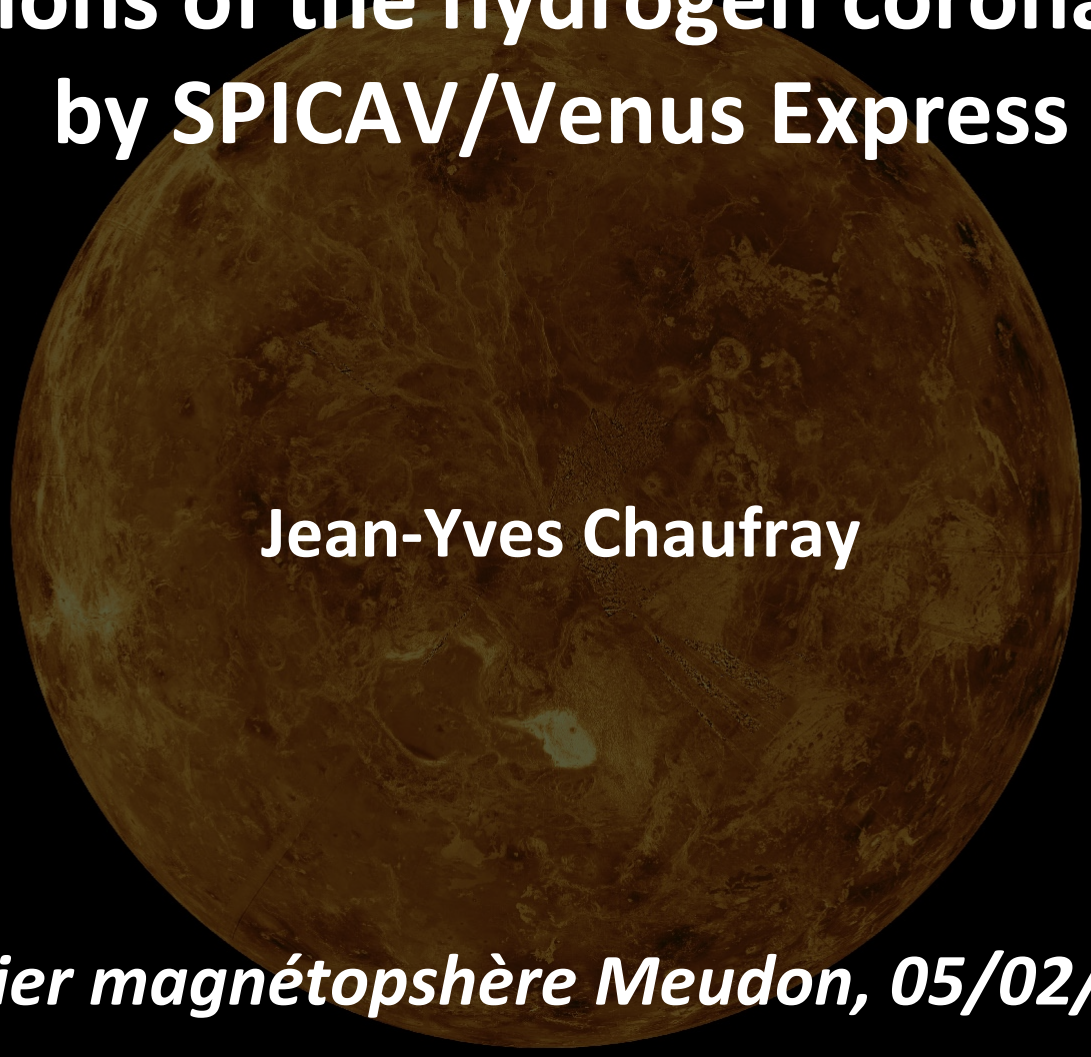
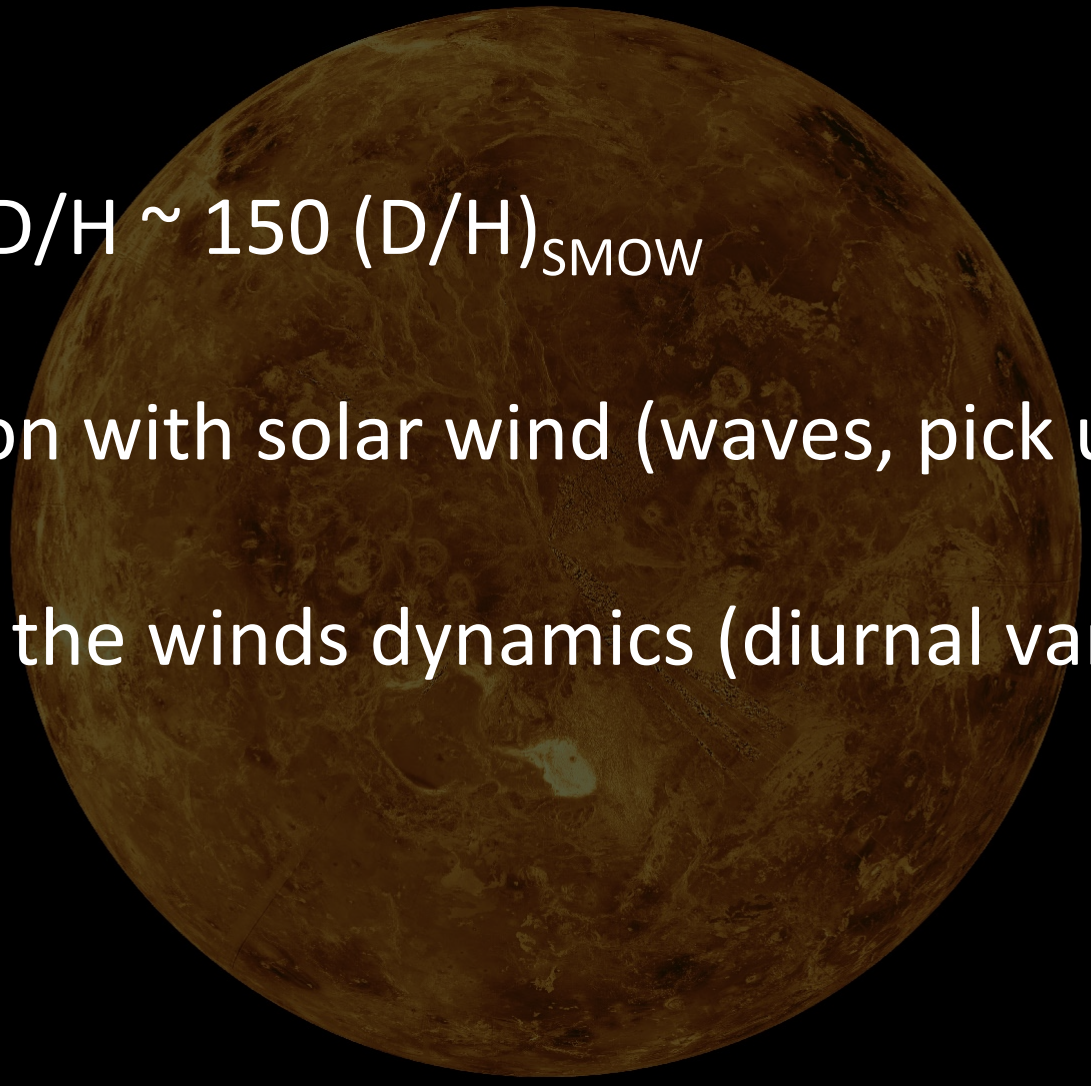
Observations of the hydrogen corona of Venus by SPICAV/Venus Express



Jean-Yves Chaufray

Atelier magnétopshère Meudon, 05/02/2015

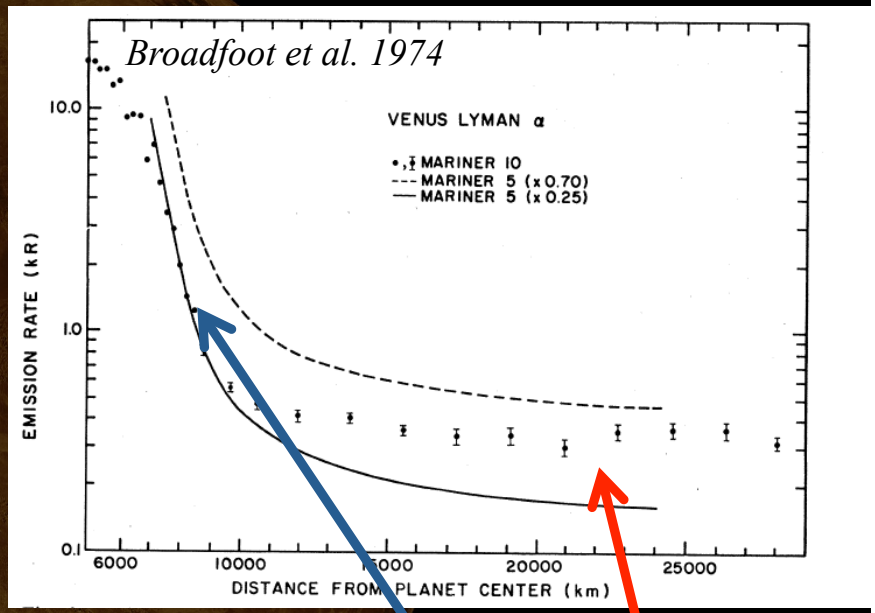
Motivation

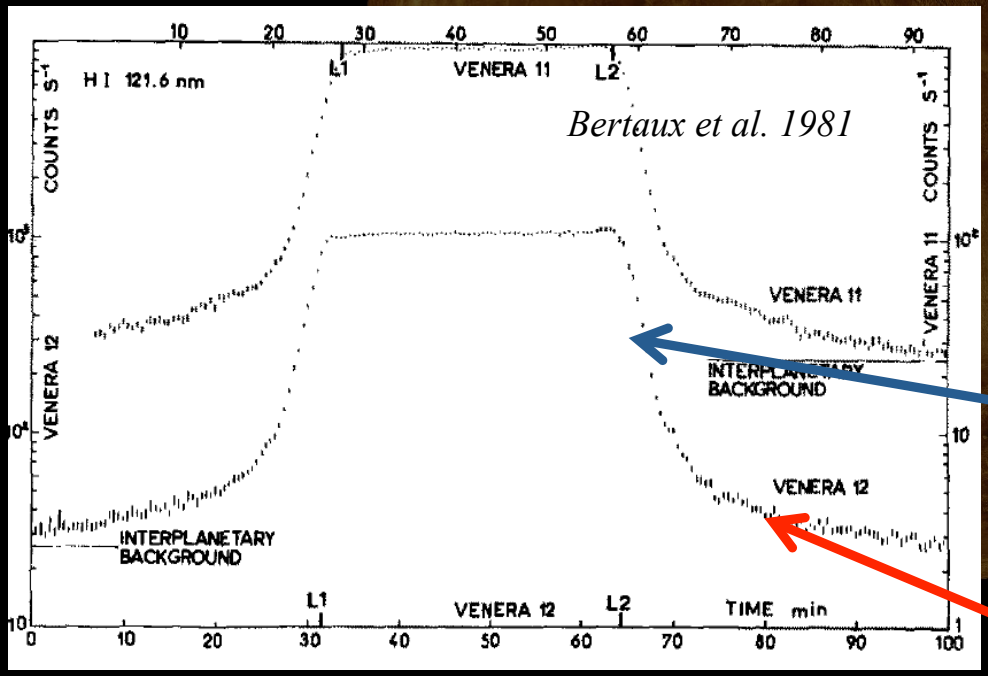


- Escape : D/H ~ 150 $(D/H)_{SMOW}$
- Interaction with solar wind (waves, pick up ions ...)
- Tracer of the winds dynamics (diurnal variations)

Observations of the H corona before Vénus Express

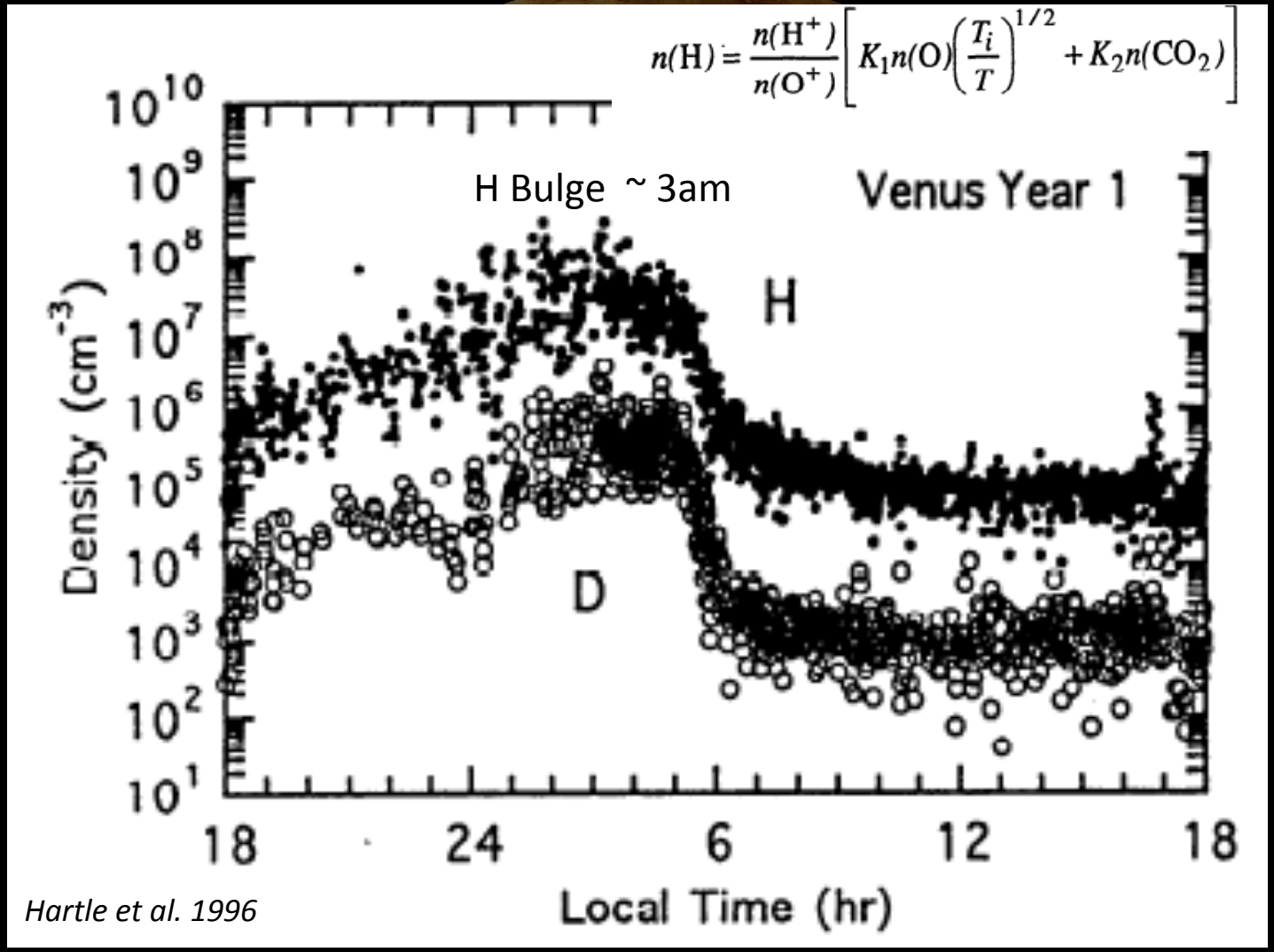
- Mariner flybys
- Venera flybys
- Pioneer Venus Orbiter





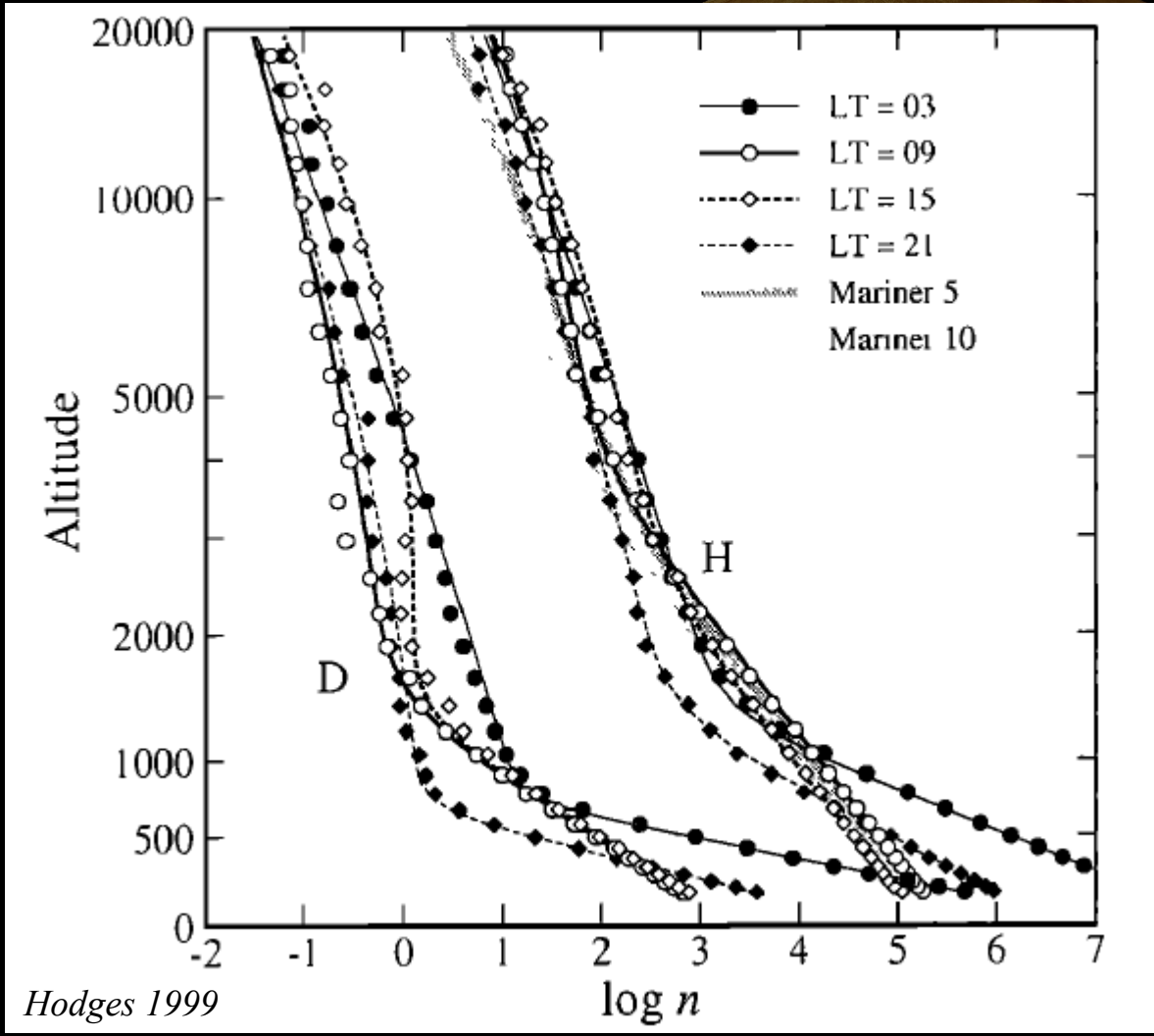
2 scale heights
- Population th thermal equilibrium with the atmosphre
- Suprathermal population (neutral escape)

Diurnal variations derived by PVO



Hartle et al. 1996

Formation of the hydrogen corona



Hodges 1999

3D Model of the hydrogen corona coupled to ionospheric model

Hot H produced by momentum transfer between planetary H^+ and thermal H

SPICAV-UV/VEX

Spectral Range : 110 - 320 nm

Mechanical slit at the focal plane of off-axis mirror

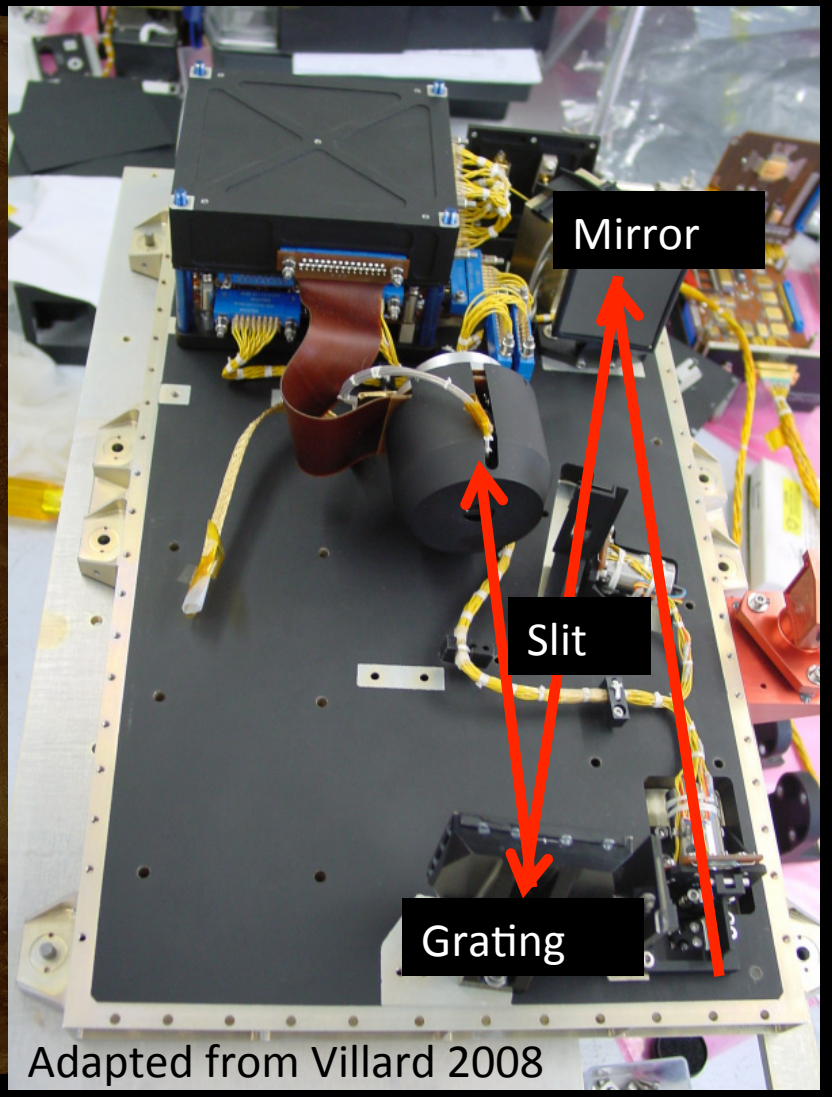
Narrow Part : resolution 1.5 nm
Wide Part : resolution 6 nm

Intensified CCD with 384 (spectral) and 288 (spatial) pixels

Bertaux et al. 2007

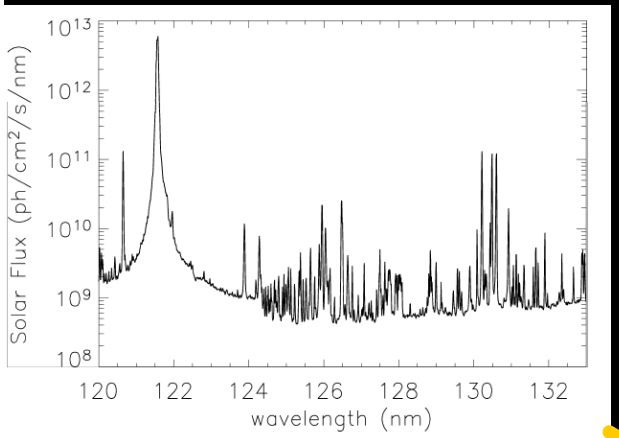
Absolute calibration at H I Lyman alpha estimated from SPICAV-VEX/ SWAN-SOHO cross calibration.

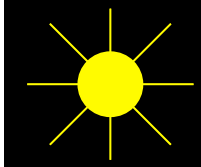
Observations from 2006 -2014



Adapted from Villard 2008

Lyman-alpha emission



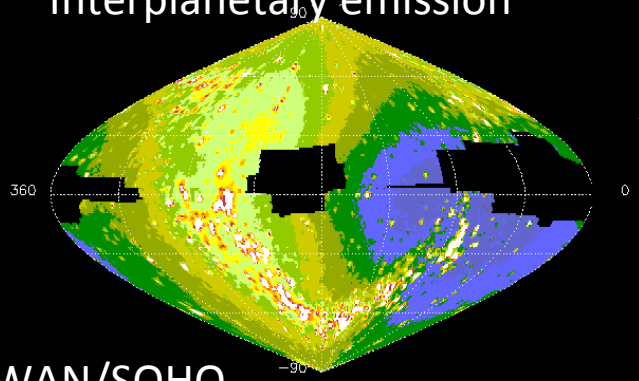


H H H H H H H H

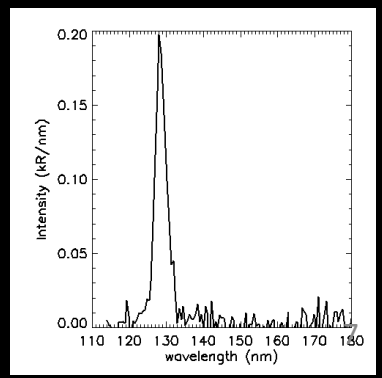
VENUS

Venusian emission

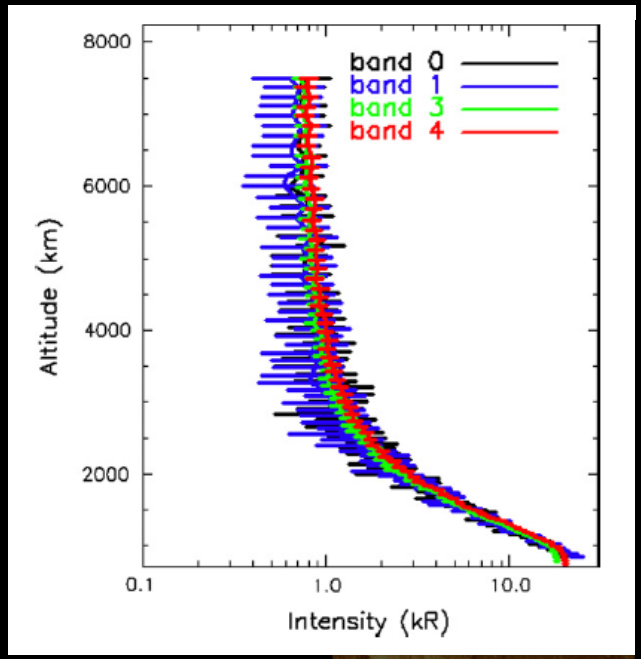
Interplanetary emission



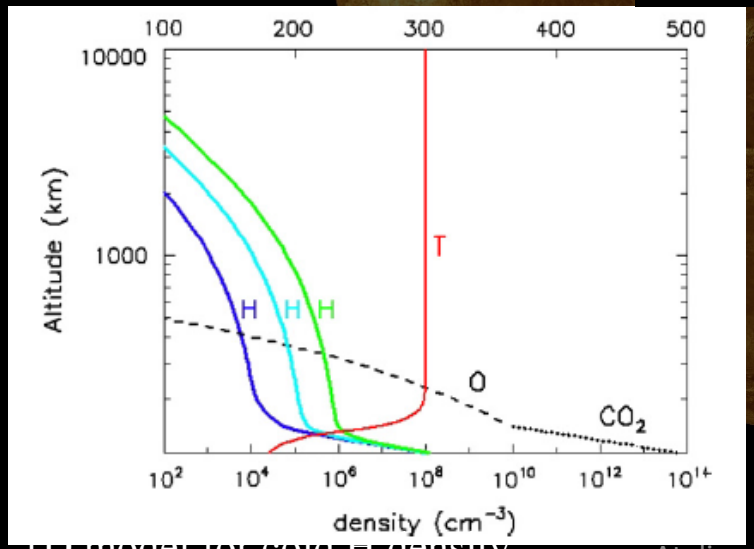
SWAN/SOHO



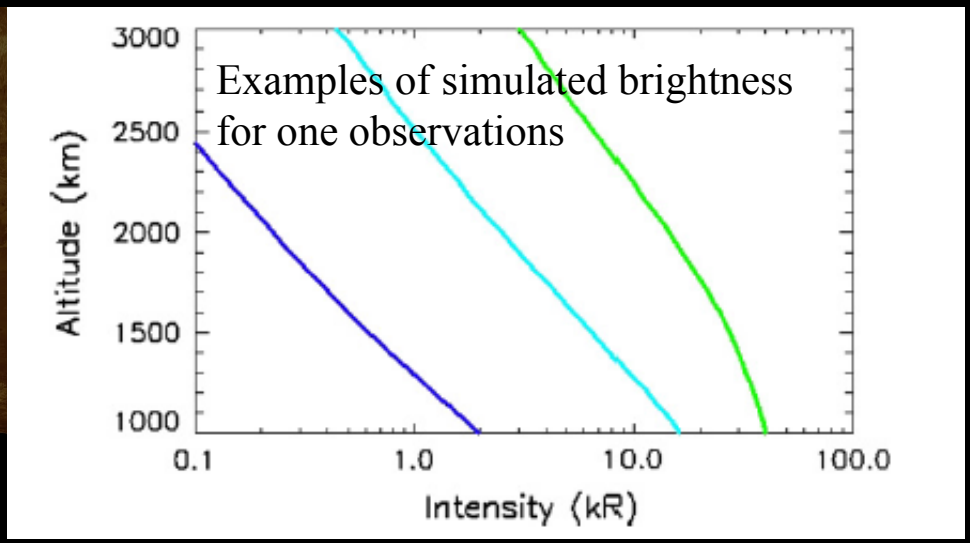
Forward approach for dayside observations



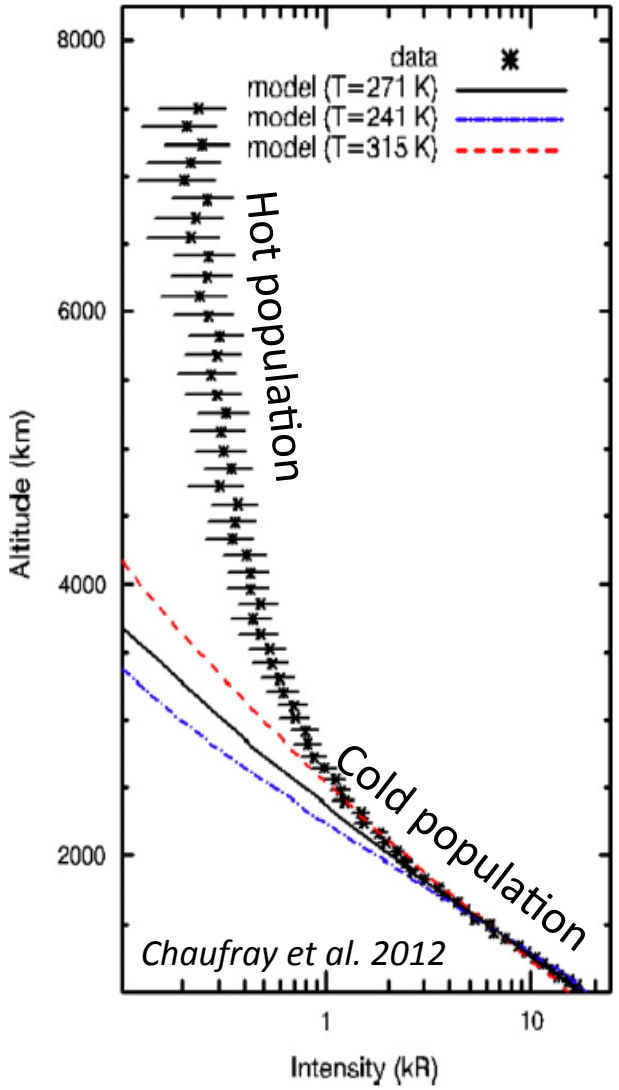
- **Below 2000 km : Cold population only**
  - Spherical symmetry
  - Optically thick : Radiative transfer model
- **Above 4000 km : Hot hydrogen only**
  - Spherical symmetry
  - Optically thin
- **Interplanetary emission estimated from SWAN/ SOHO**



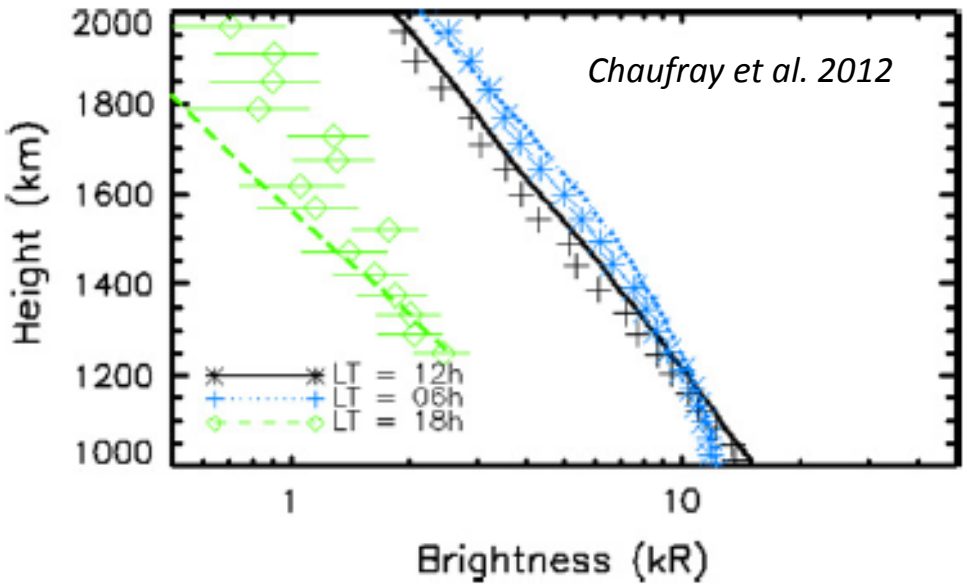
1D model for cold H density



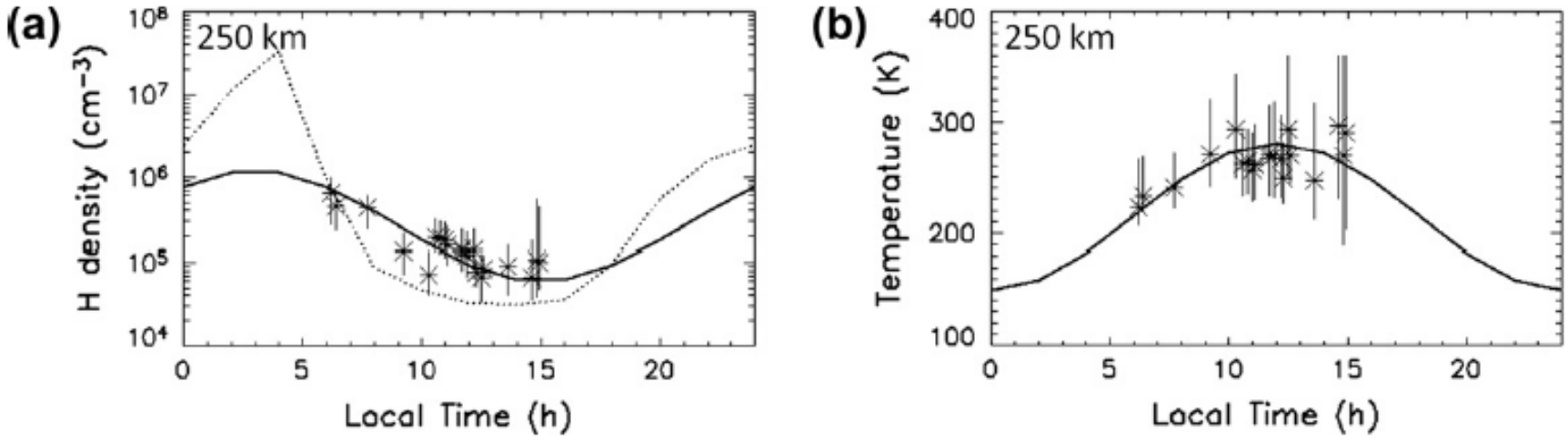
Observations at the dayside



- Observations of the two populations at the dayside
- Brightness asymmetry with local time *morning profile brighter than evening profile*



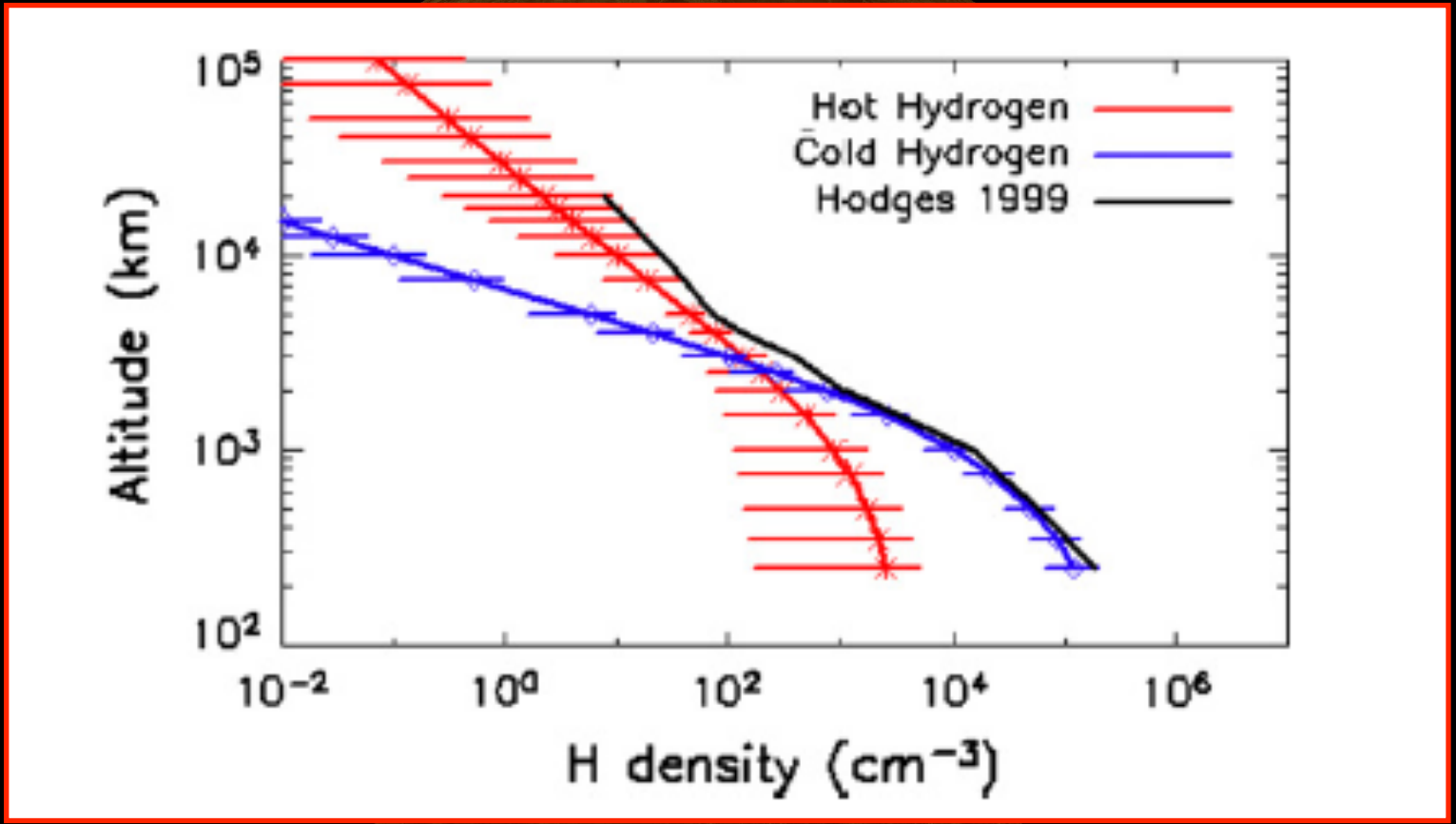
Observations at the dayside



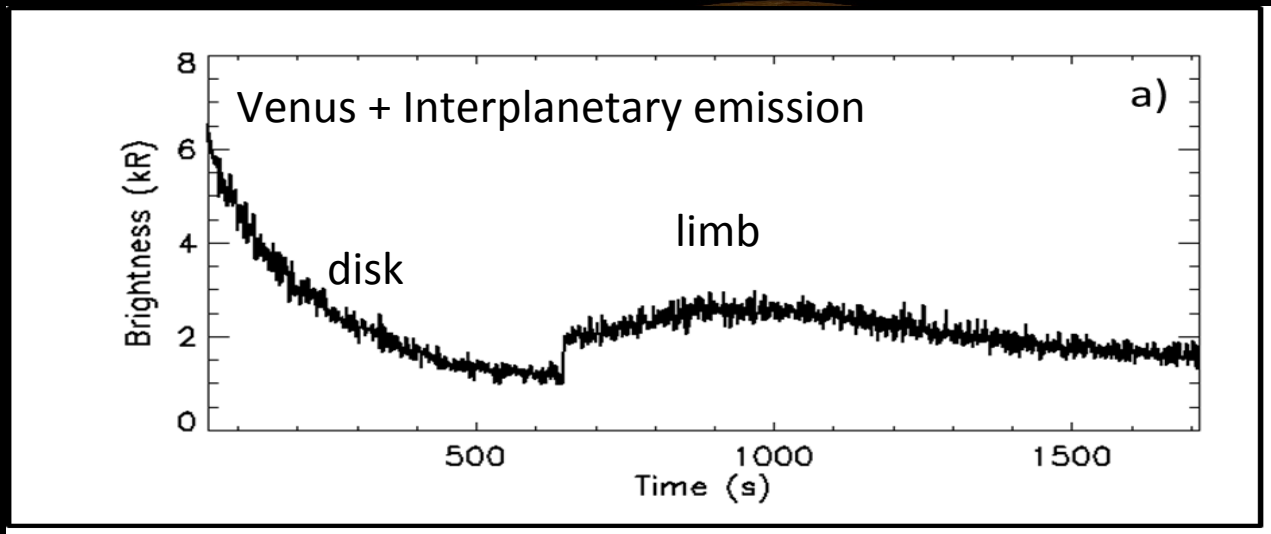
Hydrogen density variability estimated from dayside observations

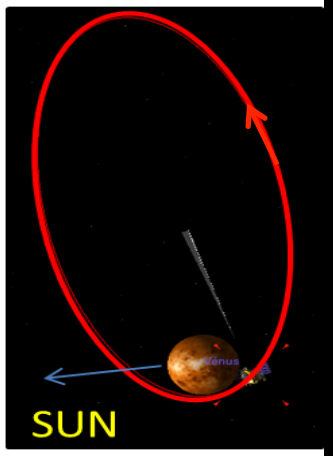
- Asymmetry dayside/nightside
- Estimated bulge density at 4 am from SPICAV/VEX < Estimate from PVO by one order of magnitude

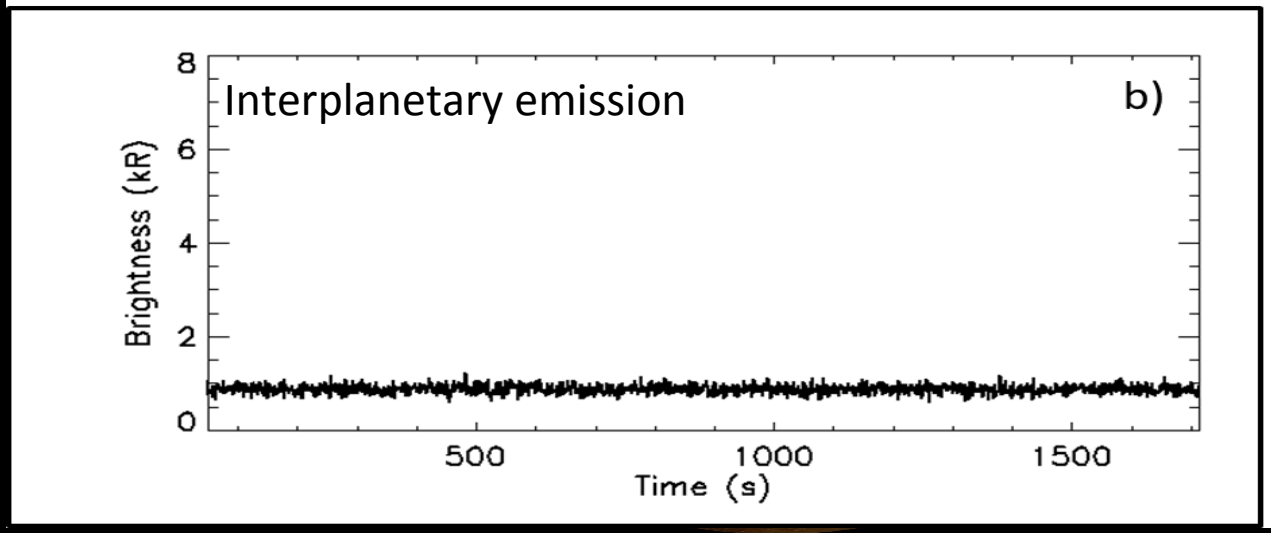
Observations at the dayside

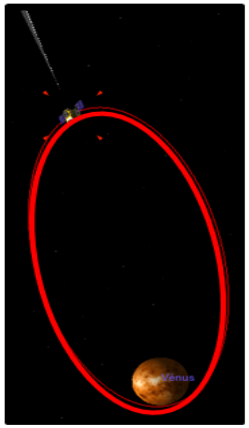


Observations at the nightside

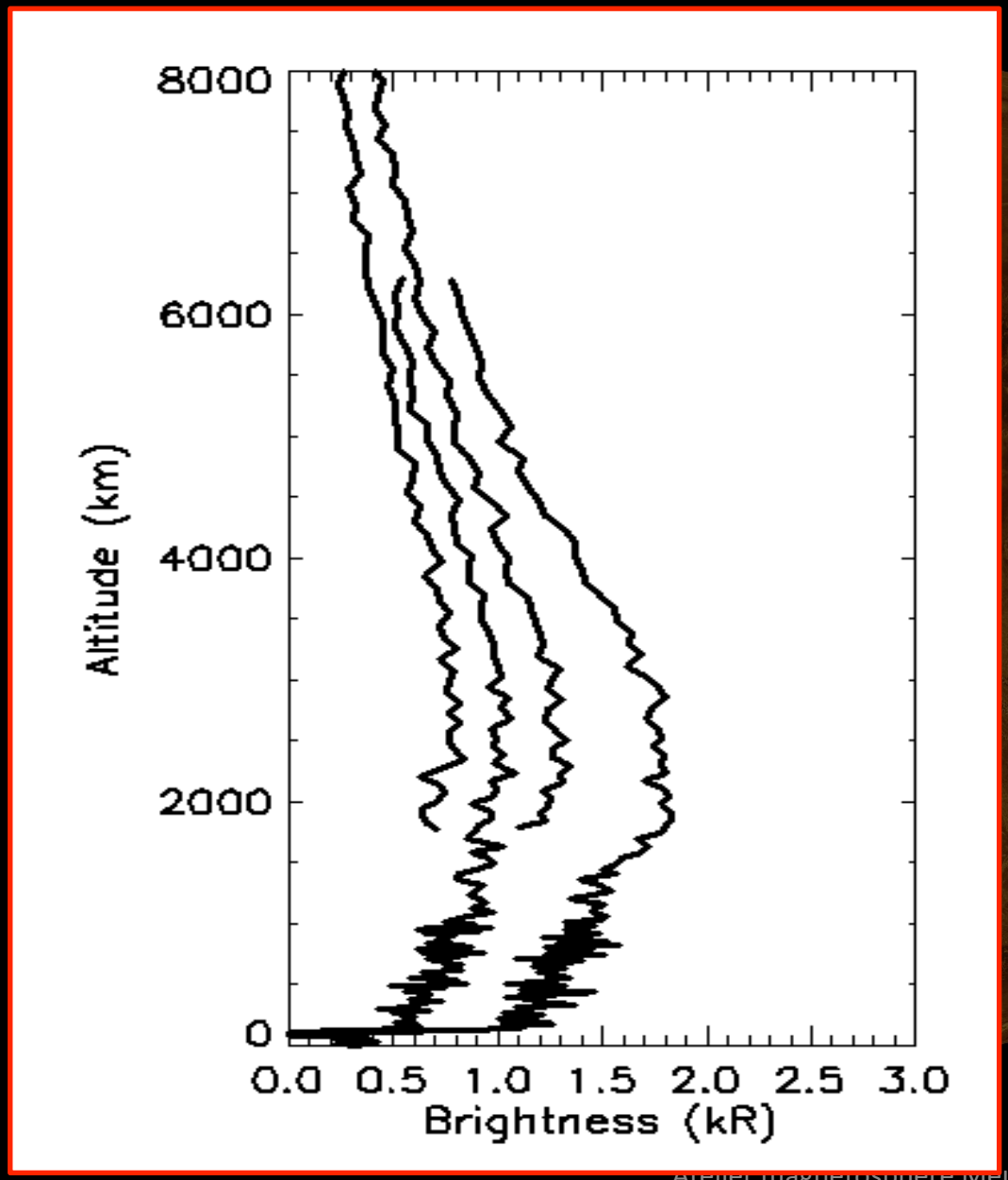




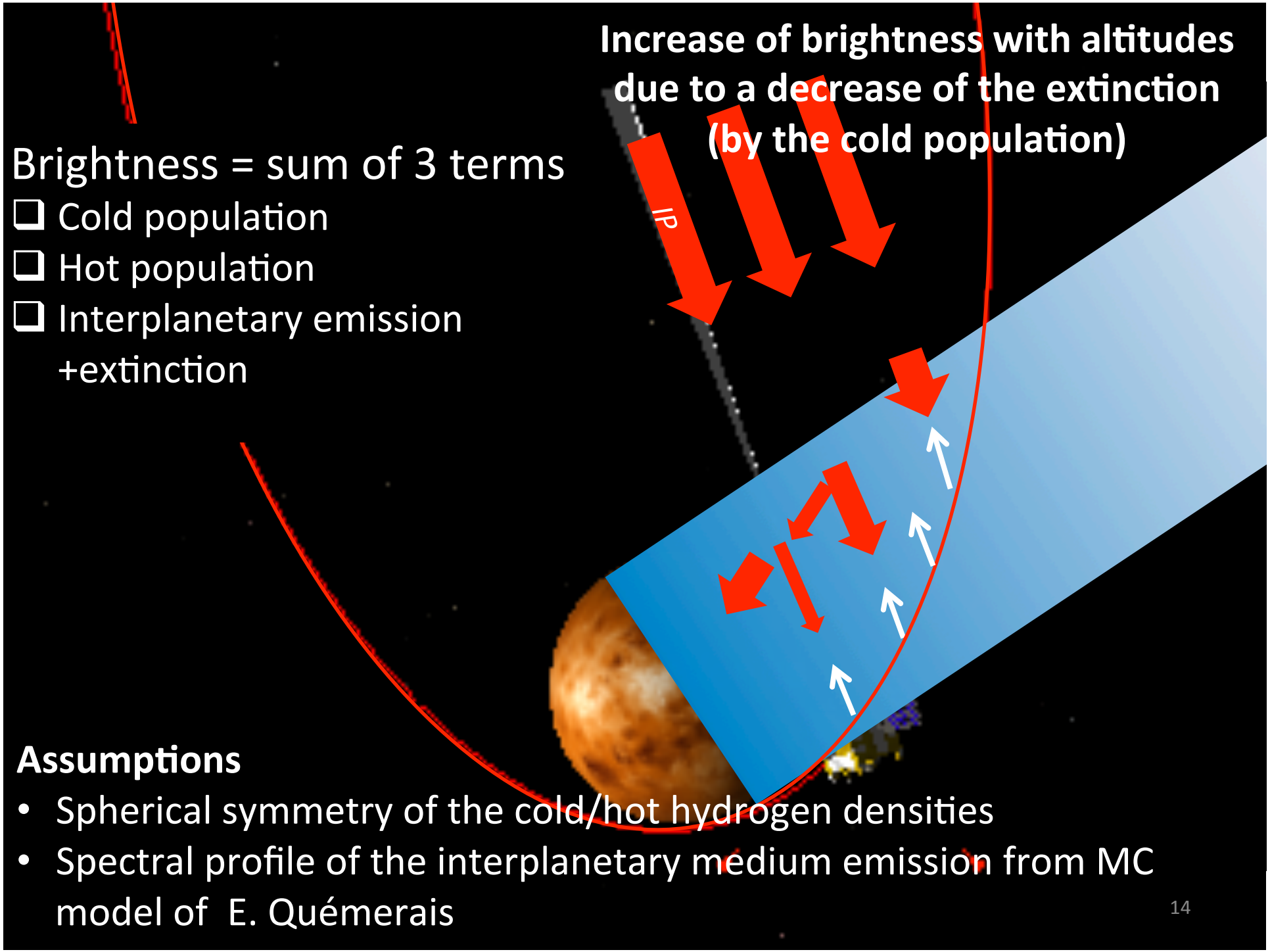




Observations at the nightside



- 4 observations performed from 12-15 October 2011 at LT ~ 20 H
- Vertical profile very different from dayside profile
- Large temporal variations of the Lyman-alpha emission in few days



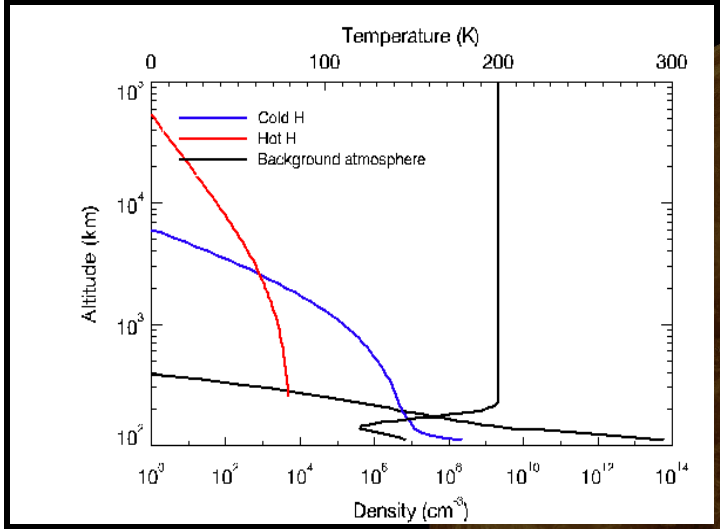
Brightness = sum of 3 terms

- ❑ Cold population
- ❑ Hot population
- ❑ Interplanetary emission +extinction

Assumptions

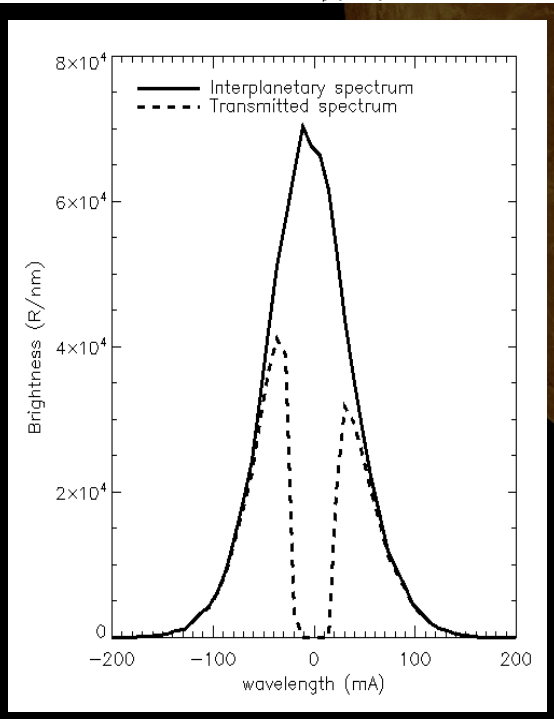
- Spherical symmetry of the cold/hot hydrogen densities
- Spectral profile of the interplanetary medium emission from MC model of E. Quémerais

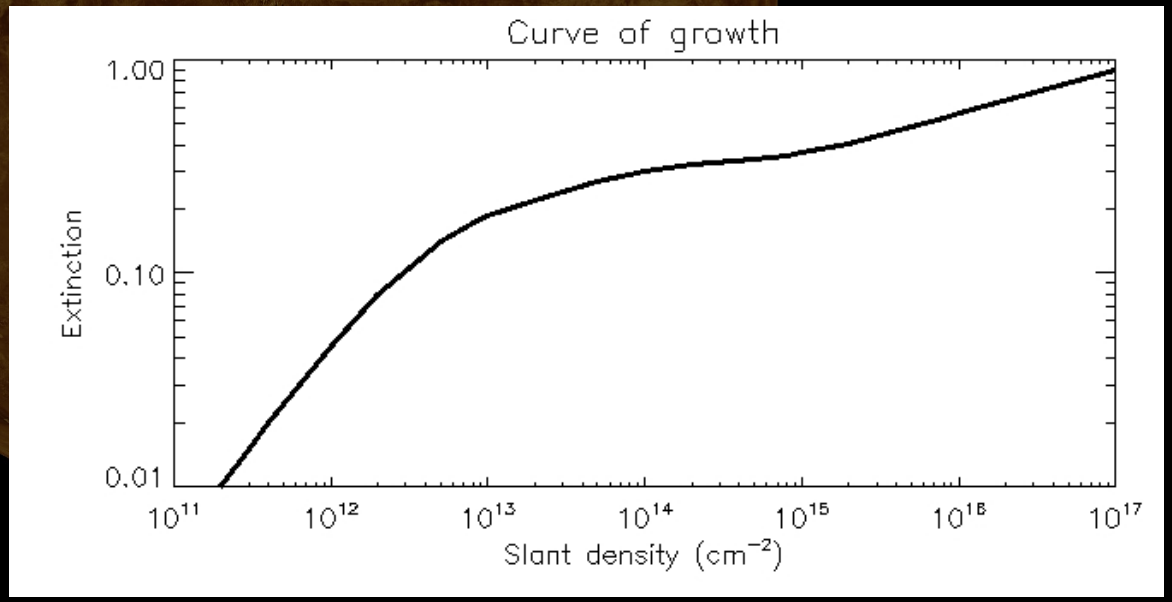
Forward approach for shadow observations



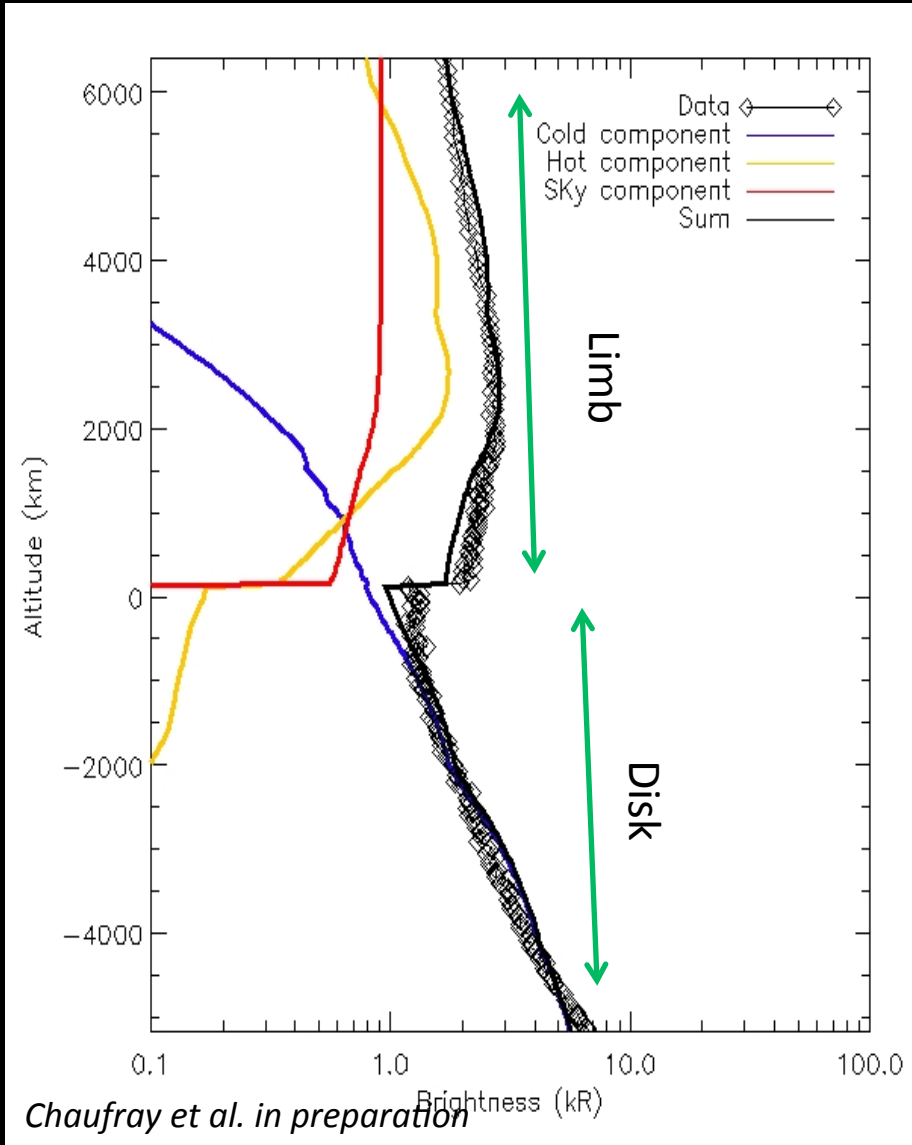
- **Venusian component**
  - **H density : Spherical symmetry**
  - **Radiative transfer model with 2 populations**

- **Interplanetary emission**
  - **Unnatuated spectral profile : from RT model of Quémerais (2000)**
  - **Extinction by the Venusian exosphere**

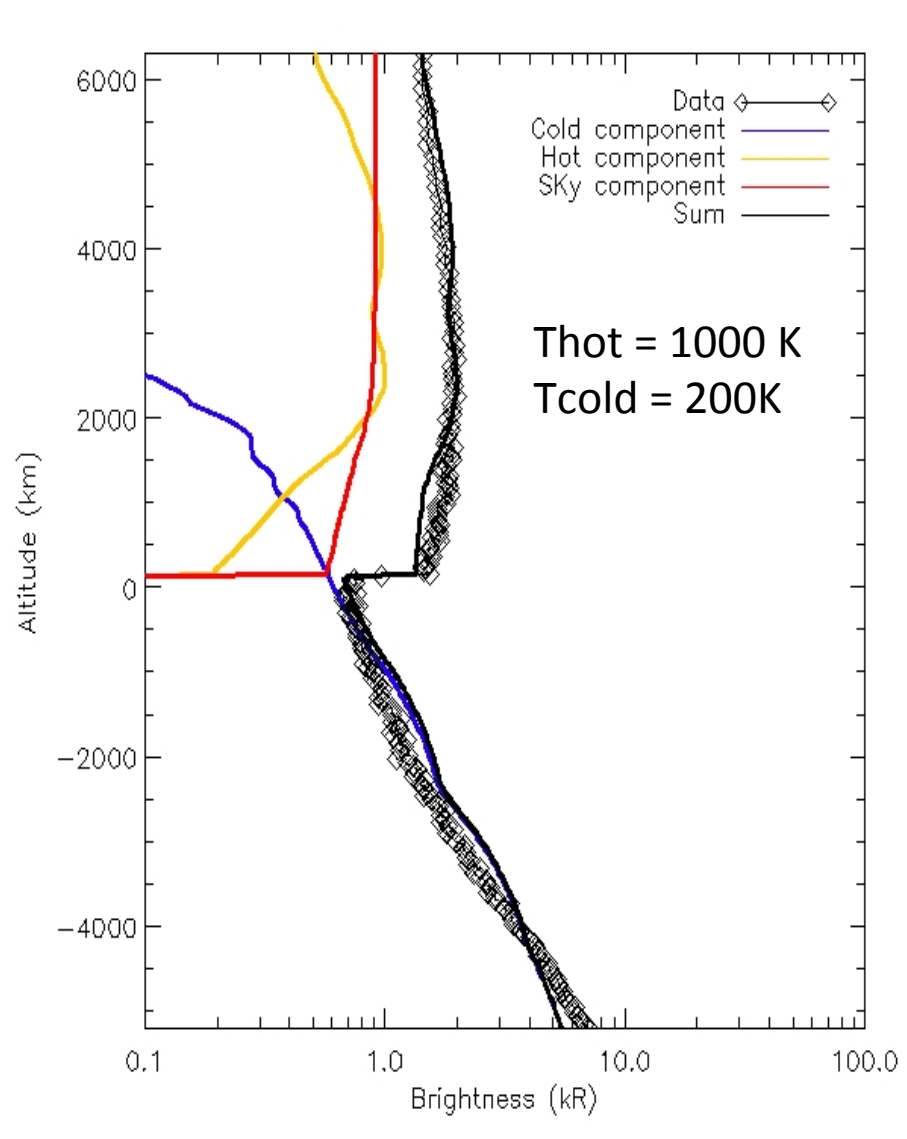




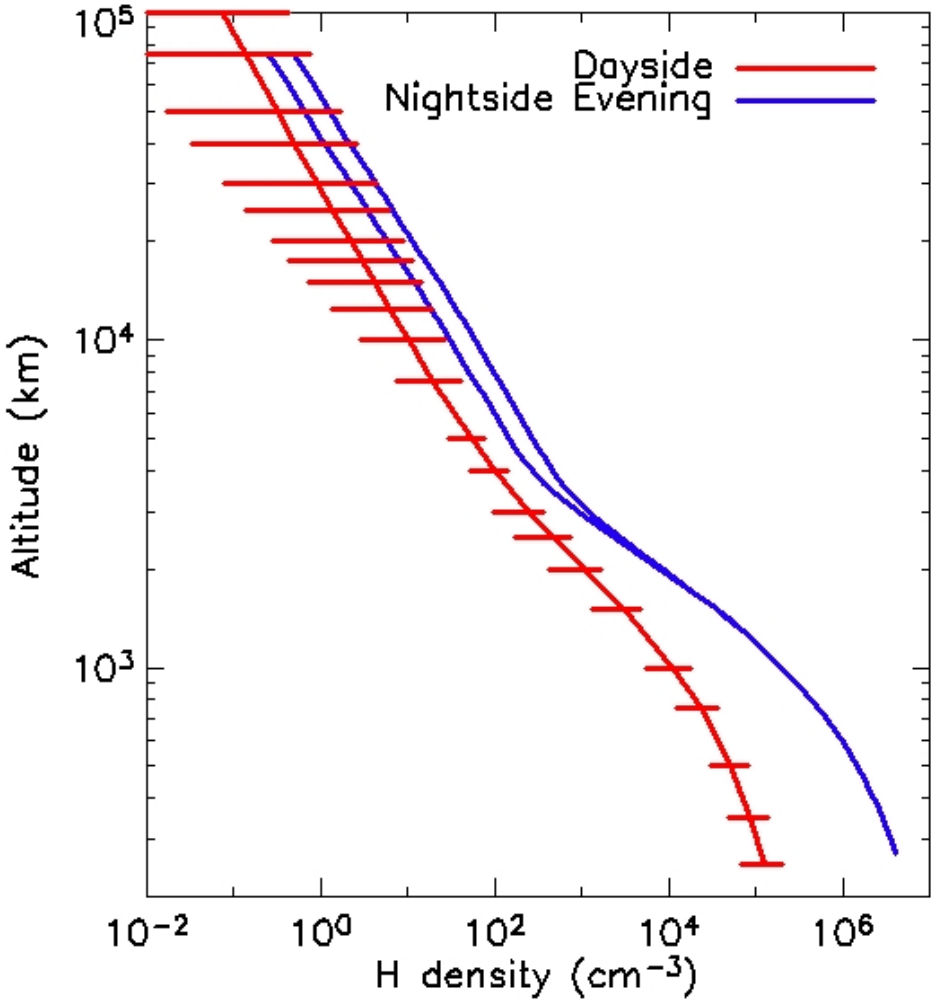
Observations at the nightside



Chaufray et al. in preparation



Observations at the nightside



- Decrease of the hot hydrogen density by a factor ~ 2 in 3 days
- Larger cold density at the nightside vs dayside
- Larger hot hydrogen density at the dayside vs dayside (hot Temperature not well constrained for cases)

Conclusion

- First Analysis of the Venusian hydrogen corona observed at the nightside (LT = 20 H) from UV observations
- Observed brightness at the nightside very sensitive to the hot hydrogen component (cold population not illuminated in the shadow)
- Large variability in few days of the hot hydrogen corona (decrease by a factor 3)
- Larger amount of hot hydrogen at the nightside than observed at the dayside in 2006-2007

Future works

- Analysis of observations at other LT (24H, 4H)
- Development of a more realistic model of hot hydrogen
- 3D Models of cold/hot hydrogen