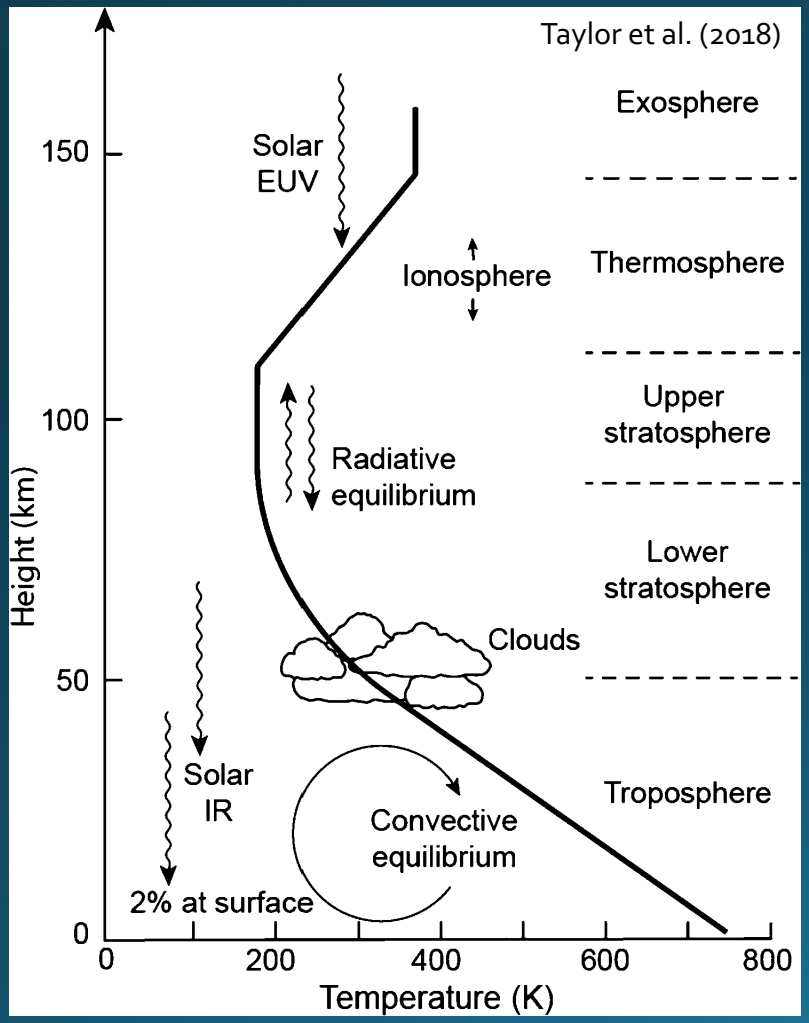
PTYS544

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

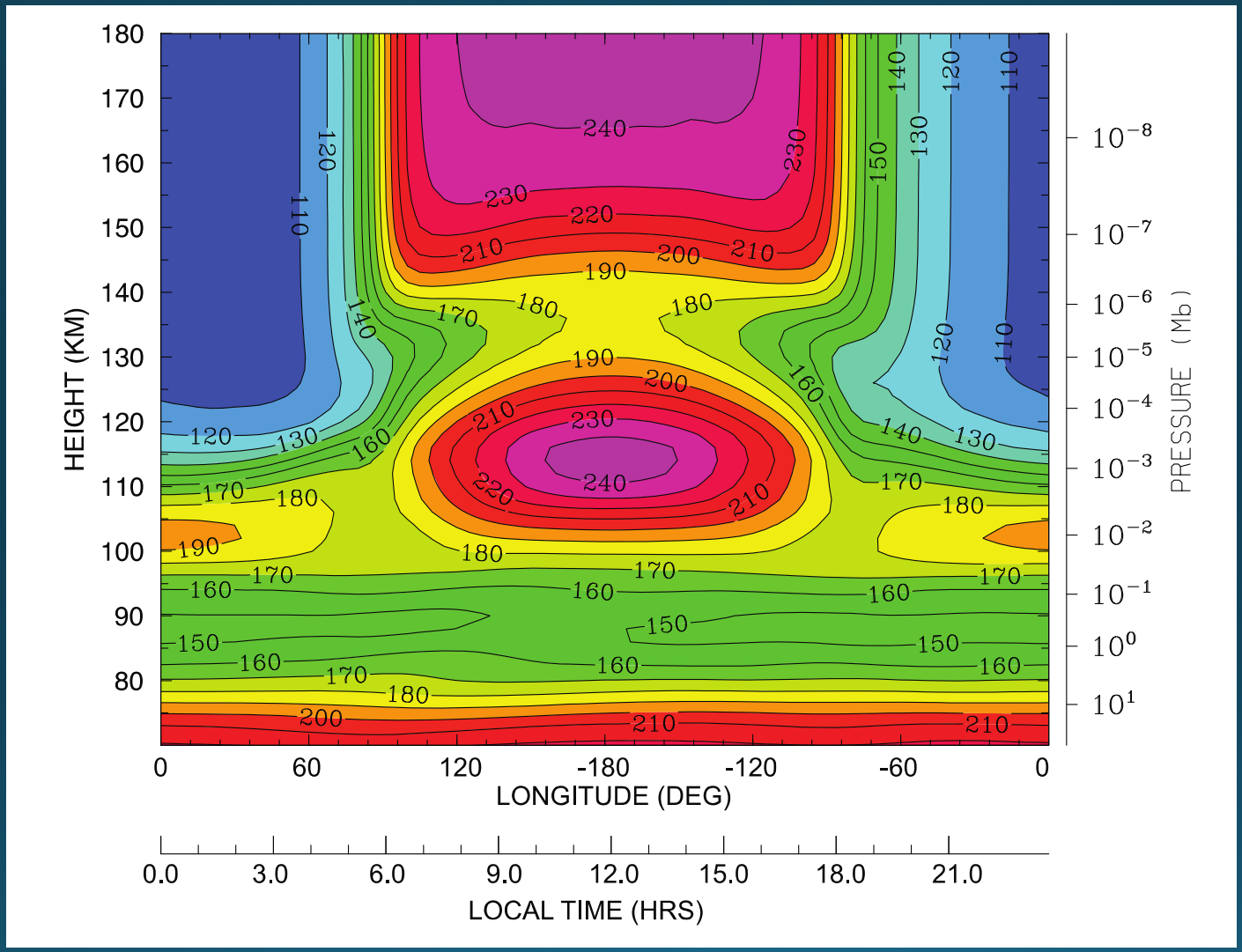
Venus



Thermosphere:
EUV and CO_2 near-IR heating.

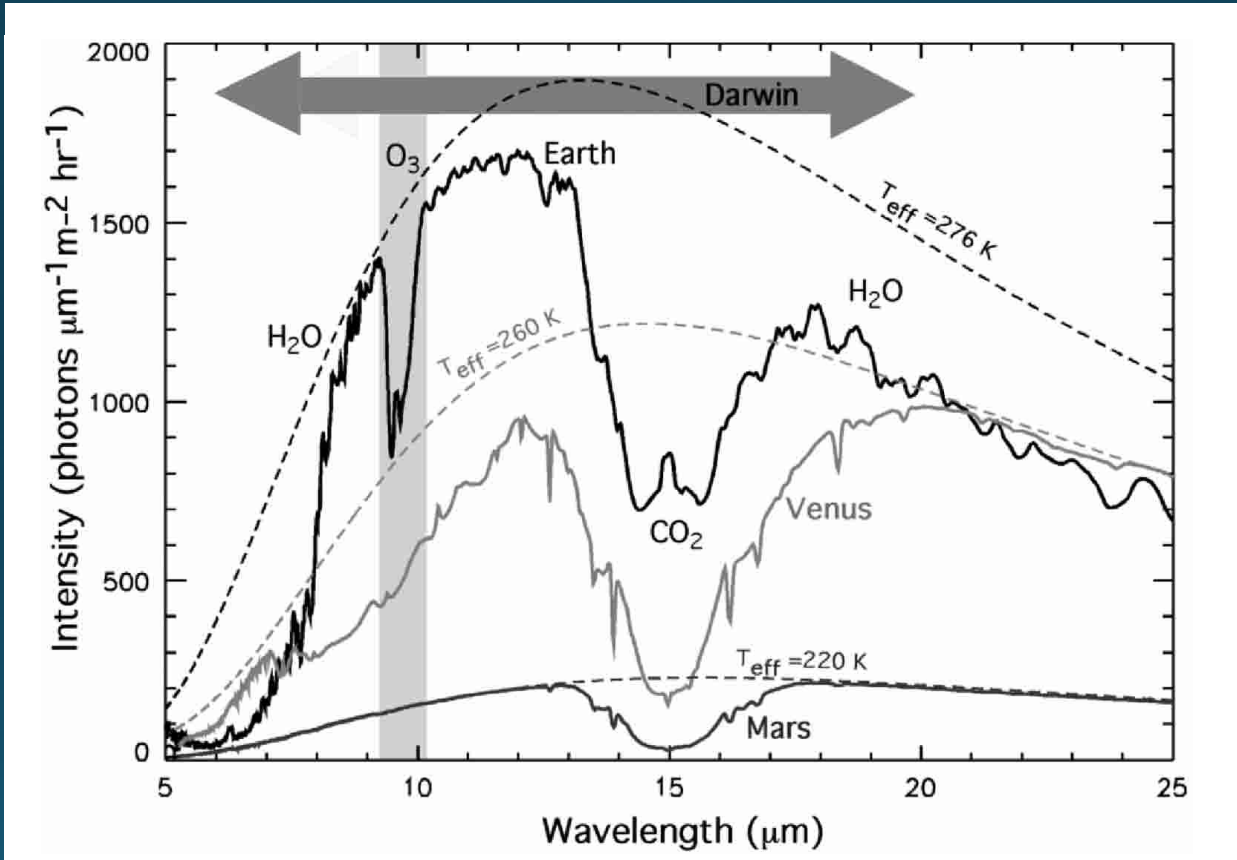
No stratospheric temperature inversion.

Troposphere:
Greenhouse effect due to a thick CO_2 atmosphere, convective equilibrium.



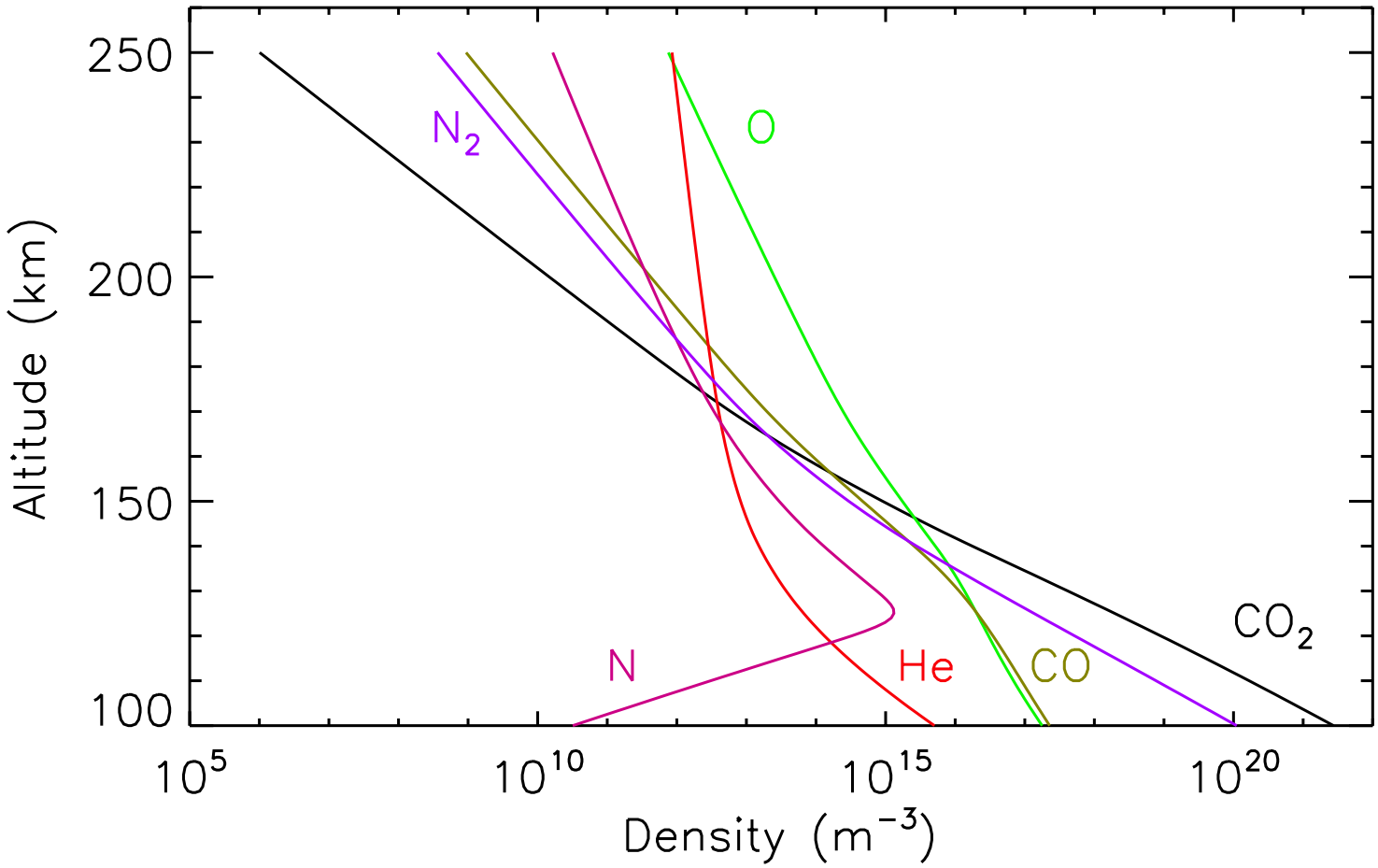
Equatorial temperature slice from the VTGCM model (Bougher et al. 2013)

Terrestrial planet IR spectra



From Cockell et al. (2009)

Mean neutral density profiles (Hedin+1983)



Venus: Neutral photochemistry

Photolysis of CO_2 in the stratosphere (above ~70 km):

$$CO_2 + h\nu \rightarrow CO + O \qquad \lambda < 169 \text{ nm}$$

The reverse reaction is spin-forbidden and thus extremely slow:

$$CO + O + M \rightarrow CO_2 + M$$

Instead, we might expect:

$$O + O + M \rightarrow O_2 + M$$

$$O + ClO \rightarrow Cl + O_2$$

$$O + OH \rightarrow O_2 + H$$

Should end up with a lot of CO, O_2 and O with $[CO]/[O_2] = 2$.

Yung and Demore (1982):

$$Cl + CO + M \rightarrow ClCO + M$$

$$ClCO + O_2 + M \rightarrow ClCO_3 + M$$

$$ClCO_3 + O \rightarrow Cl + CO_2 + O_2$$

$$\boxed{CO + O \rightarrow CO_2}$$

$$ClCO_3 + Cl \rightarrow Cl + CO_2 + ClO$$

$$ClO + O \rightarrow Cl + O_2$$

$$\boxed{CO + O \rightarrow CO_2}$$

$$ClO + SO \rightarrow Cl + SO_2$$

$$SO_2 + h\nu \rightarrow SO + O$$

$$SO_2 + O + M \rightarrow SO_3 + M$$

$$SO_3 + H_2O + M \rightarrow H_2SO_4 + M$$

$$\boxed{CO + SO_2 + O_2 + H_2O \rightarrow CO_2 + H_2SO_4}$$

Eddy and molecular diffusion

Mean neutral density profiles (Hedin+1983)