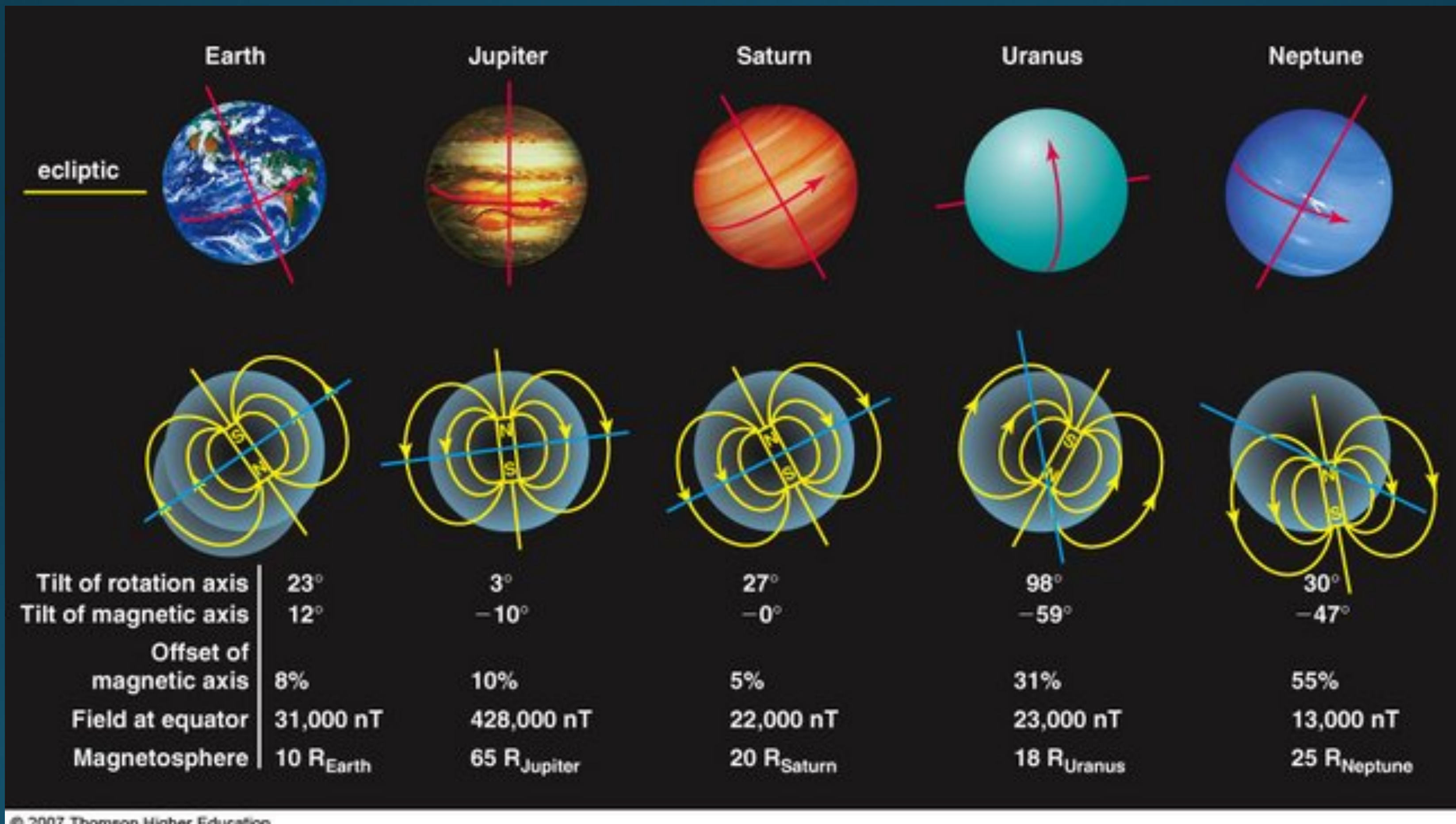
PTYS544

Physics of the High Atmosphere

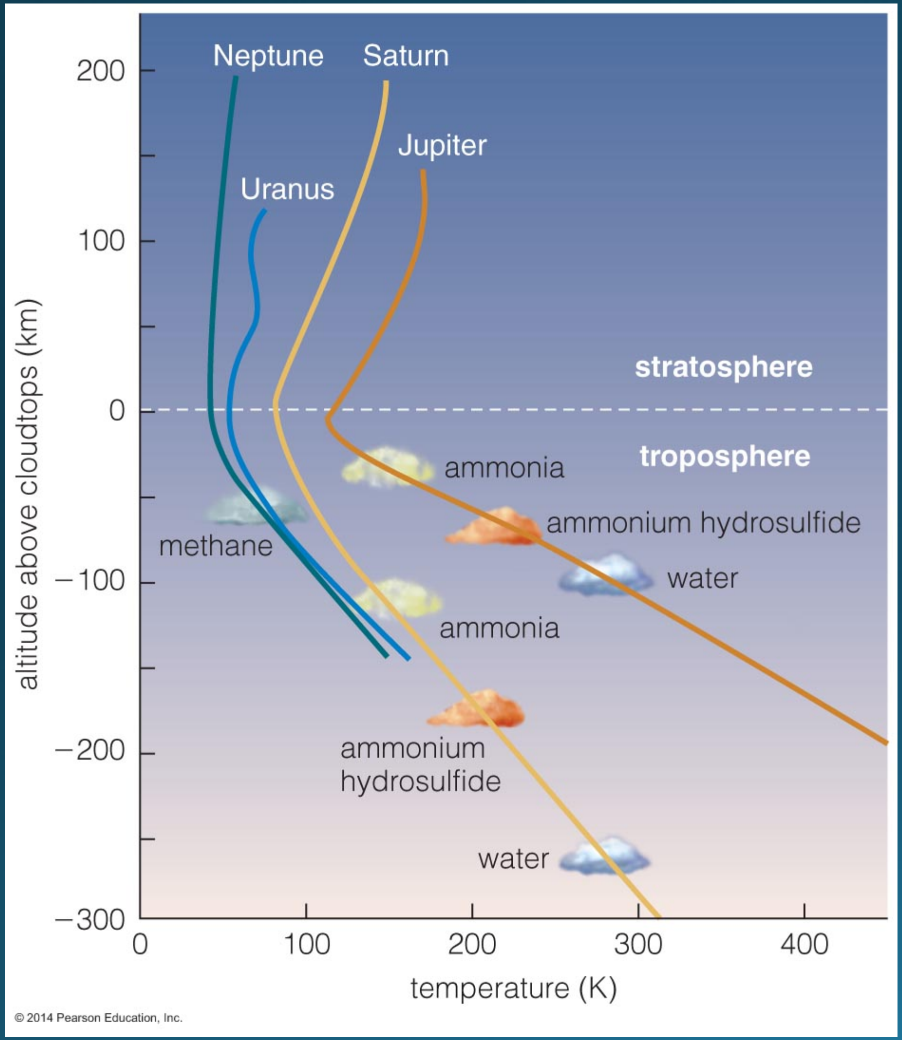
Basic details

- Location / Time
  - Tuesday & Thursday, 12:30 – 13:45
  - Kuiper Space Science (KSS)
- Instructor
  - Tommi Koskinen, KSS 421
  - tommik@email.arizona.edu

Axial tilt and magnetic fields

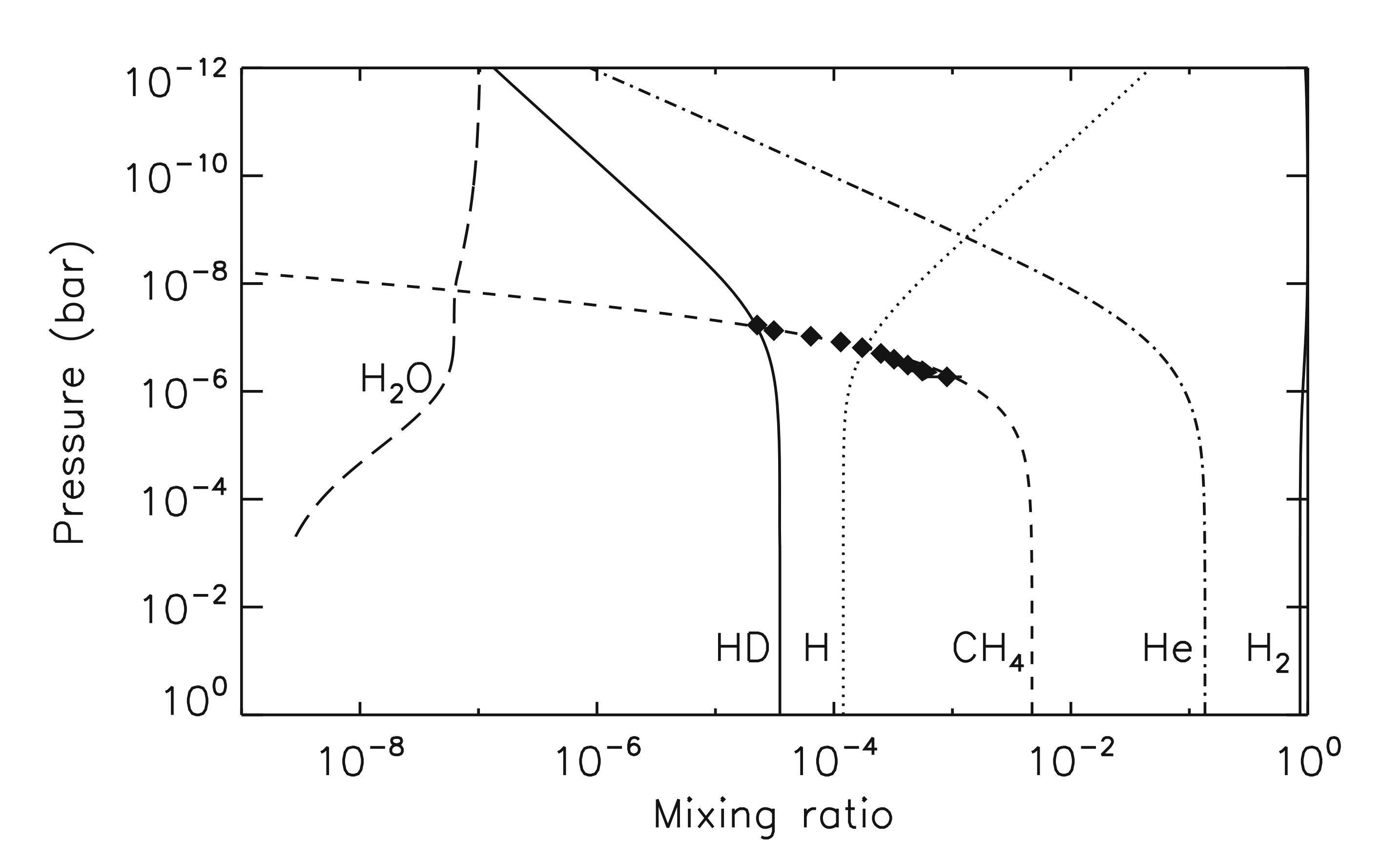


Temperature profiles



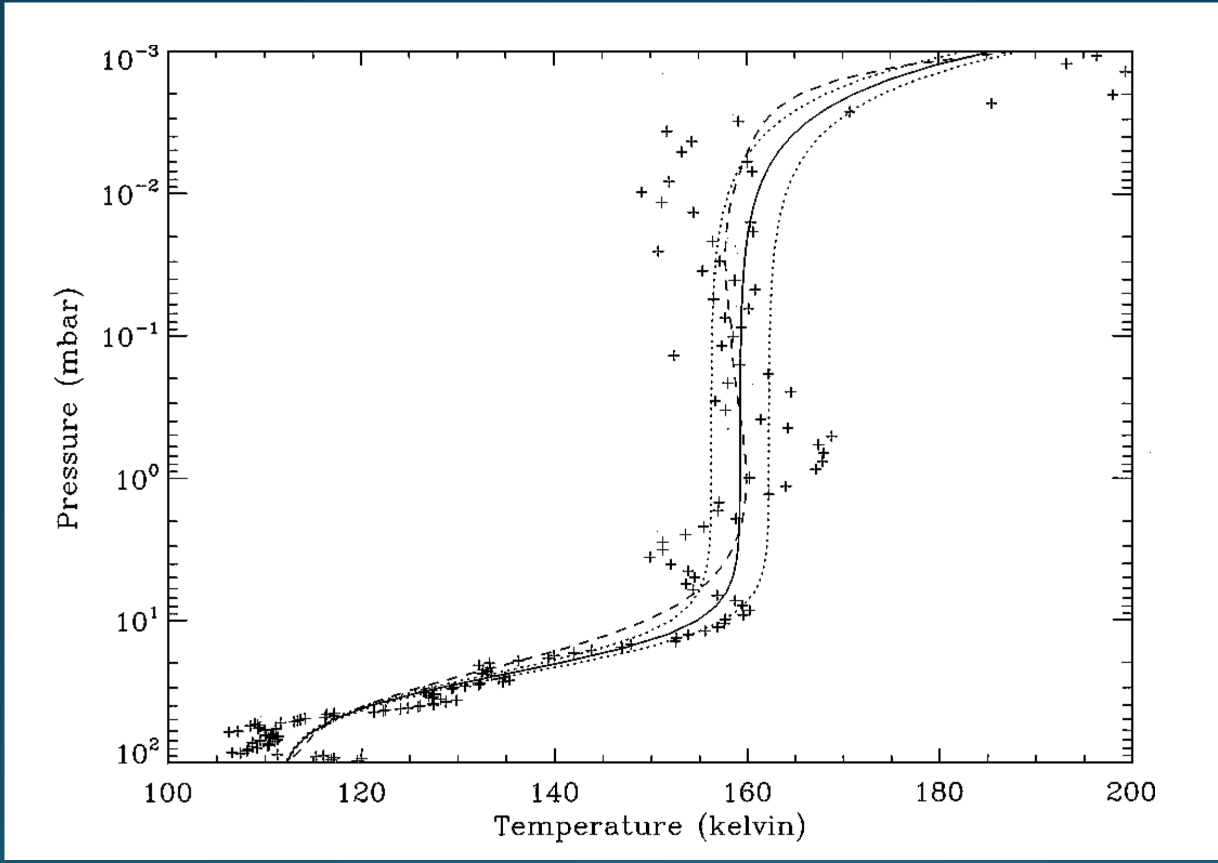
Jupiter: Internal heat flux maintains convective transport; slightly super-adiabatic lapse rate below 400-600 mbar. Similar expectation on other giant planets (although Uranus has weak internal heat flux).

Basic composition



The composition of Saturn (based on Strobel et al. 2016) represents the basic composition of giant planet atmospheres.

Jupiter: Stratosphere



Temperature from the Atmospheric Structure Instrument (ASI) with various parameter model fits at latitude of 6N (Yelle et al. 2001).

Stratosphere heating rates

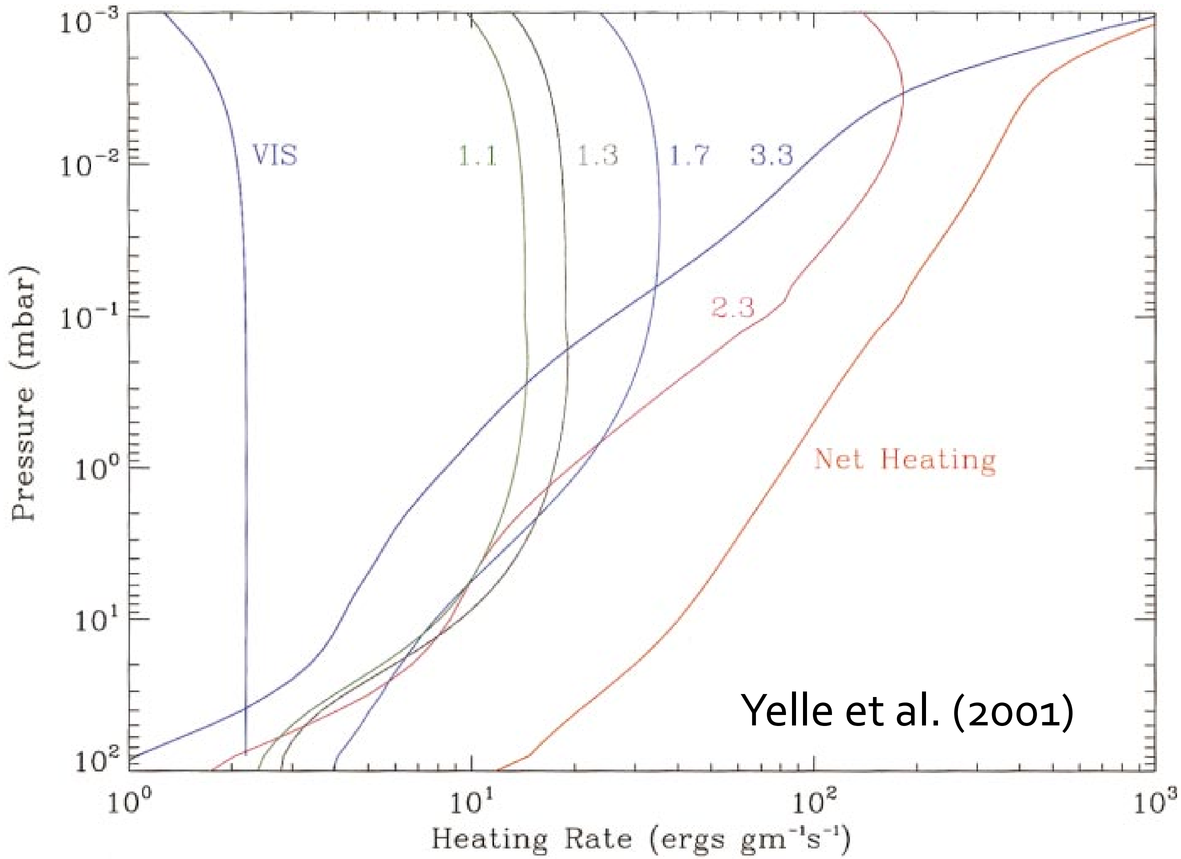
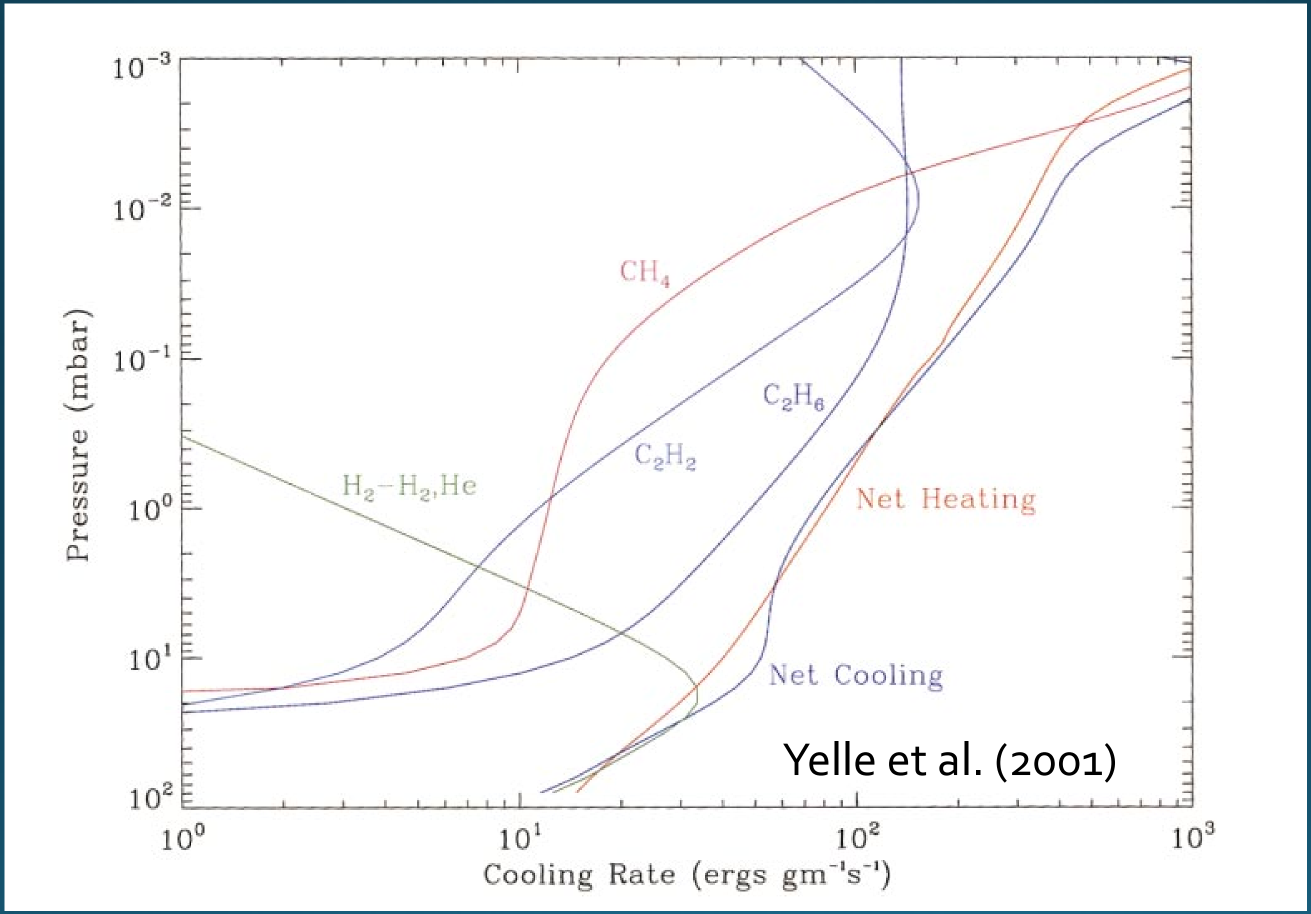


FIG. 10. Heating rates in the near IR bands of CH_4 and for absorption of visible radiation by CH_4 and aerosols.

Stratosphere cooling rates and balance



Ethane is the prominent coolant in the stratosphere. Heating and cooling rates balance to a good accuracy (radiative equilibrium).

Diffusive separation of CH_4

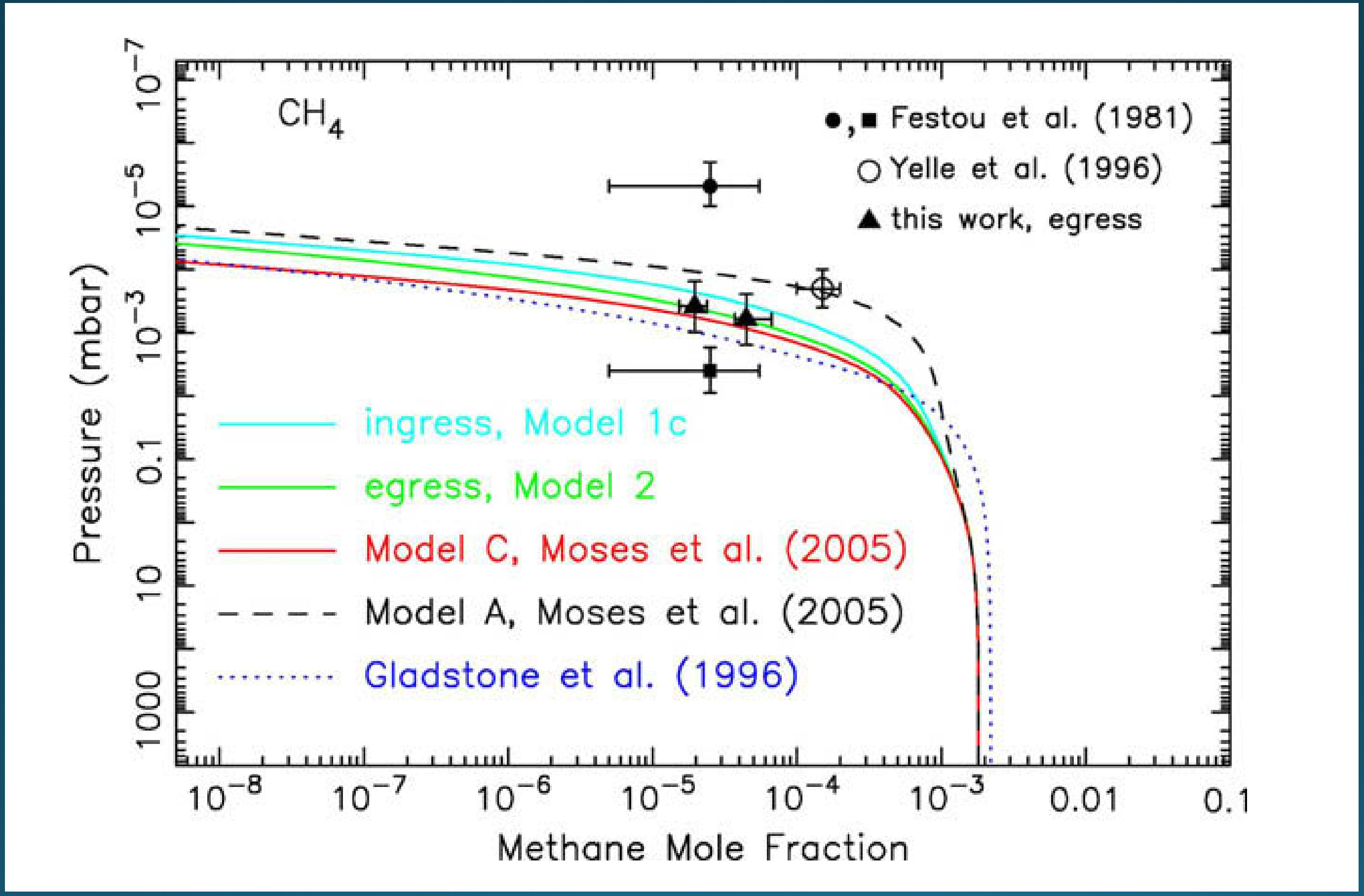
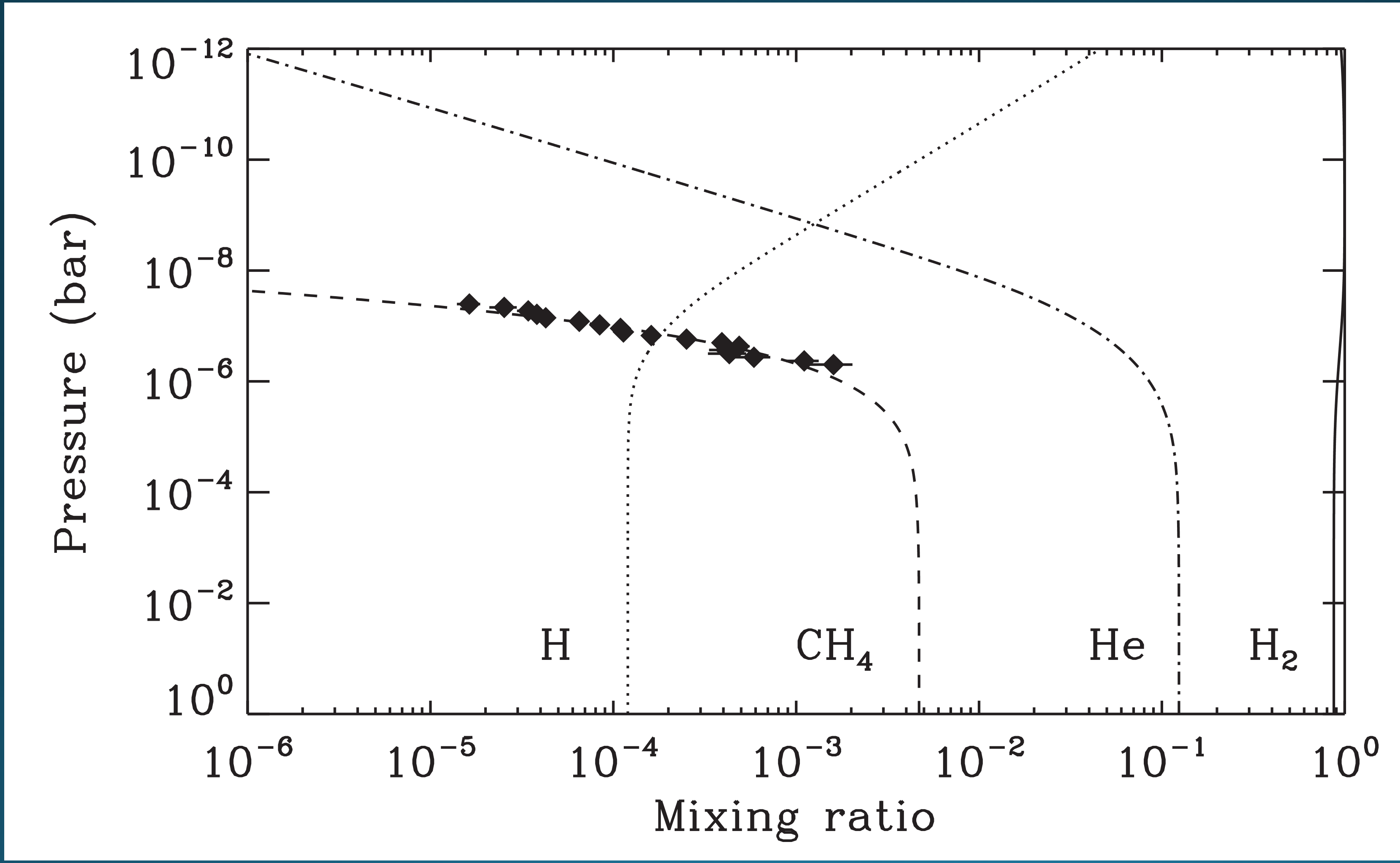
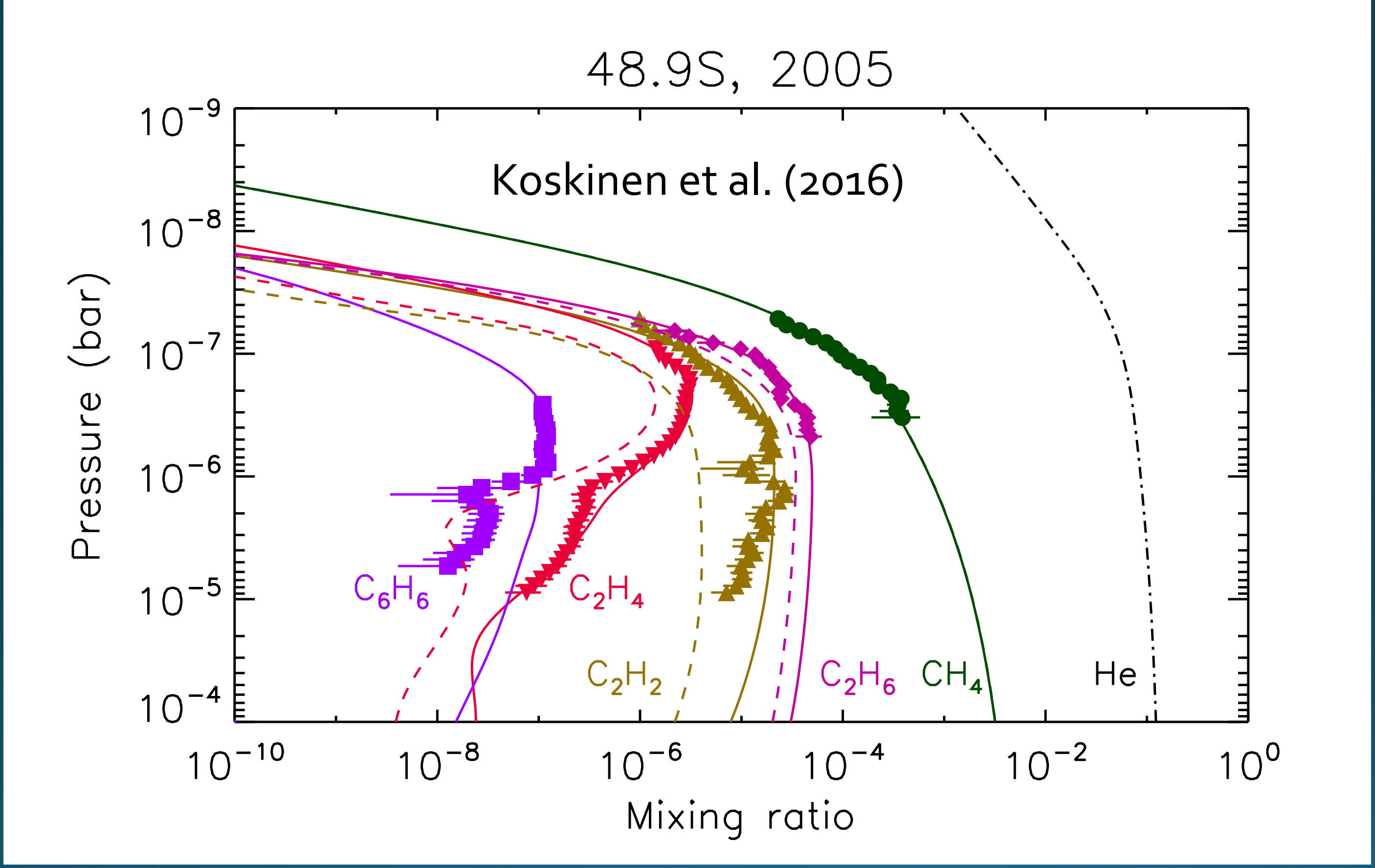


Figure from Greathouse et al. (2010)

Another example: Saturn (Koskinen and Guerlet 2018)

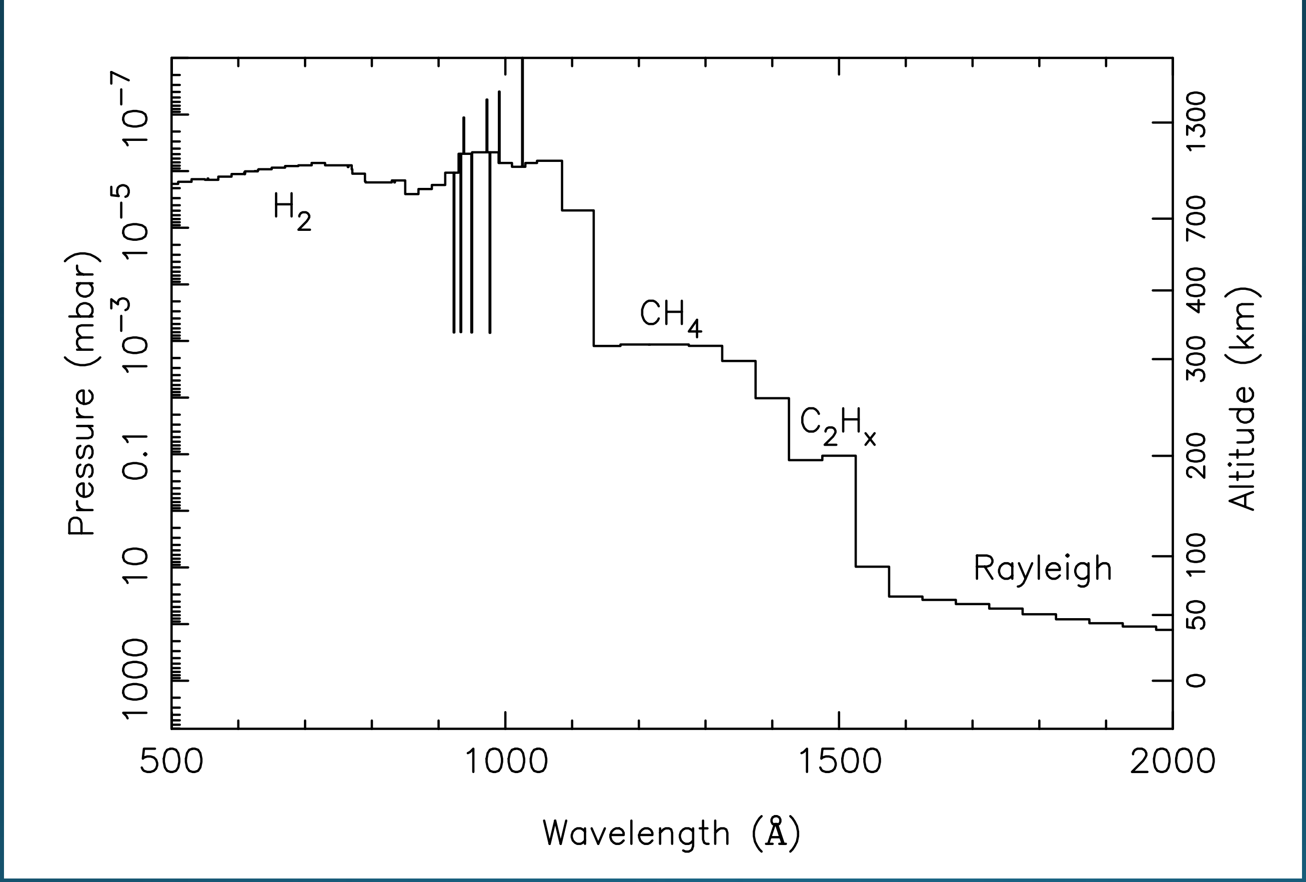


Methane photochemistry on giant planets



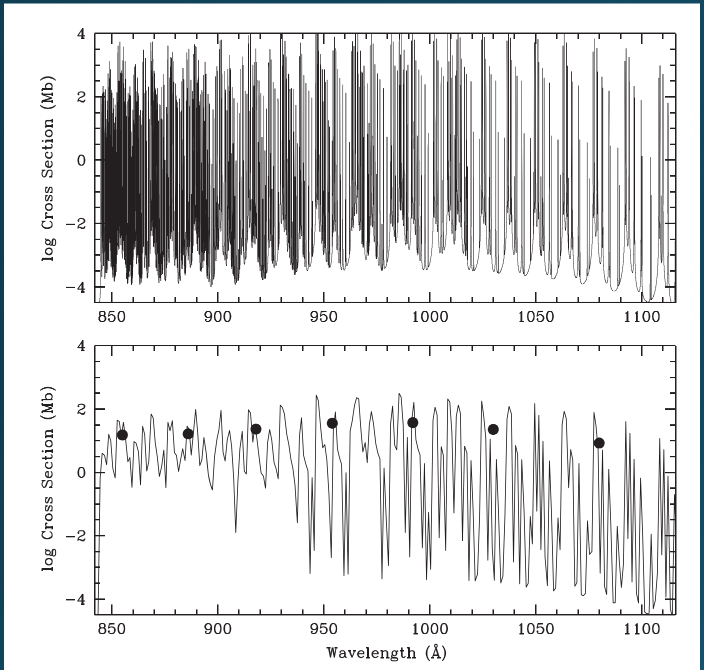
Representative mixing ratios of some key hydrocarbons on Saturn.

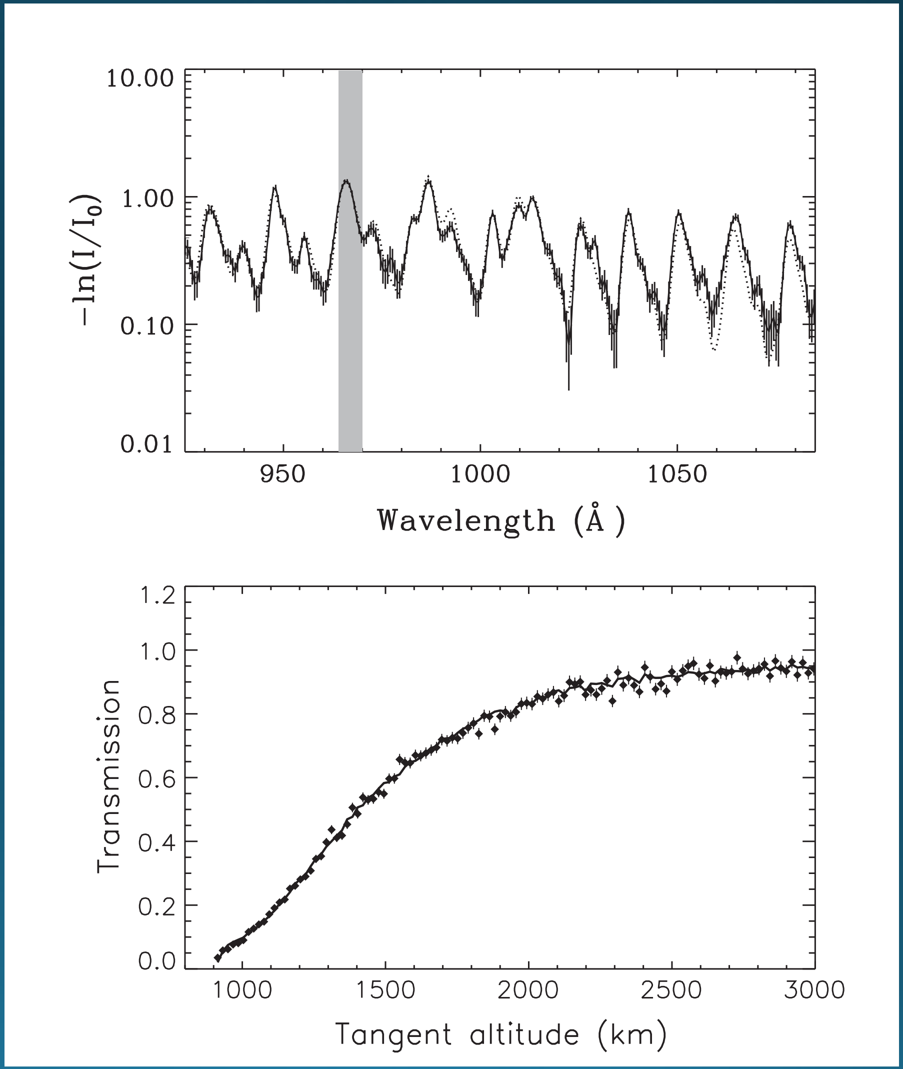
Penetration of UV radiation



Depth of penetration of solar radiation into Jupiter's atmosphere (Moses et al. 2005).

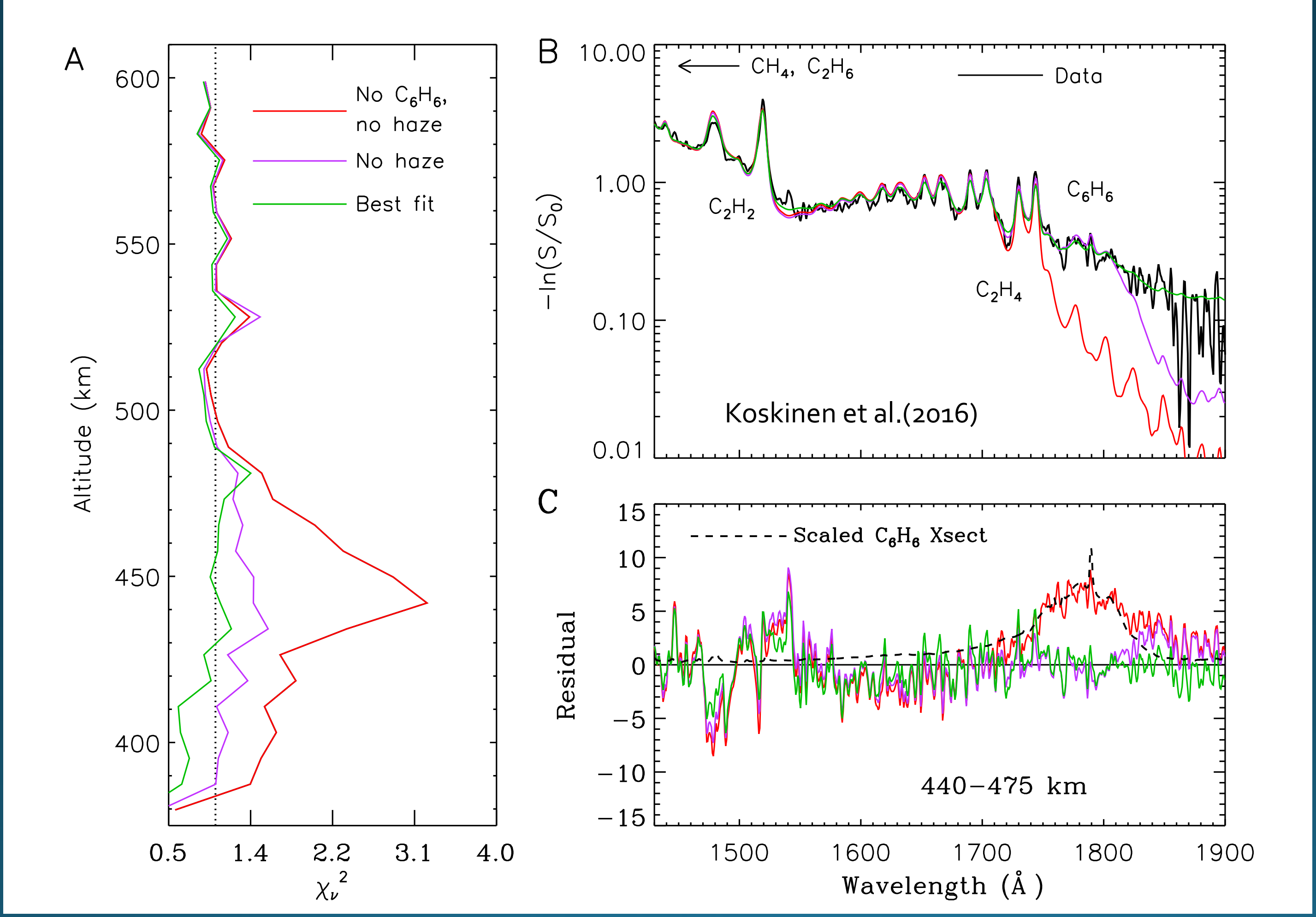
Transmission in H_2 bands





Above: Kim et al. (2014); right: observed transmission from Koskinen et al. (2015)

Hydrocarbon transmission



Temperatures in the thermosphere

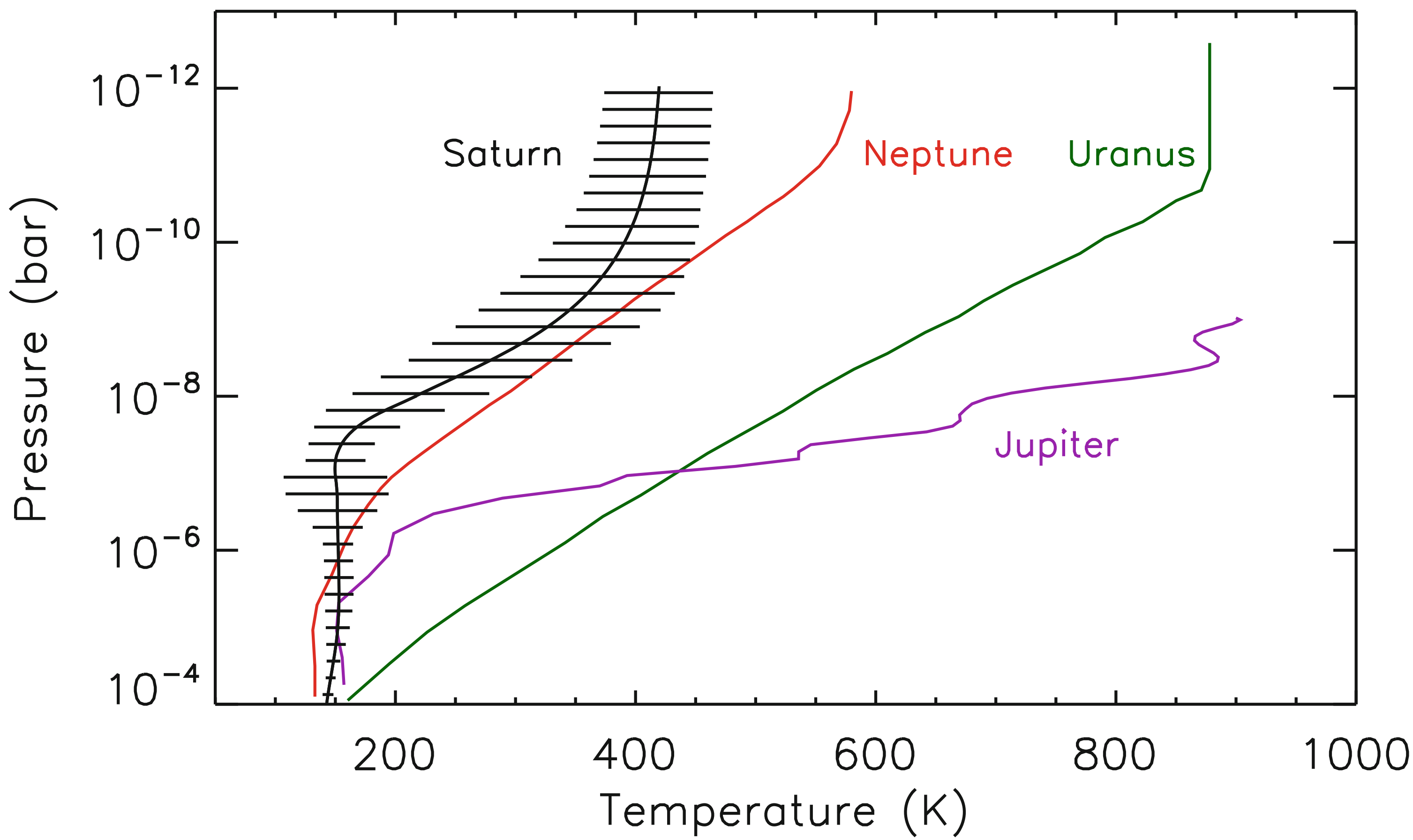
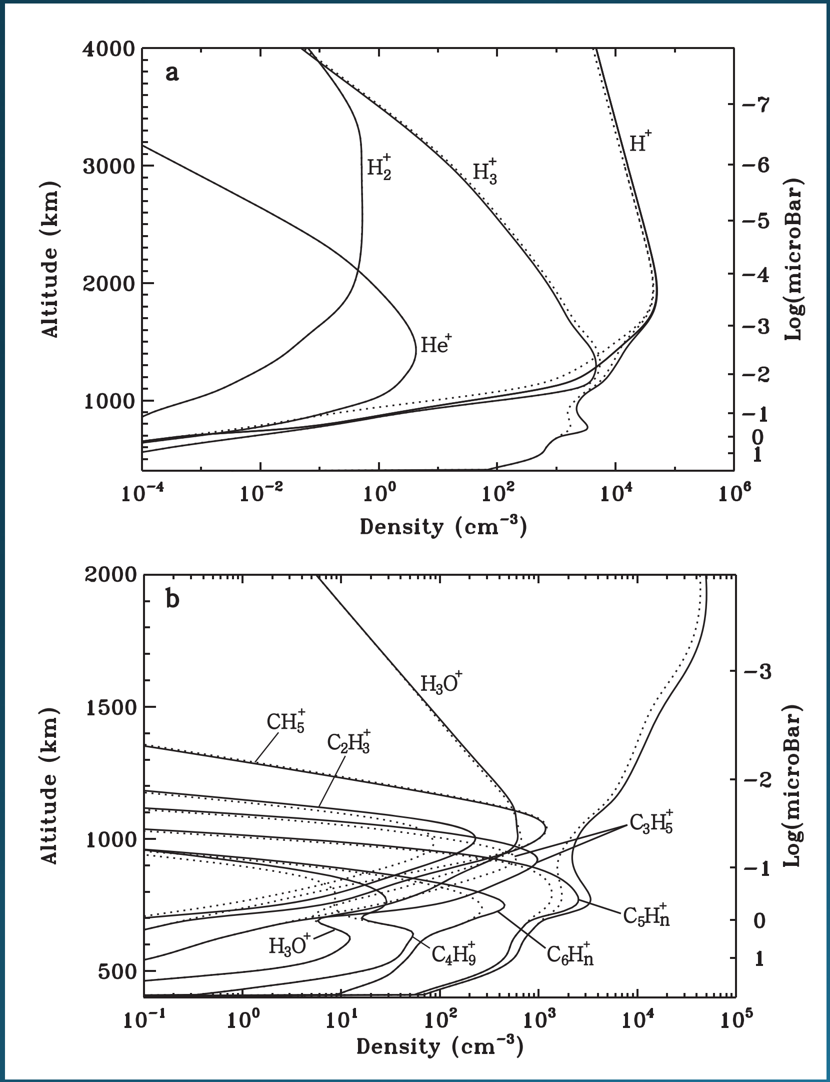


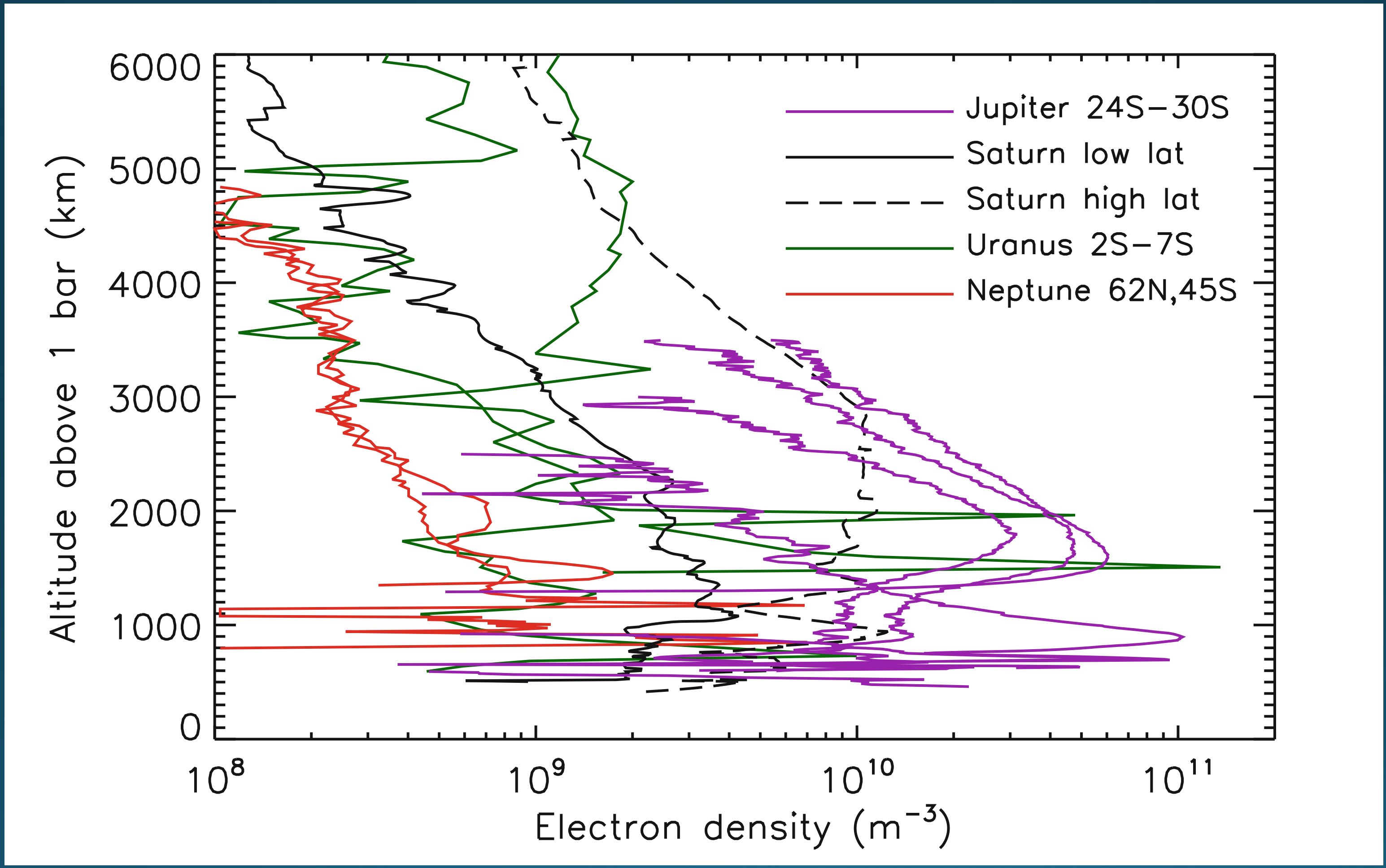
Figure from Garcia Munoz, Koskinen, Lavvas (2017)

Giant planet ionospheres



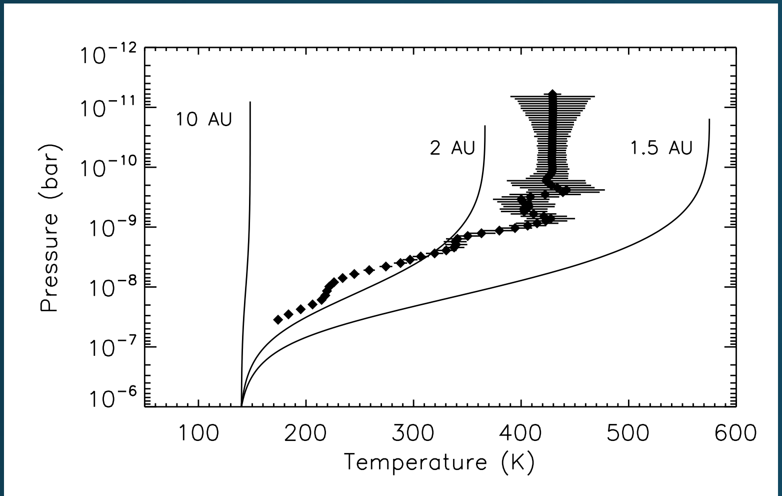
Model ionospheric composition for Saturn (Kim et al. 2014)

Electron densities

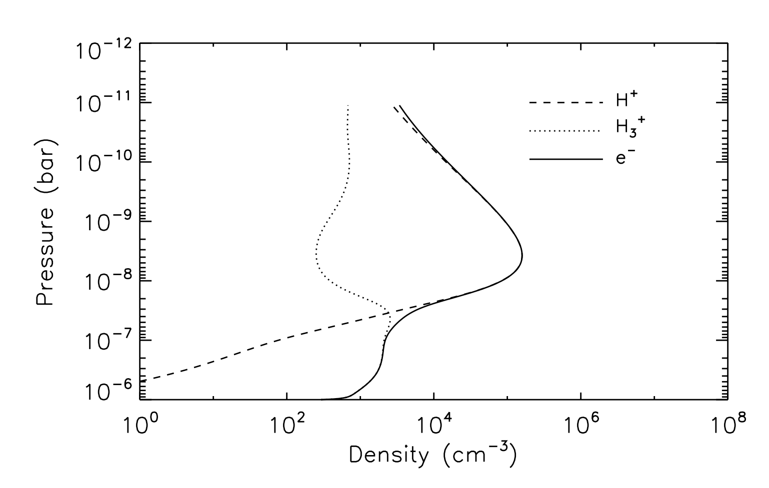


From Garcia Munoz, Koskinen and Lavvas (2017)

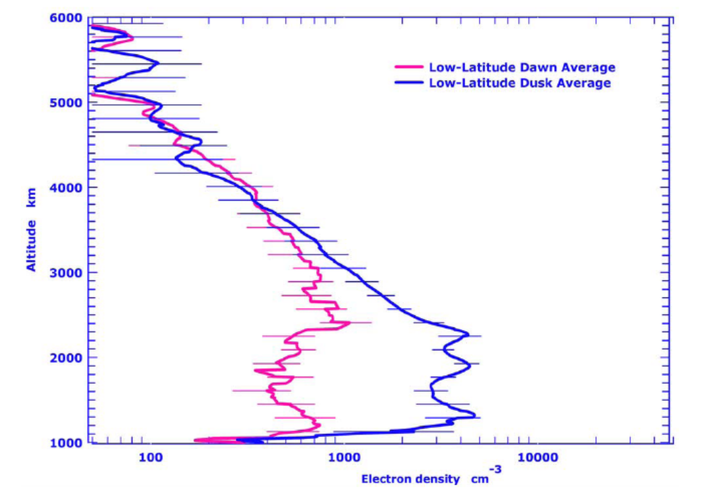
The ionosphere problem: Saturn



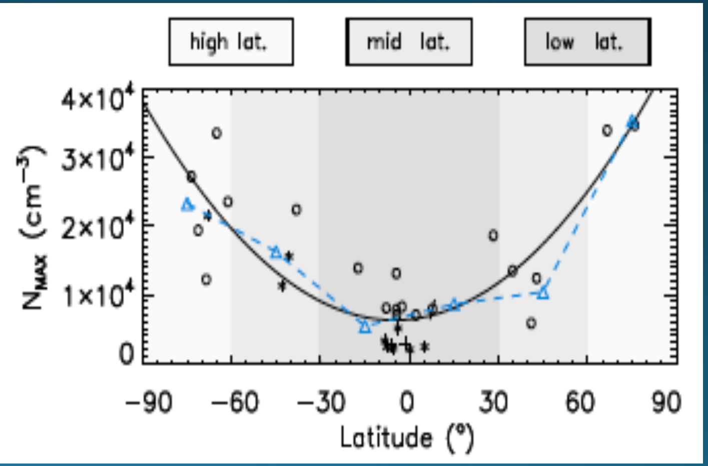
Model T-P profiles (Koskinen et al. 2014) compared with UVIS equatorial T-P profile.



"Naïve" ionosphere from a 10 AU simulation.

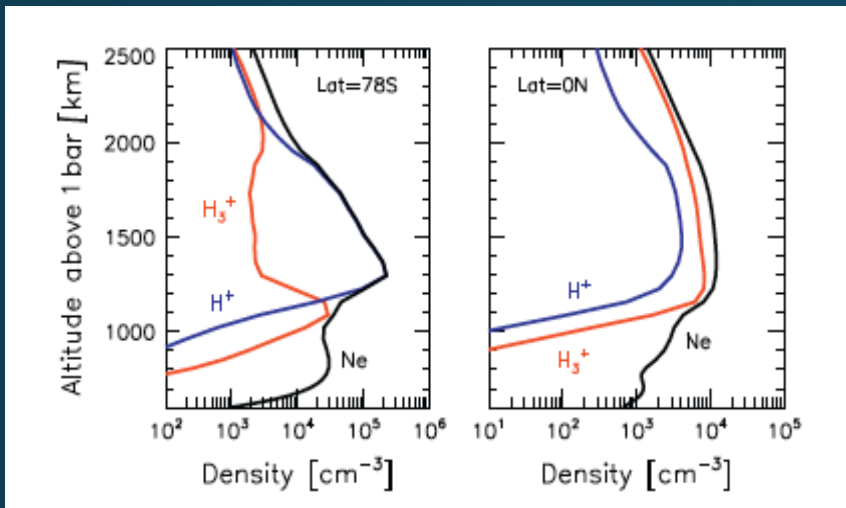


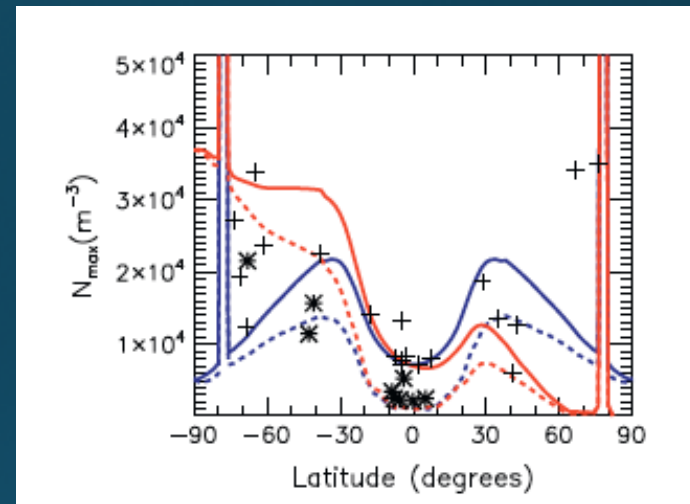
From Kliore et al.(2009)

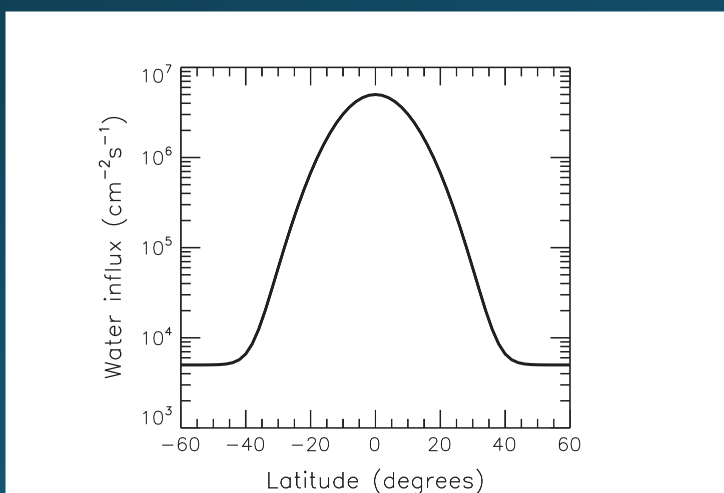


From Moore et al.(2010)

The ionosphere problem: Saturn







Electron densities as a function of latitude achieved with equatorial water influx (Muller-Wodarg et al. 2012).

Equatorial ionosphere

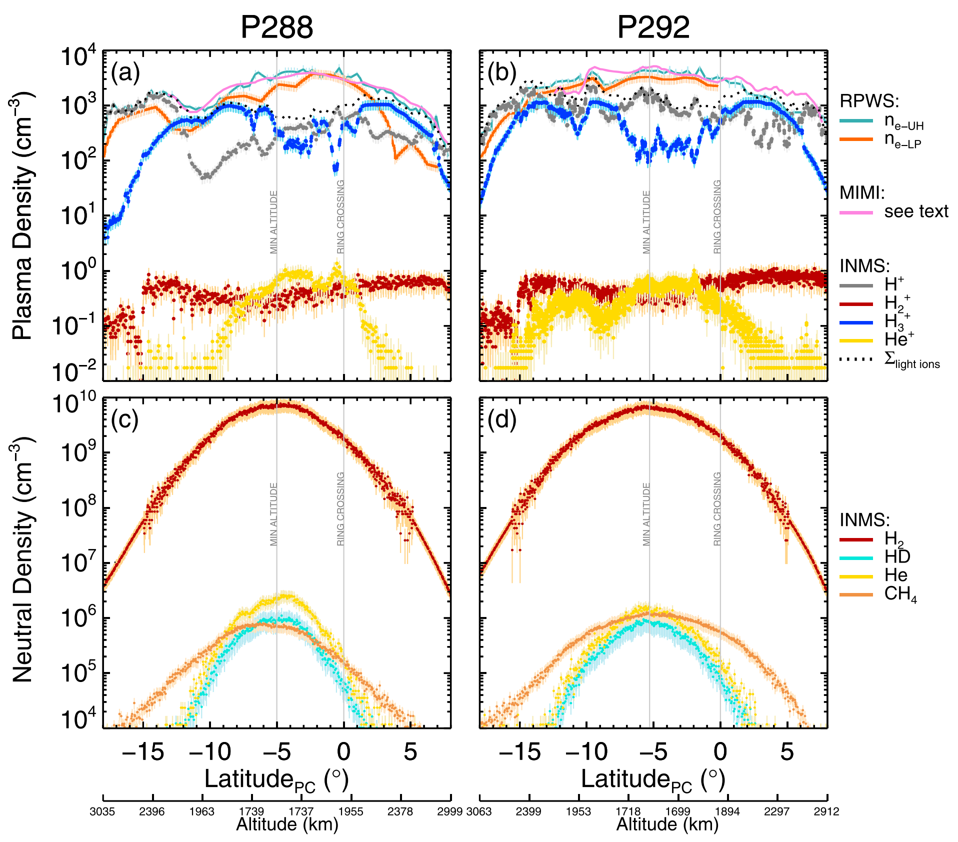


Figure 1. Data comparisons from the INMS, RPWS and MIMI/CHEMS instruments for proximal orbits (a and c) 288 and (b and d) 292. Cassini sampled the upper atmosphere near local solar noon at closest approach. The minimum altitude and the ring plane crossing for each orbit are indicated by gray vertical lines. Panel (a) is adapted from Waite et al. (2018). RPWS = Radio and Plasma Wave Science; INMS = Ion and Neutral Mass Spectrometer; MIMI = Magnetospheric IMaging Instrument; CHEMS = Charge Energy Mass Spectrometer.

Unknown heavy ion dominates equatorial ionosphere…☹ (Moore et al. 2018).