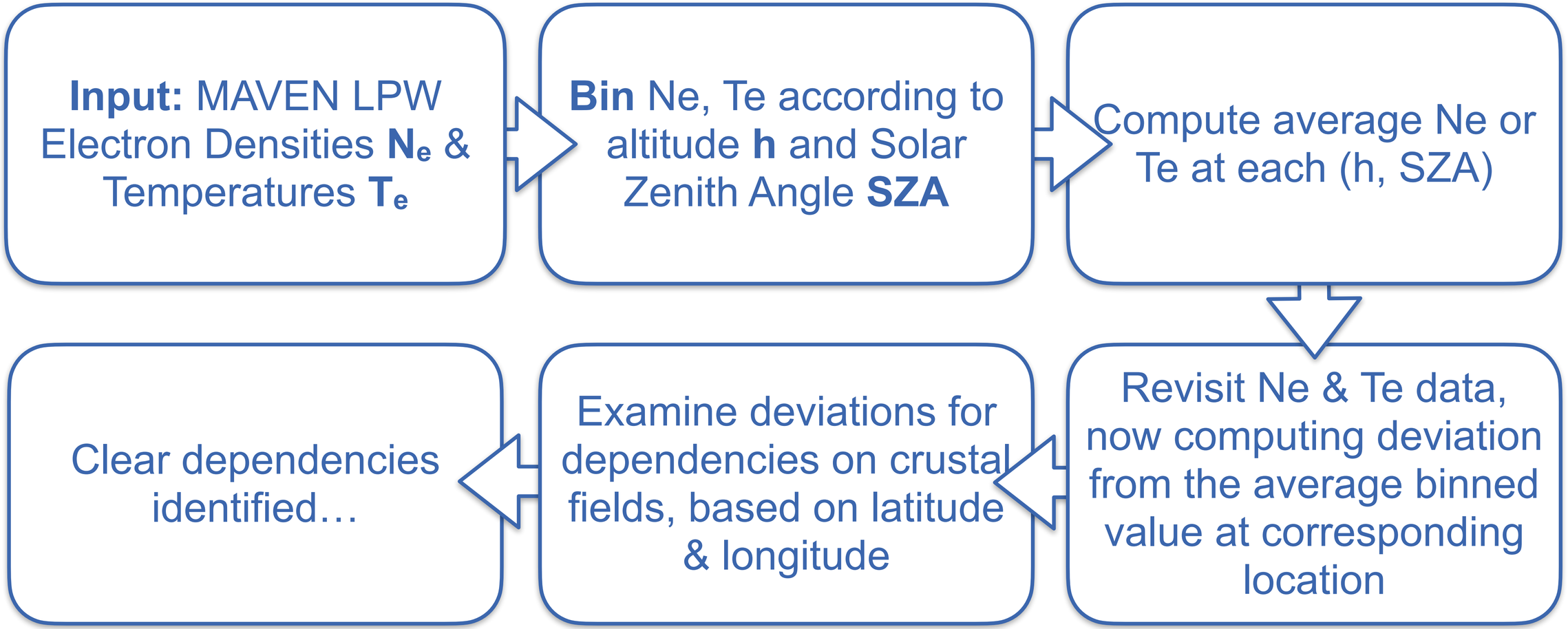


Andrews+13

Reduced densities in regions of strong crustal fields

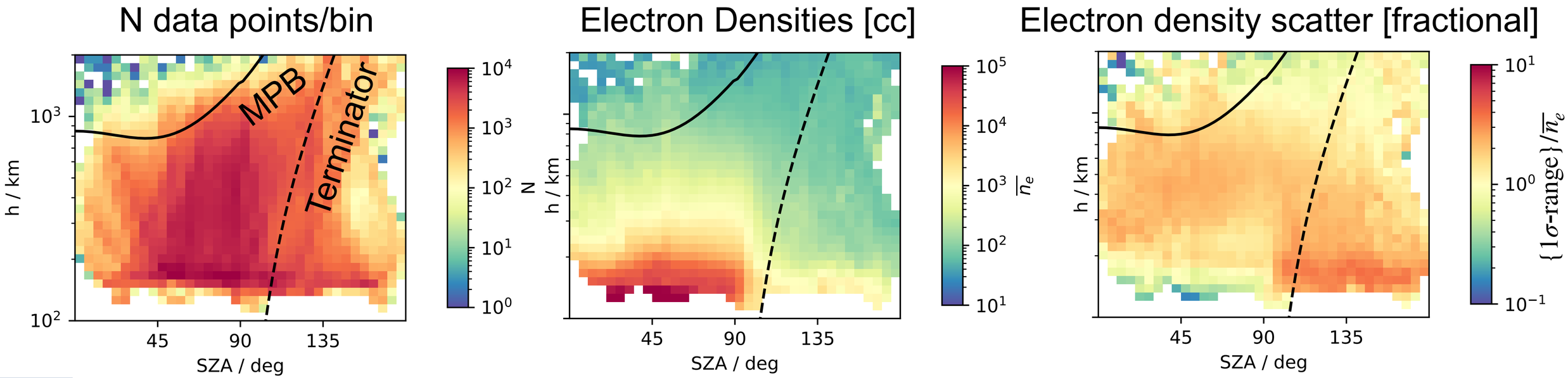
Study Outline

Motivation: To understand dependencies on crustal fields, primary variations with altitude and SZA must first be removed from the data



Average **densities** from LPW

Determine mean of Ne with altitude **h** and Solar Zenith Angle (**SZA**), using all available LPW measurements



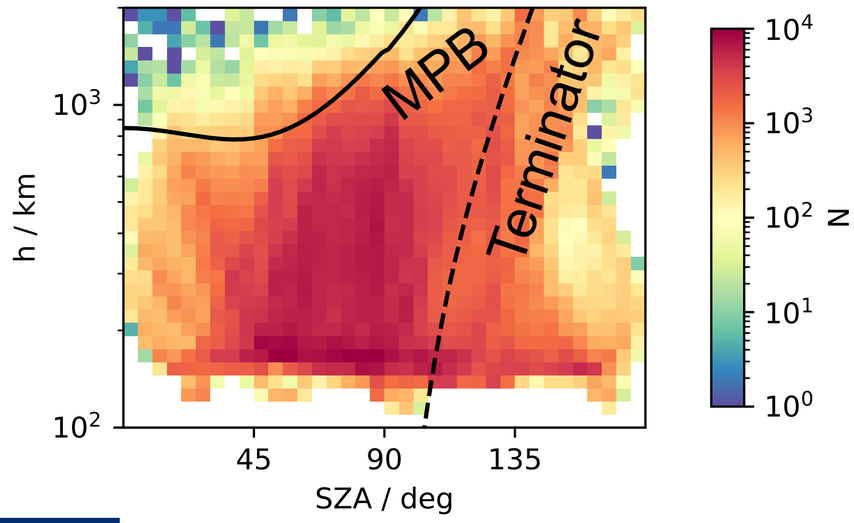
Use these to define empirical "maps" $\langle N_e \rangle$**(h, SZA),** $\langle T_e \rangle$**(h,SZA).**

Measurements along a given orbit can then be compared to these averages

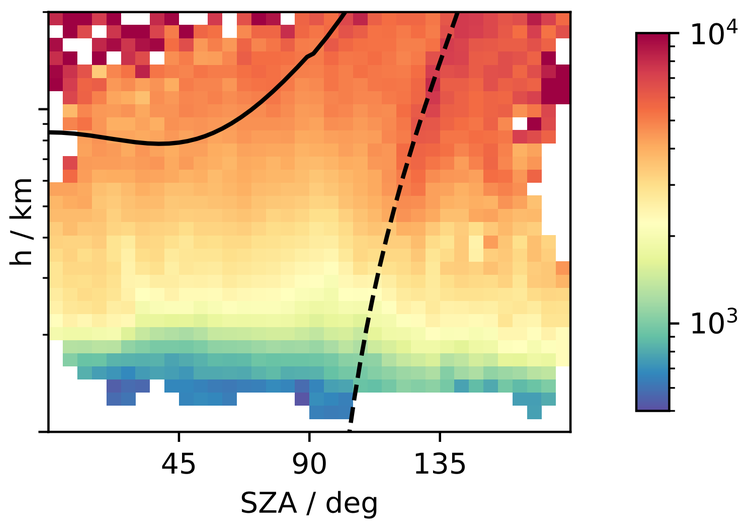
Average **temperatures** from LPW

Determine mean of Ne with altitude **h** and Solar Zenith Angle (**SZA**), using all available LPW measurements

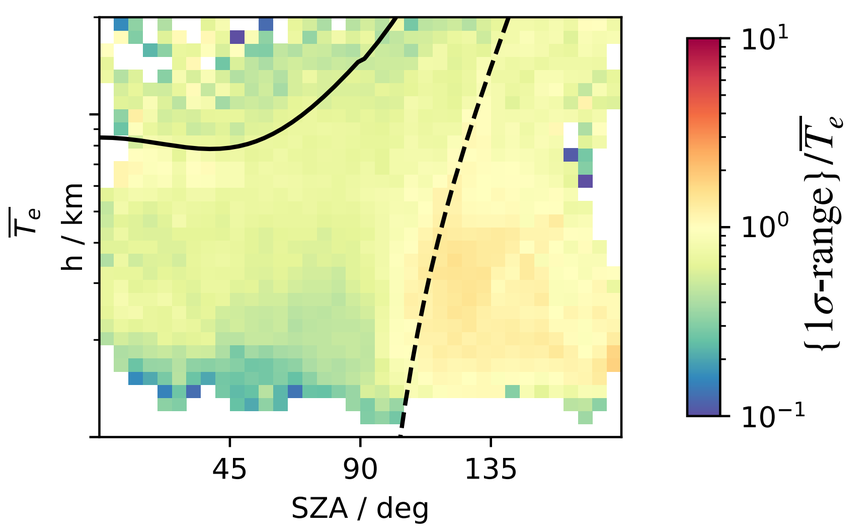
N data points/bin



Electron Temperatures [K]



Electron temperature scatter [fractional]

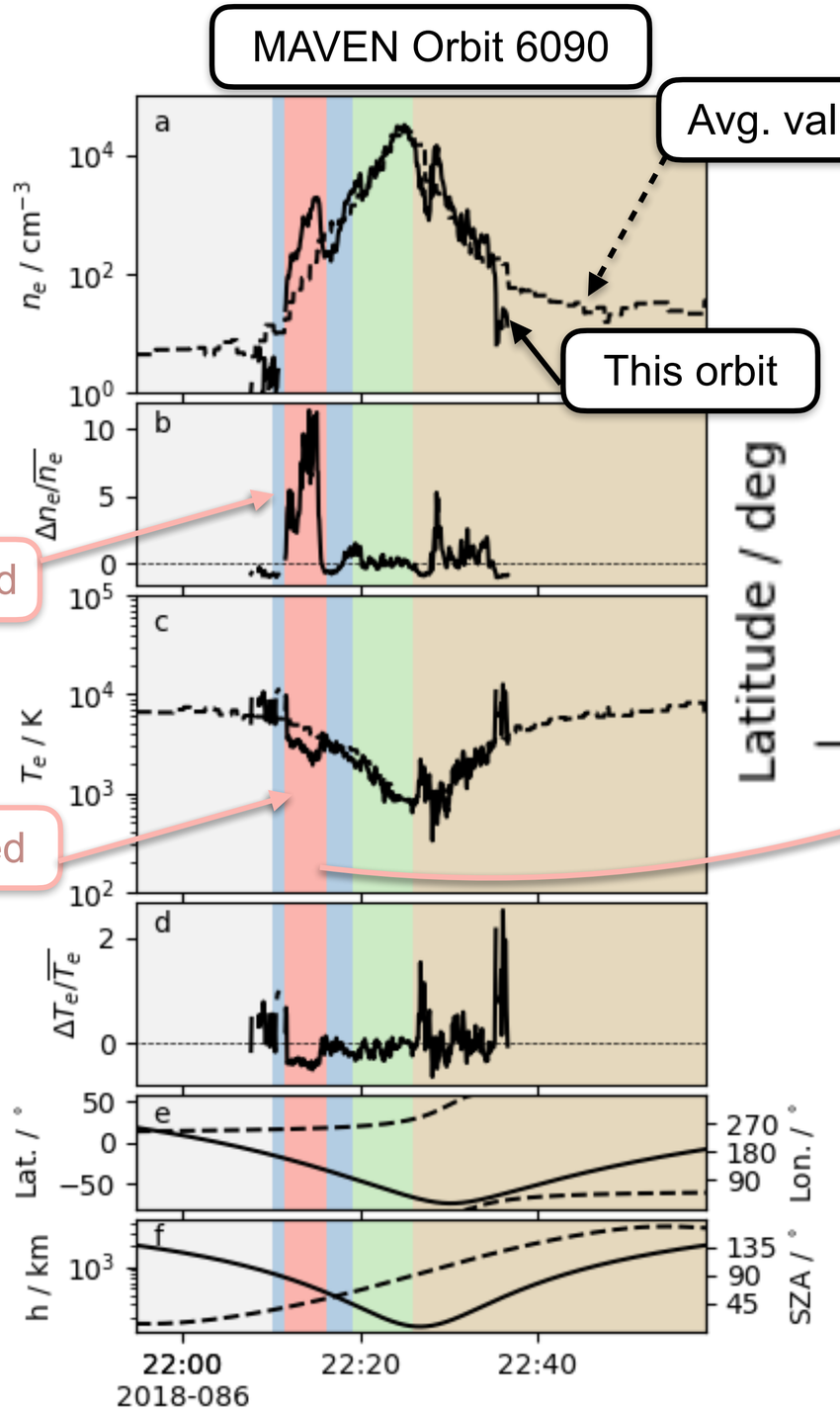


Use these to define empirical "maps" $\langle N_e \rangle$**(h, SZA),** $\langle \mathbf{T_e} \rangle$**(h,SZA).**

Measurements along a given orbit can then be compared to these averages

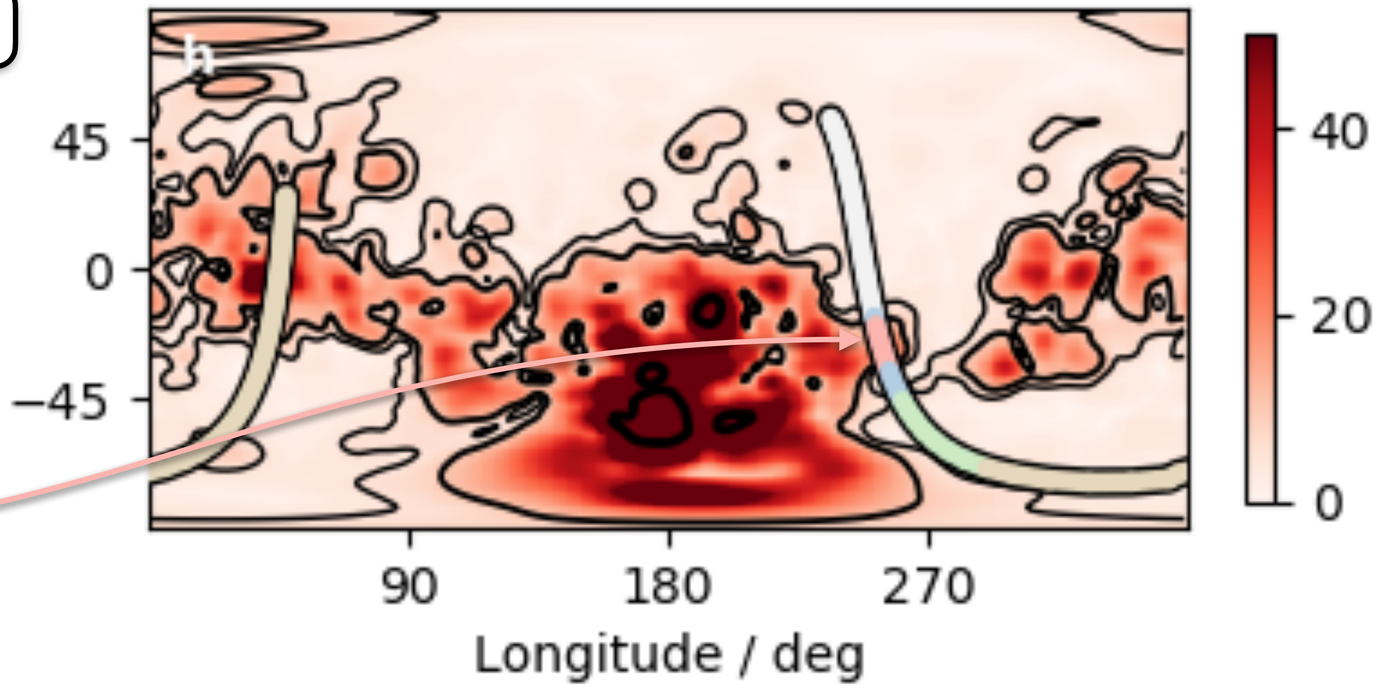
Examples in data

Q: Is the dependence on crustal fields evident in the underlying timeseries data? A: Yes!



n_e increased

T_e decreased



Dayside, strong crustal fields (B_{400} > 10nT), 300-500km

Dayside, weak crustal fields(B_{400} < 10nT), 300-500km

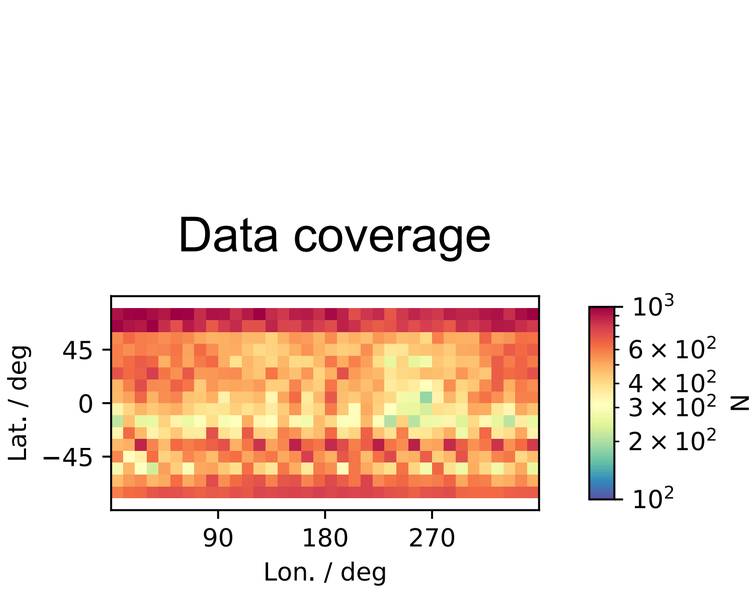
Deep Ionosphere, h < 300 km

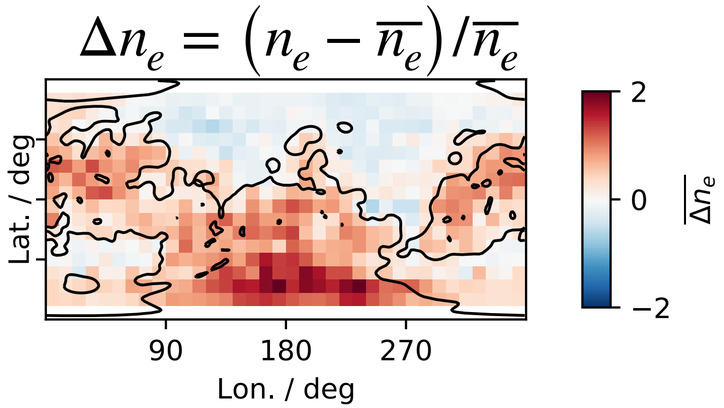
Nightside

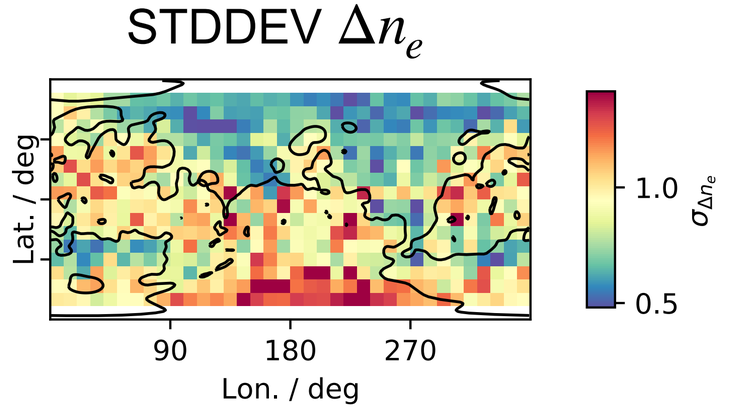
Fractional Density & Temperature Variations

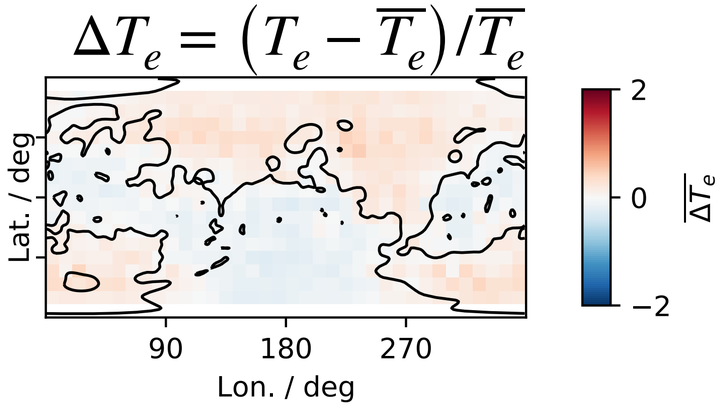
How do Ne and Te depart from the averaged values at a given latitude & longitude?

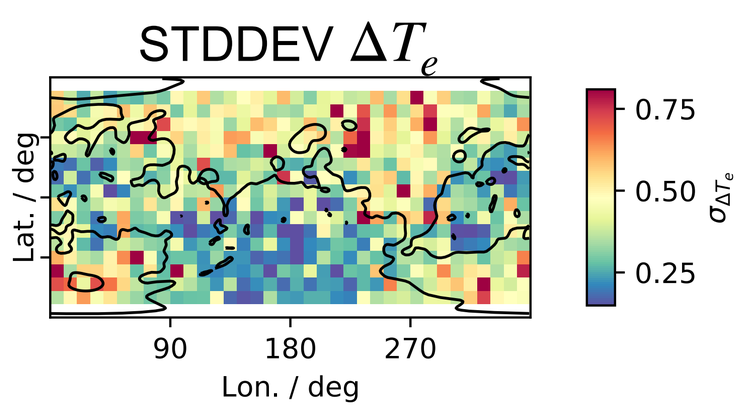
Example: On the dayside, and in the 300 - 500 km altitude range…









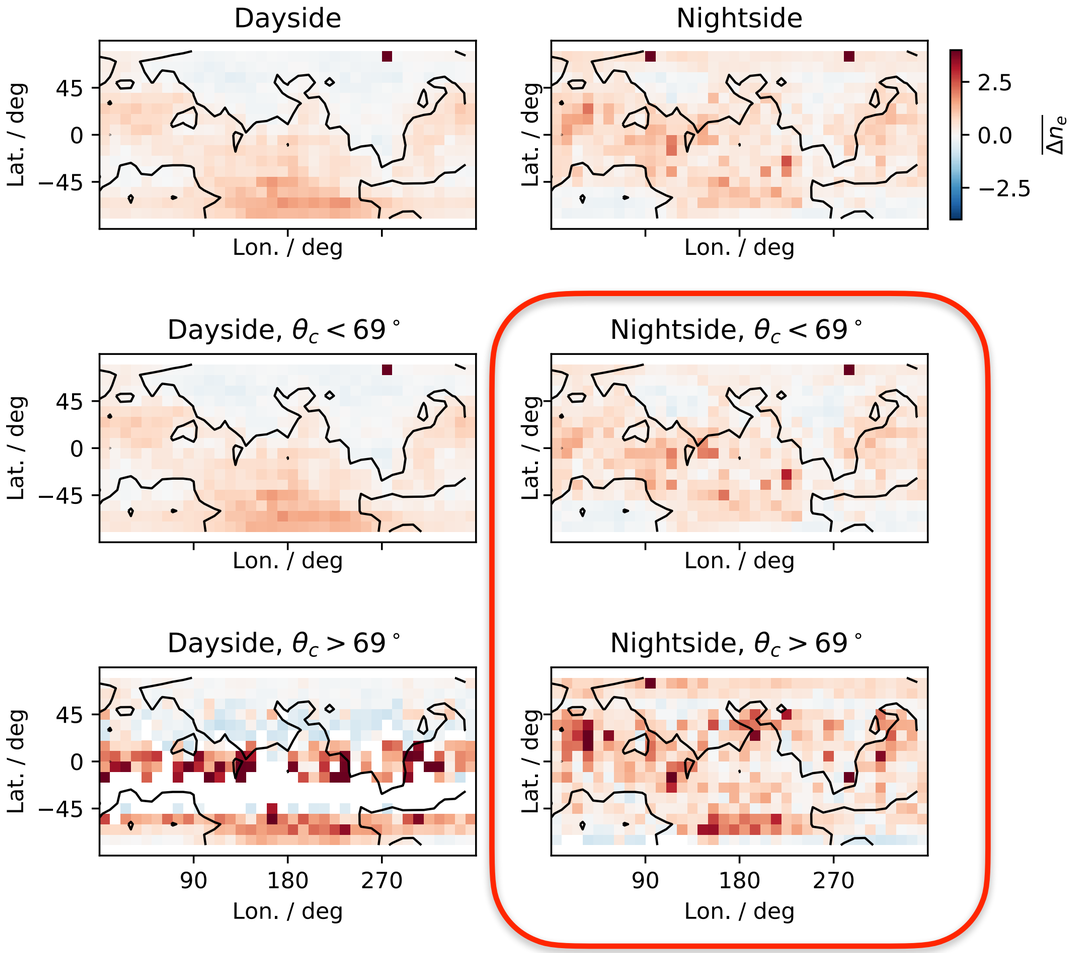


Structure correlates well with crustal fields

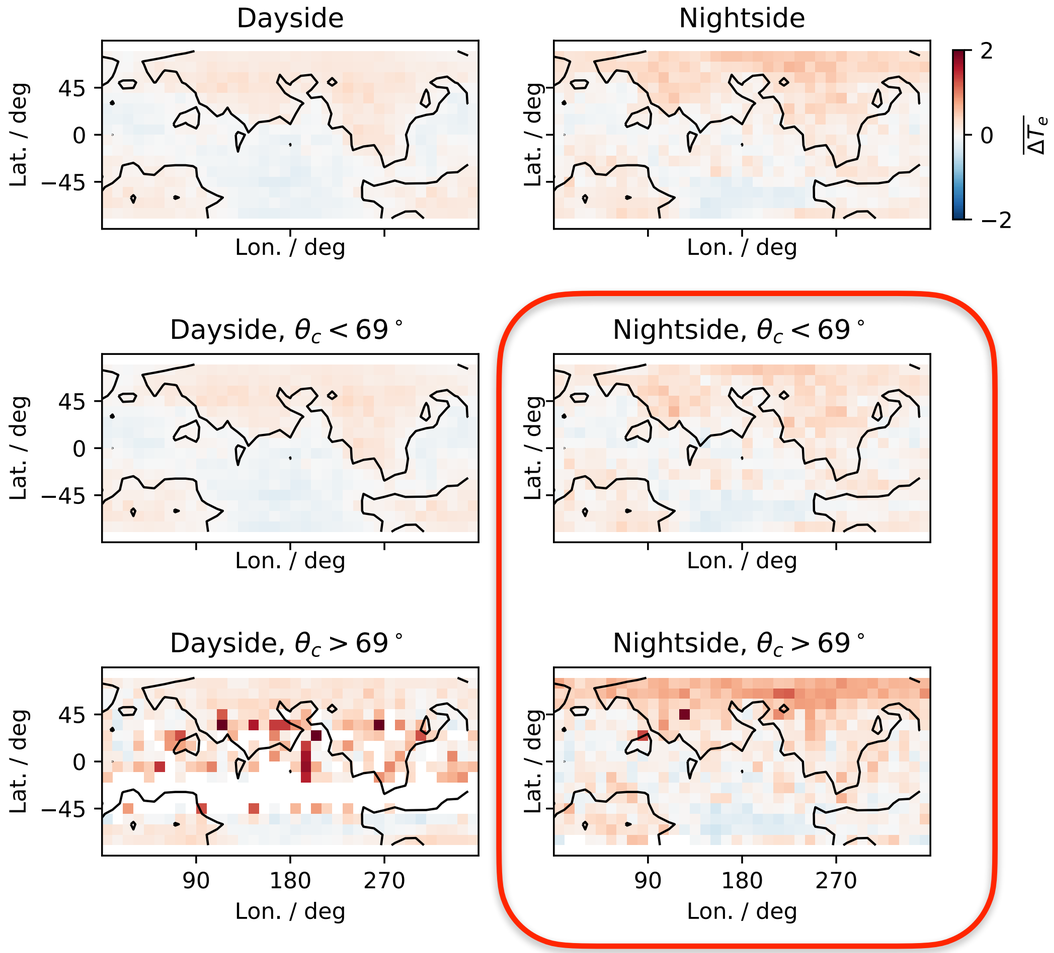
Consistent with previous reported results [Andrews+13,15, Sakai+19]

IMF Cone Angle Dependence (?)

- Electron densities -



- Electron temperatures -

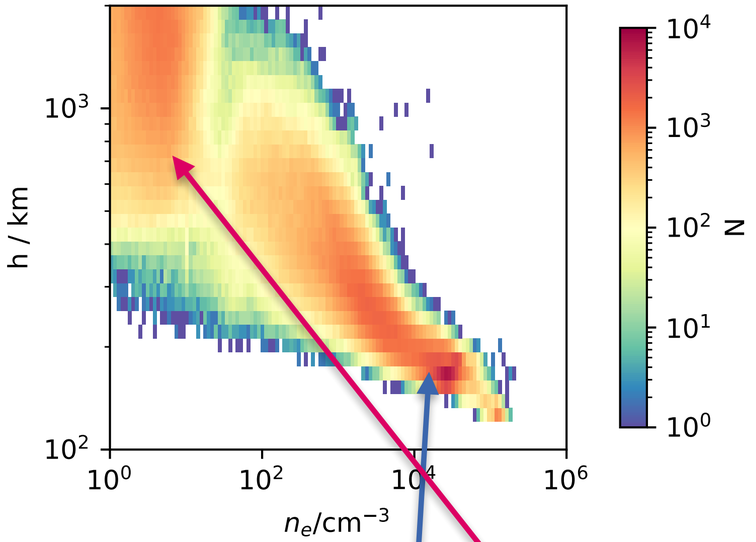


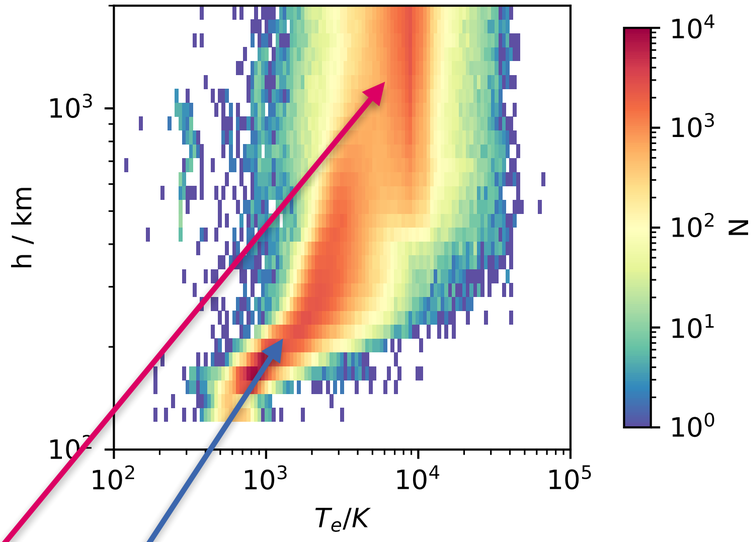
Summary & Conclusions

- Mars's crustal significantly affect ionospheric density and temperature of the plasma in the altitude range ~200 - 1400 km on the dayside
- A less significant effect is present on the nightside (not shown today - talk to me after about this!)
- Crustal field effects are evident also when examining along-orbit measurements
- Solar wind parameters apparently have only a minor influence on this structuring. *Not quite what we expected, given the extent to which draping conditions can change in this region.*

Backup material

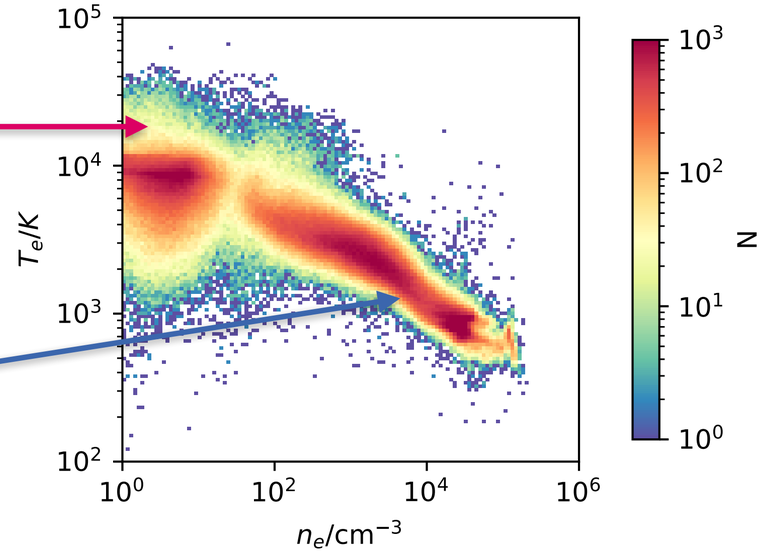
LPW data, overall distributions



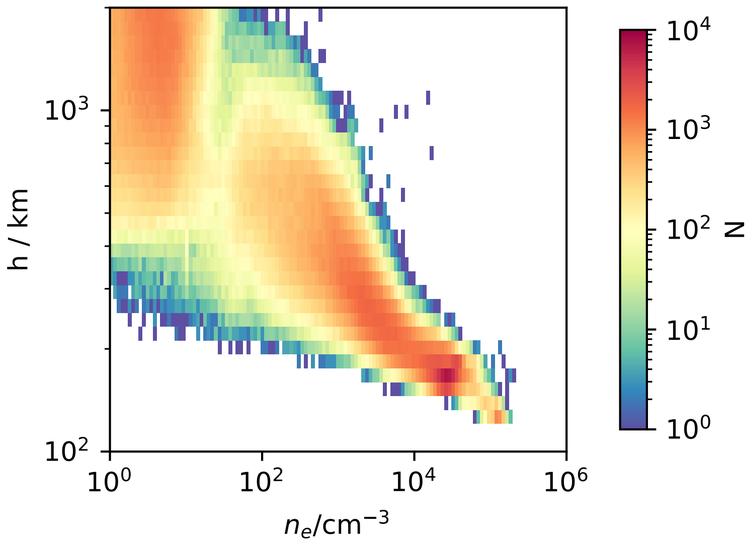


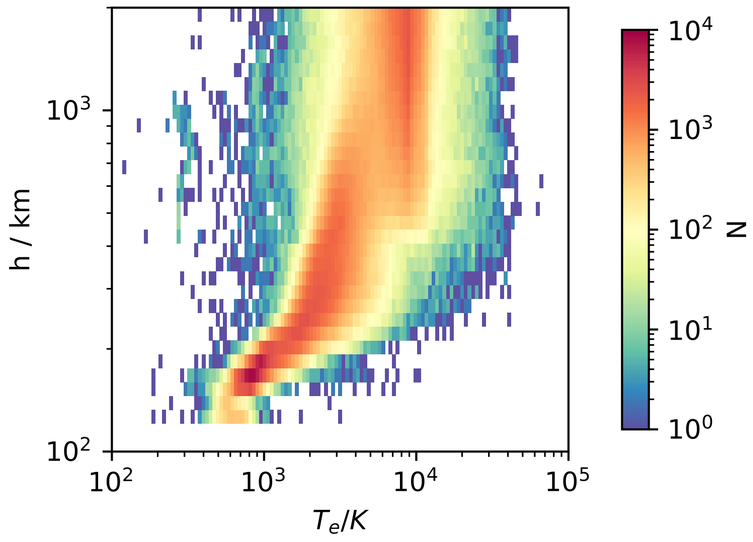
Tenuous Magnetosheath

Dense Ionosphere

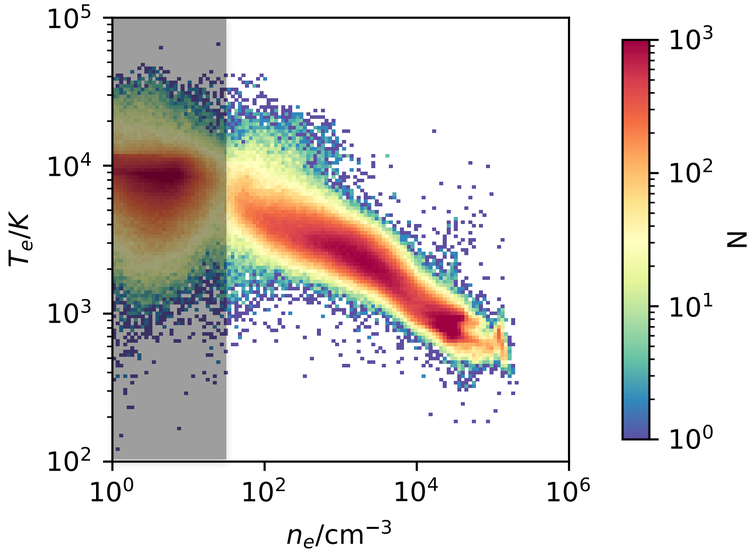


LPW data, overall distributions



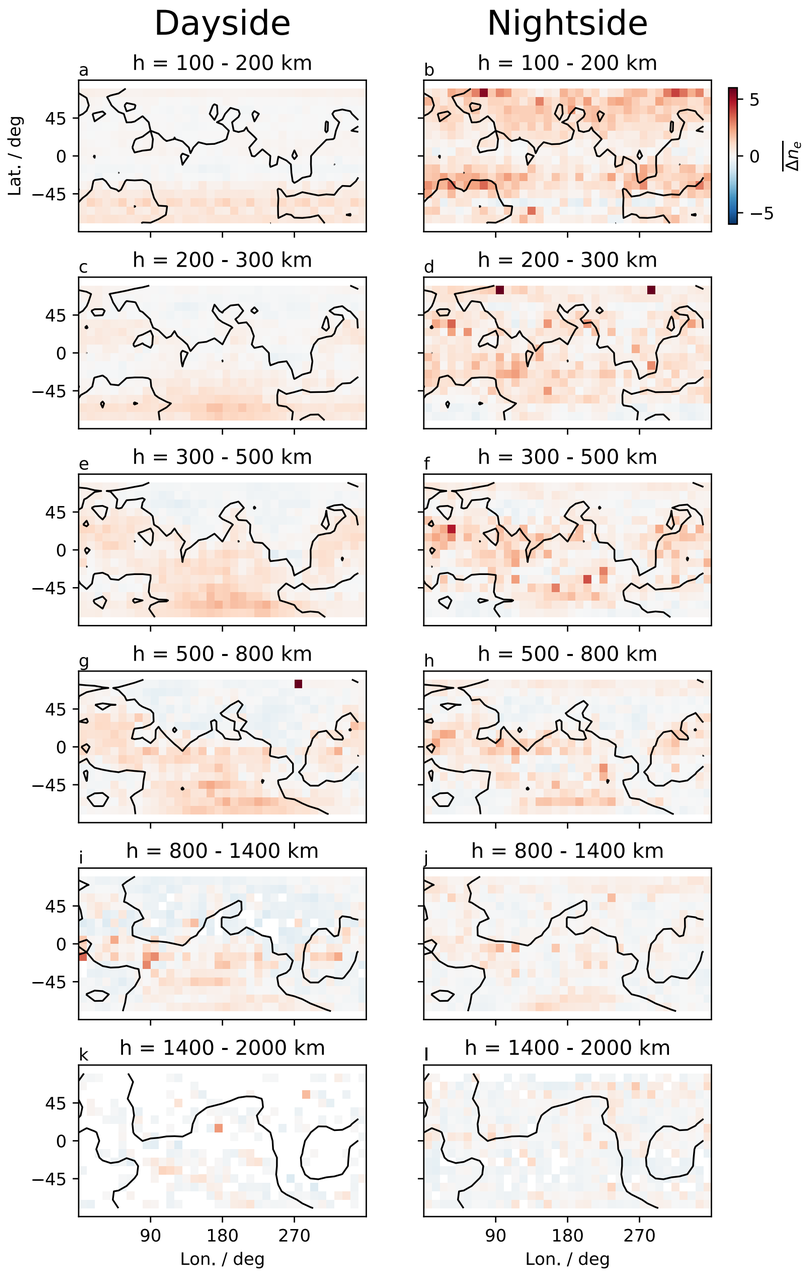


Removing $n_e < 30$ cm^{-3} reliably selects only the ionospheric population



Vertical Variations

- Electron densities -



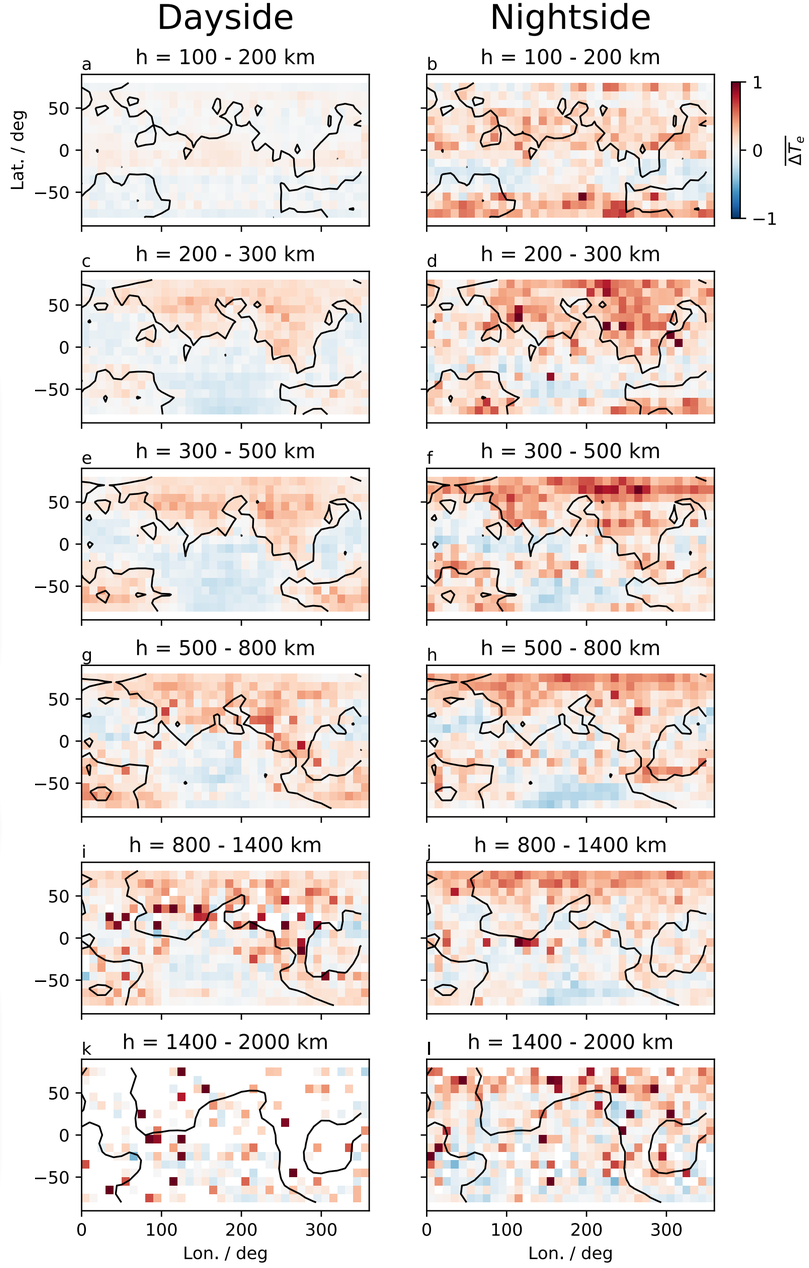
Over what altitude range is the influence of the crustal fields exerted?

Poor statistics below ~200km, but no evidence of organization: Dominance of photochemical equilibrium < 200km

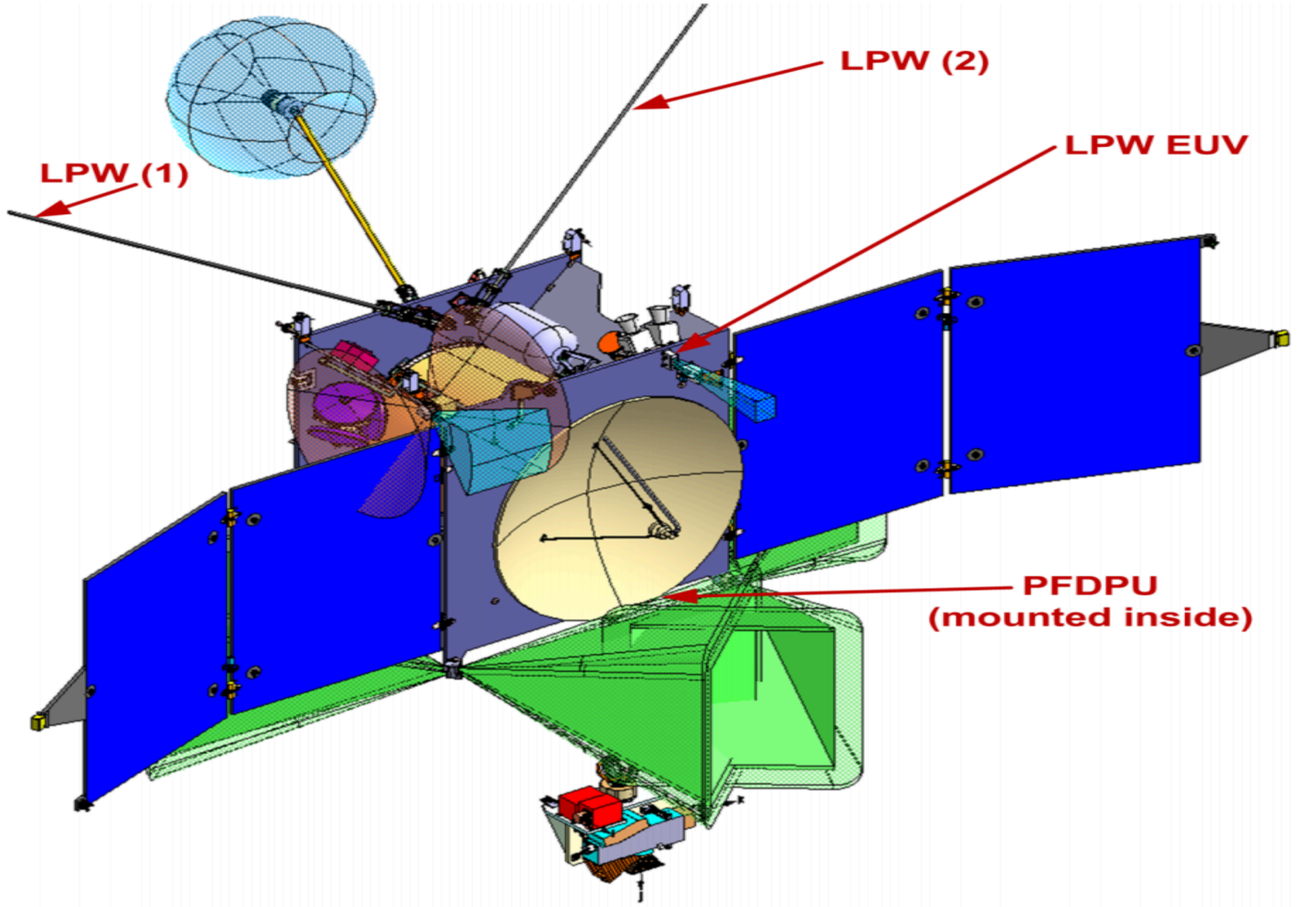
Clear dayside control in the range ~200 - 1400 km

Organization by crustal fields on the nightside less evident

- Electron temperatures -



MAVEN Langmuir Probe & Waves



{ Tedious statistical interlude }

Densities can't be negative, so log-normal statistics apply

$$\mu = \frac{1}{N}\sum_{i=1}^{N} \log(n_{e,i})$$

$$\mu^* = \exp(\mu)$$

is the *median* value of the distribution.

What about the spread? 1-σ range (68% of the data) found in the interval

$$[\mu/\sigma,\ \mu \cdot \sigma]$$

So, divide that range by μ to get a dimensionless measure of the spread…