

GHG Ranking Factors

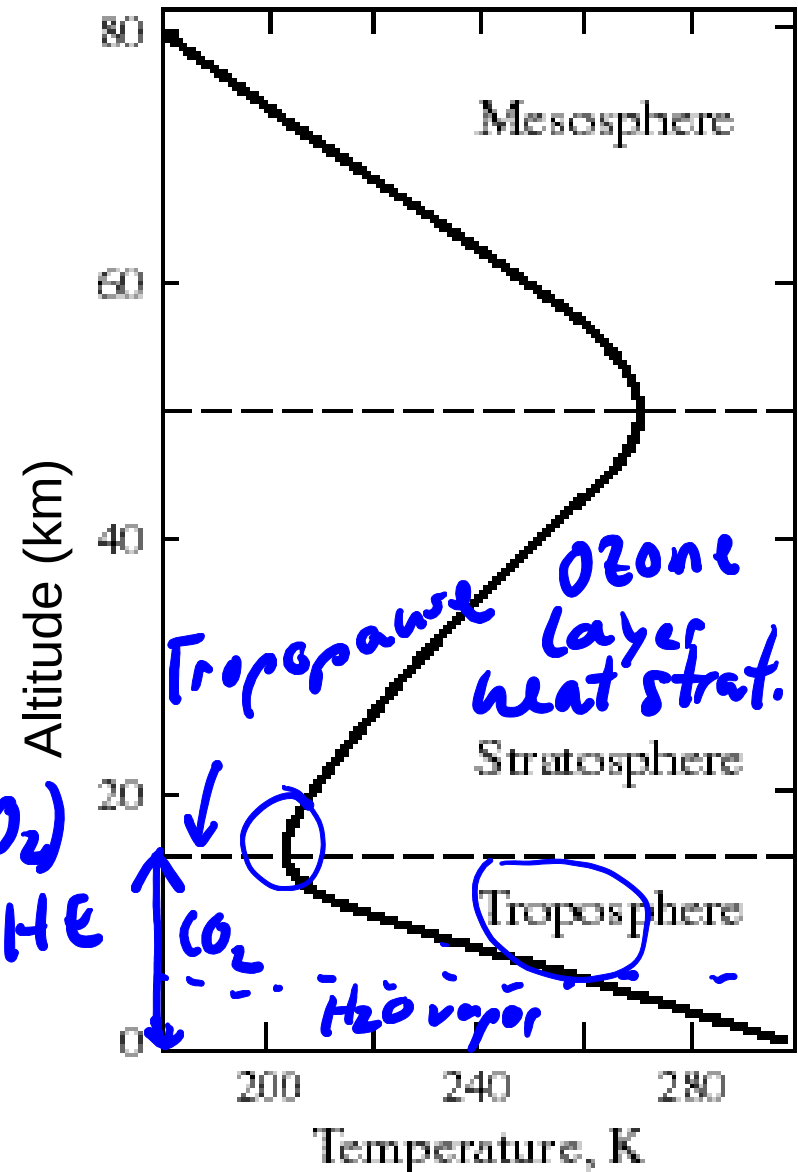
1. **Amount:** more GHG, more radiation can be absorbed
2. **Ability:** depends on wavelength and GHG
Absorptivity (ϵ) $\sim$ **Amount*****Ability**
3. **Location:** both where in altitude and where in outgoing radiation spectrum (wavelength)

Altitude Location: Atmospheric Temperature

Amount of radiation emitted by atmospheric gases will depend on their temperature

- T is set by conduction between atm & surface & then convection (transfer of heat by air motions)
- T of GHG is set by T of surrounding atm (N_2 & O_2)
GHE
- T decreases $\sim 6.5 \text{ K/km}$

Mean values for 30°N, March

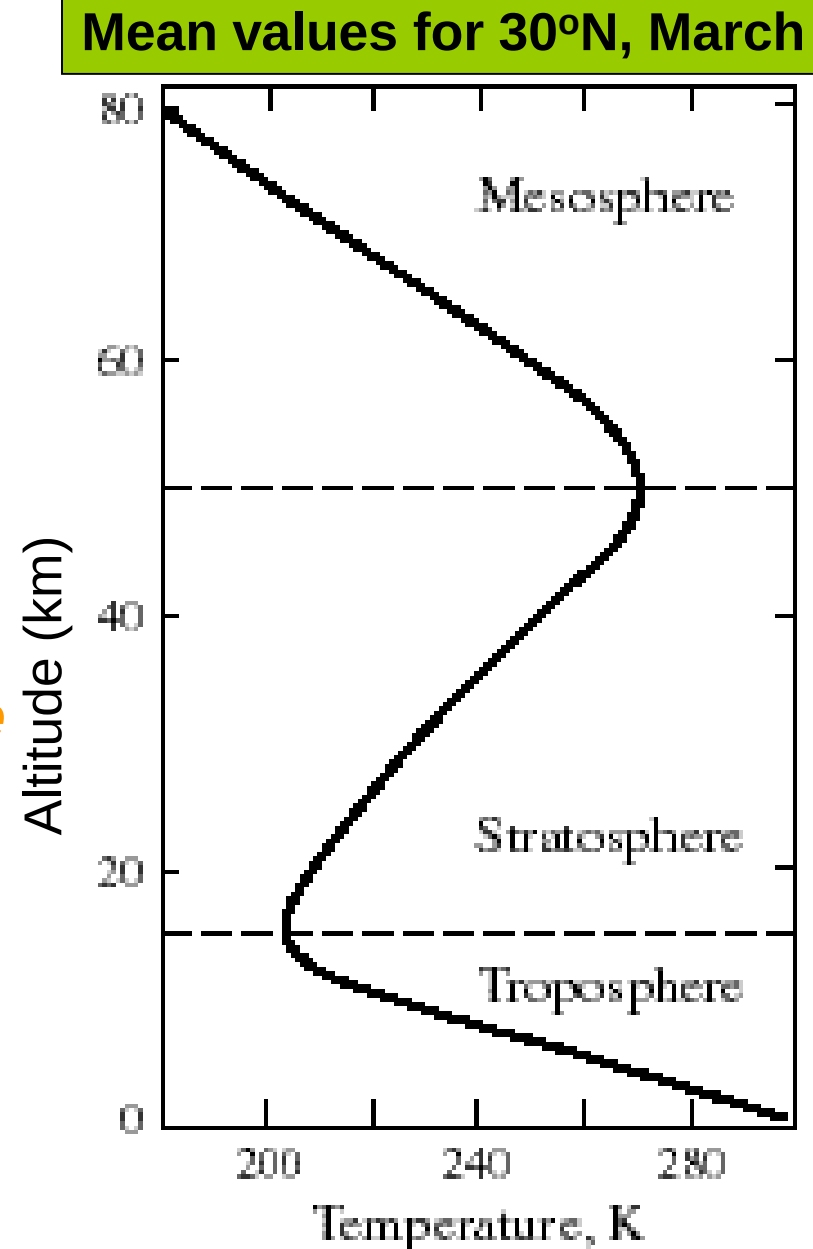


Altitude Location: Atmospheric Temperature

Amount of radiation emitted by atmospheric gases will depend on their temperature

Solar heating of the surface sets tropospheric temperature profile

Temperature decreases with increasing altitude in troposphere



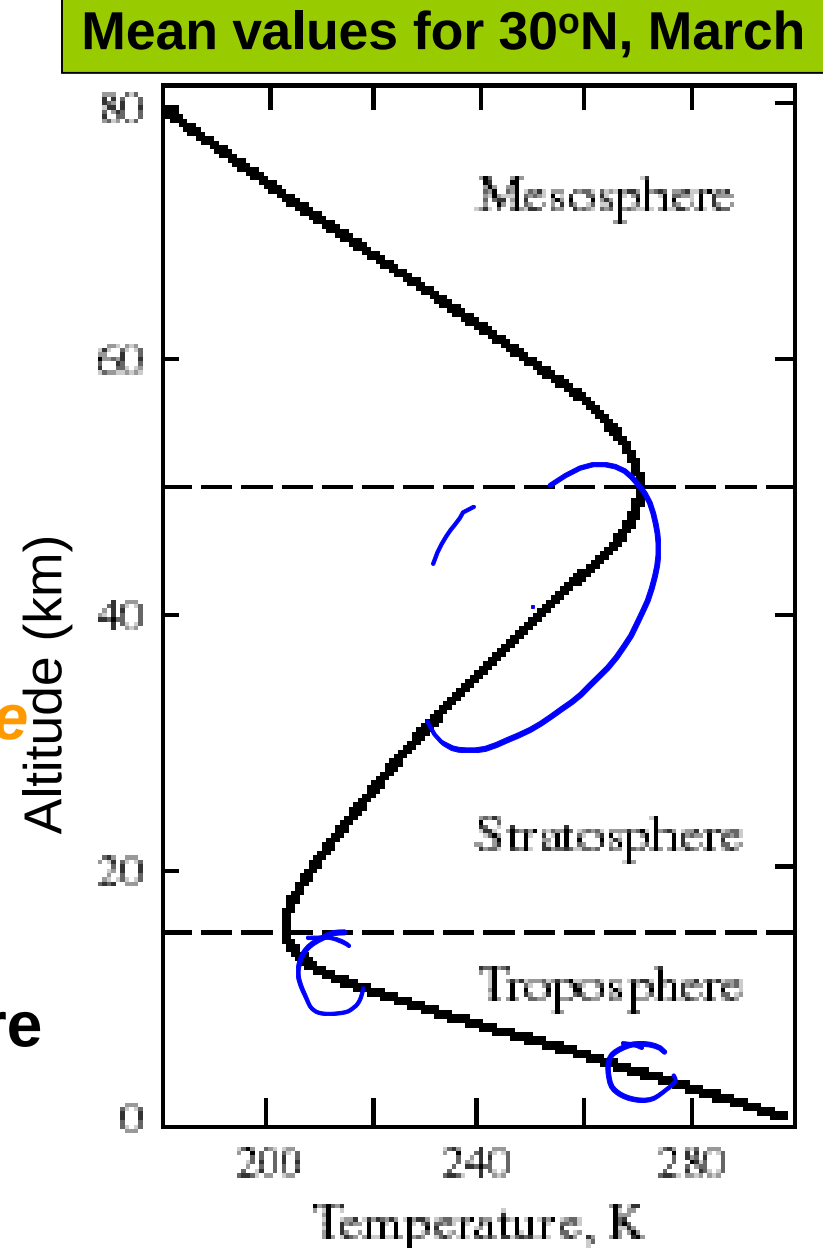
Altitude Location: Atmospheric Temperature

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Solar heating of the surface sets tropospheric temperature profile

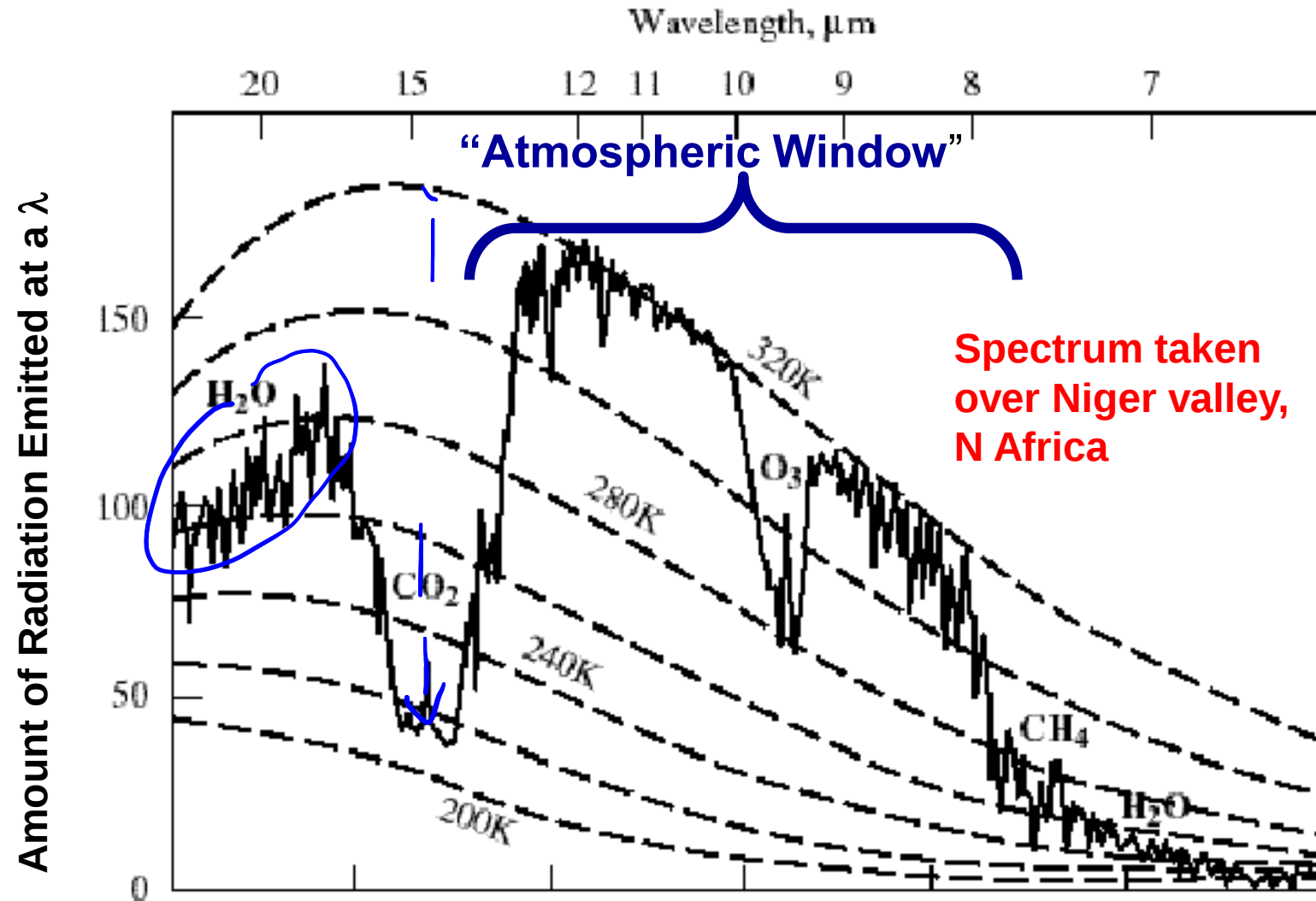
Temperature decreases with increasing altitude in troposphere

Absorption of short-wave solar radiation by ozone in stratosphere causes temperature to increase



Emission Spectrum of Earth Taken From Space

Emission from cold atmosphere and warm surface



Poll

W

At wavelengths absorbed by H₂O vapor, Earth emission spectrum looks like it has a T ~ 260 – 280 K, while at those absorbed by CO₂ it looks like T ~ 220 K, therefore

Visual settings 

Activate 

Show results 

Show correct 

Lock 

 **Poll locked.** Responses not accepted.

Clear results 

Fullscreen 



Water vapor is confined to lower in the atmosphere than CO₂

Water vapor is more effective at absorbing the wavelengths it emits.

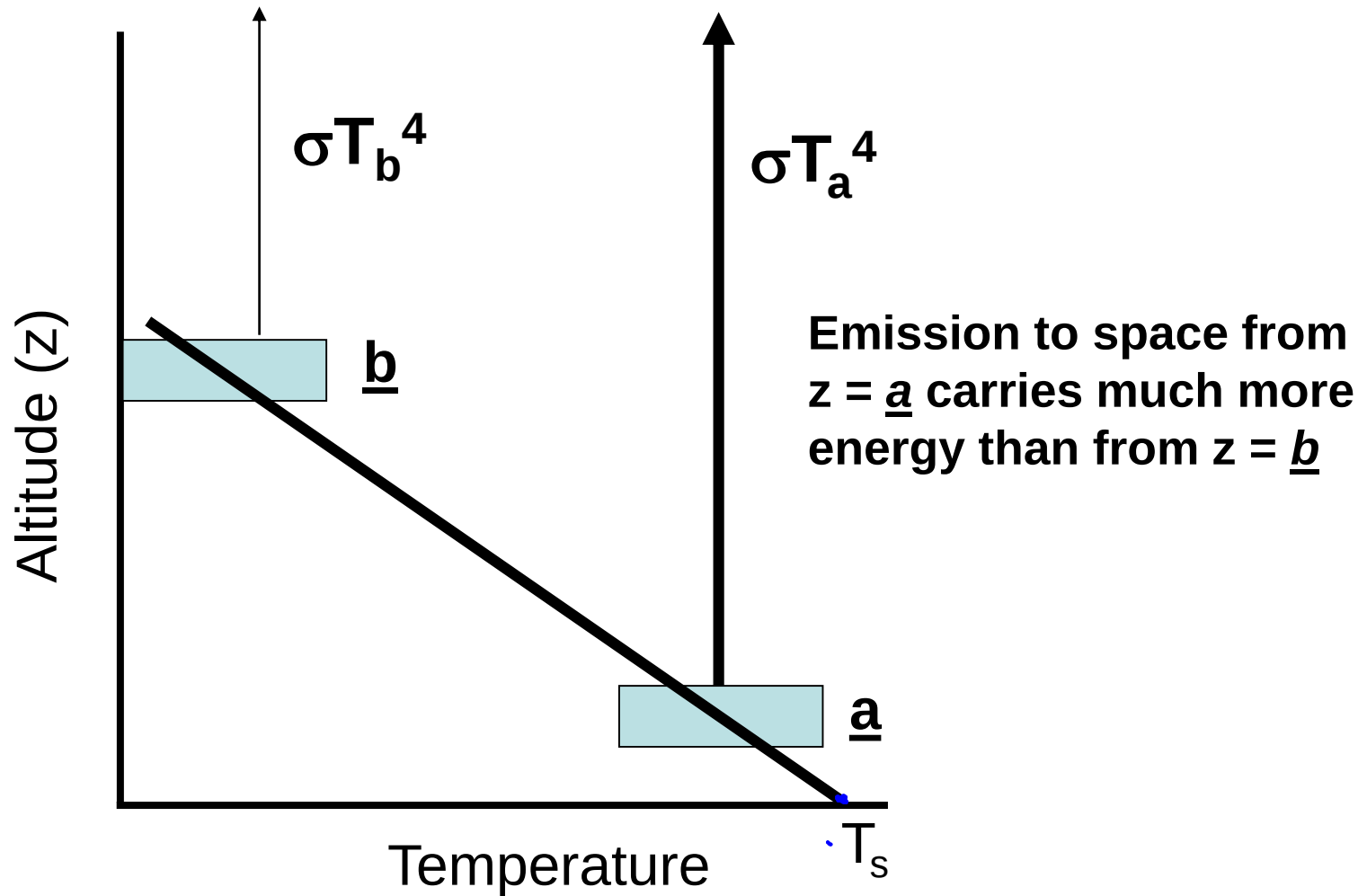
CO₂ is less effective at emitting the radiation it does absorb

Next 

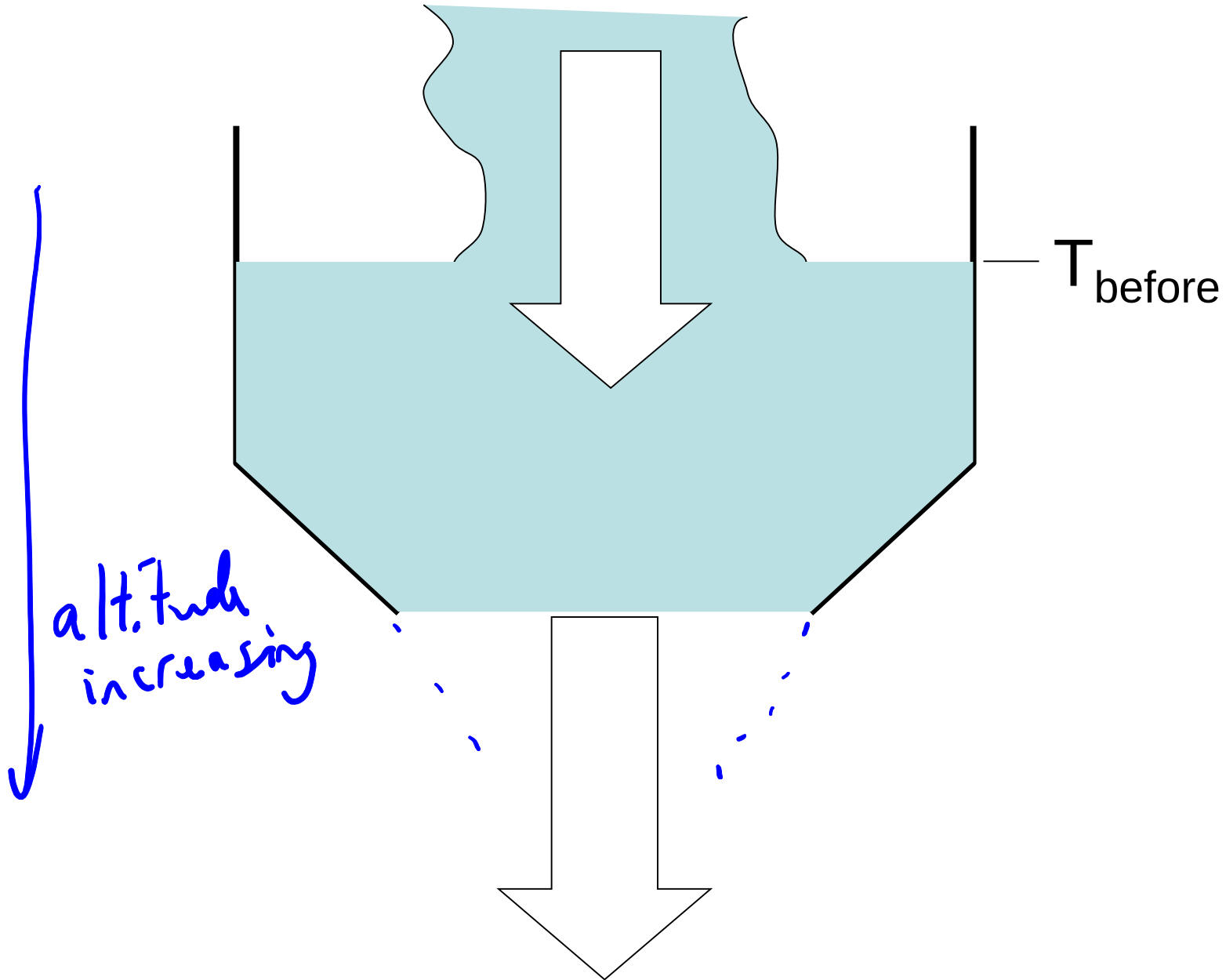
Previous 

Total Results: 81

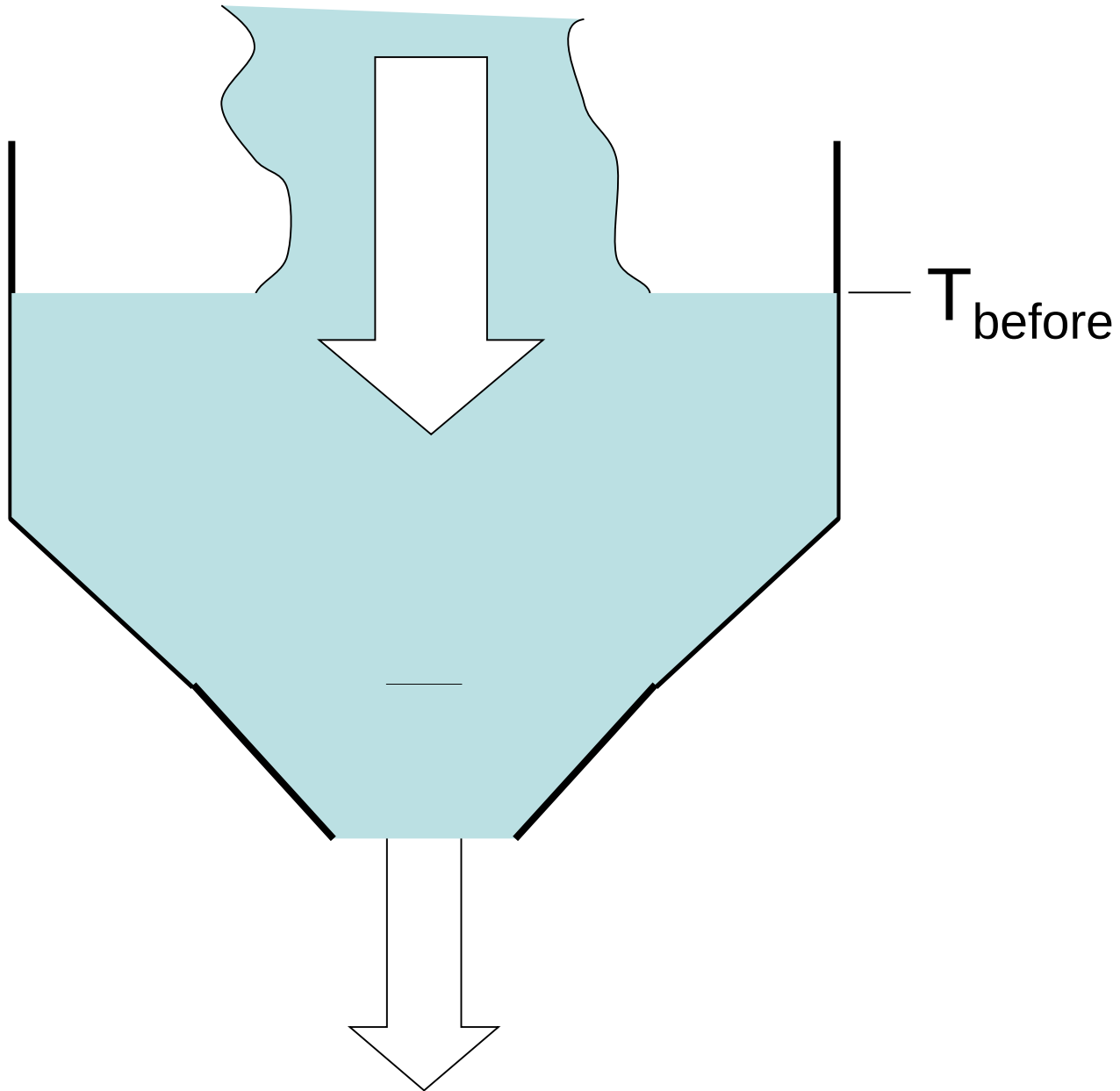
“Emission Height”



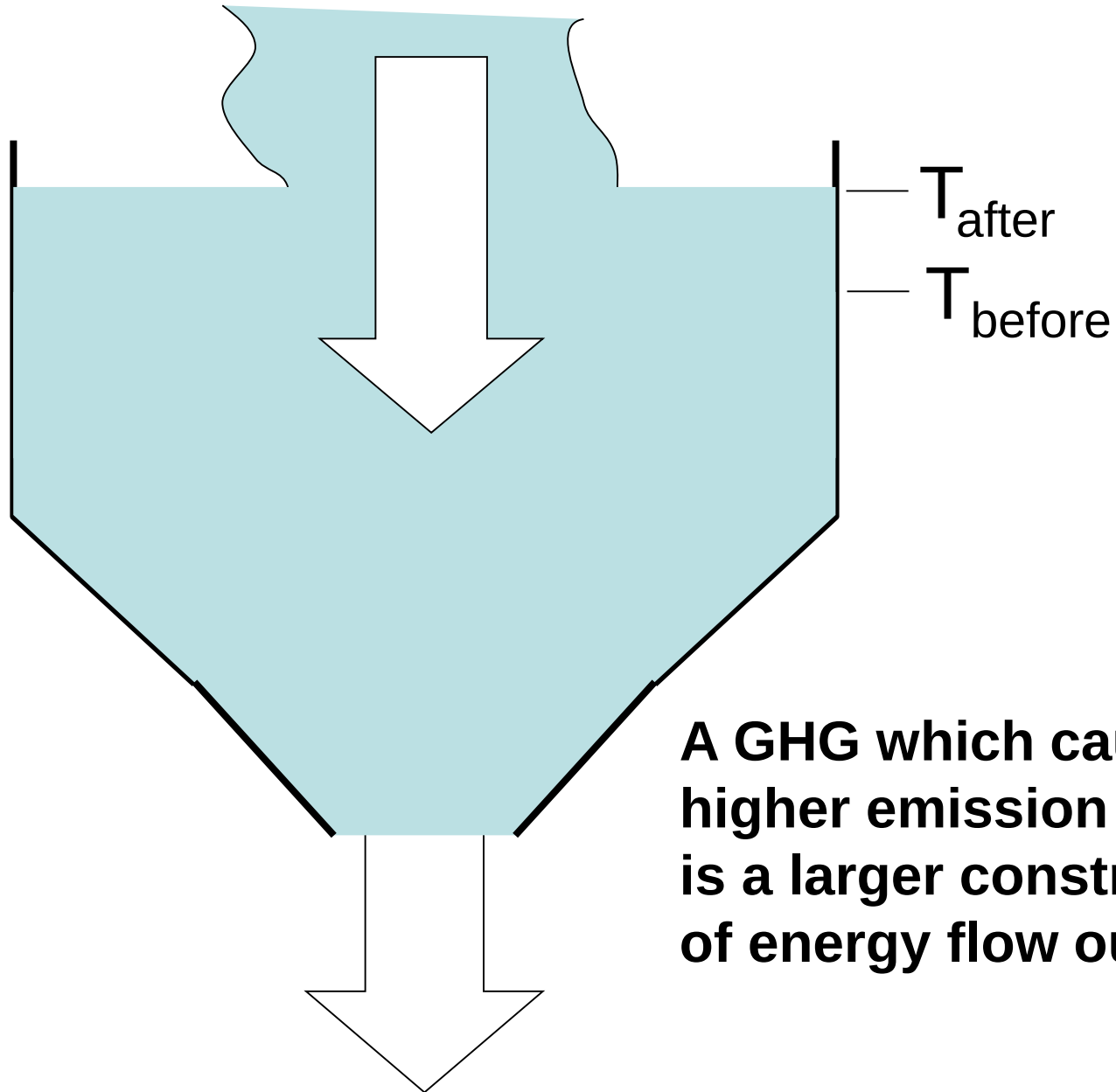
GHG Ranking: Emission Height (Location)



GHG Ranking: Emission Height (Location)



GHG Ranking: Emission Height (Location)



Poll

W

Suppose you are Dr. Evil. You want to create and distribute the most effective GHG and then demand 1 million dollars to stop emitting it. What GHG properties would you seek?

Visual settings 

Activate 

Show results 

Show correct 

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Clear results 

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 **Poll locked.** Responses not accepted.

A gas that absorbs strongly in the 20 microns, and remains concentrated low in altitude.

A gas that absorbs strongly at 11 microns, and is mixed to the upper troposphere

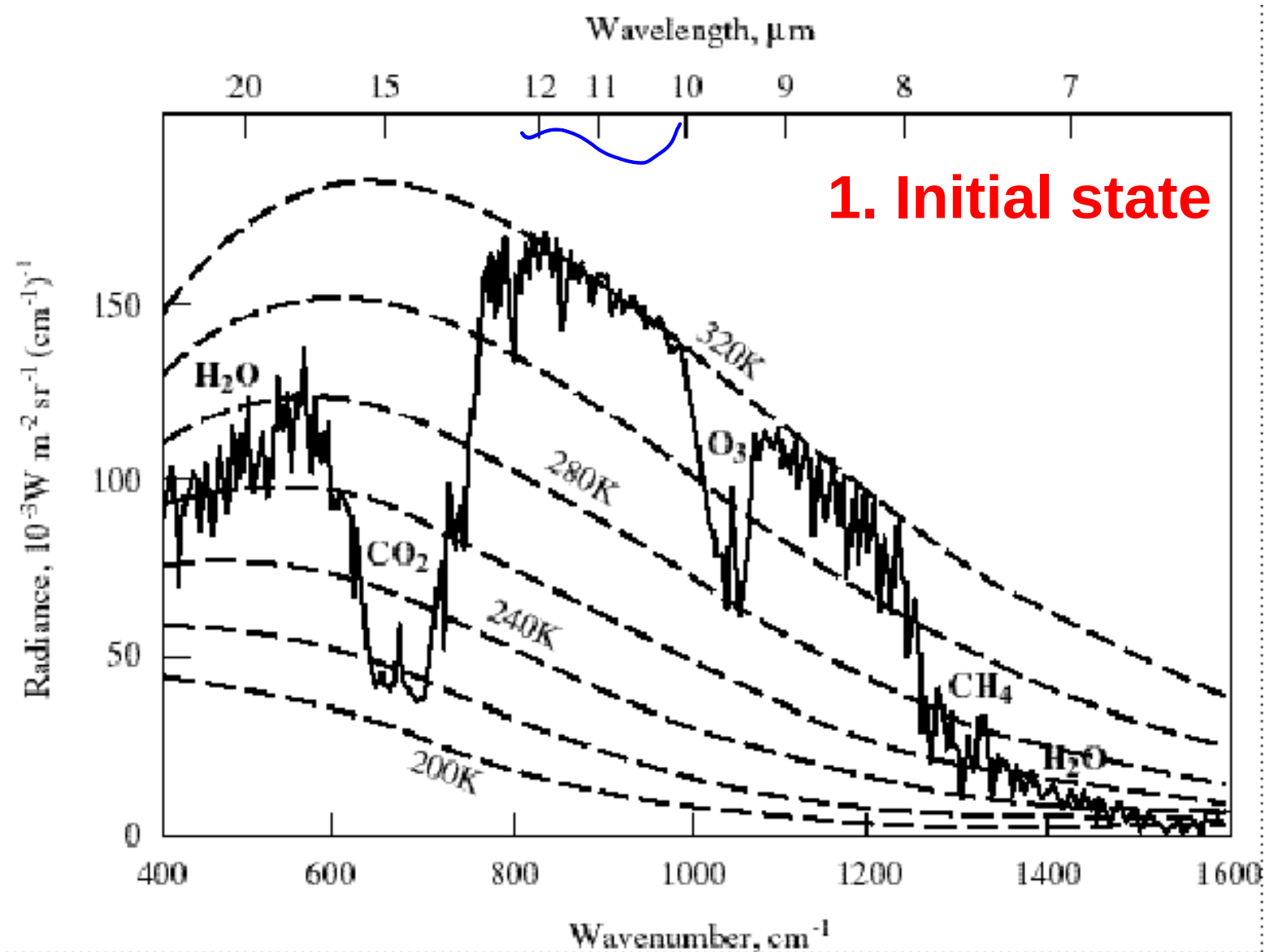
A gas that absorbs weakly in the IR to avoid band saturation

Next 

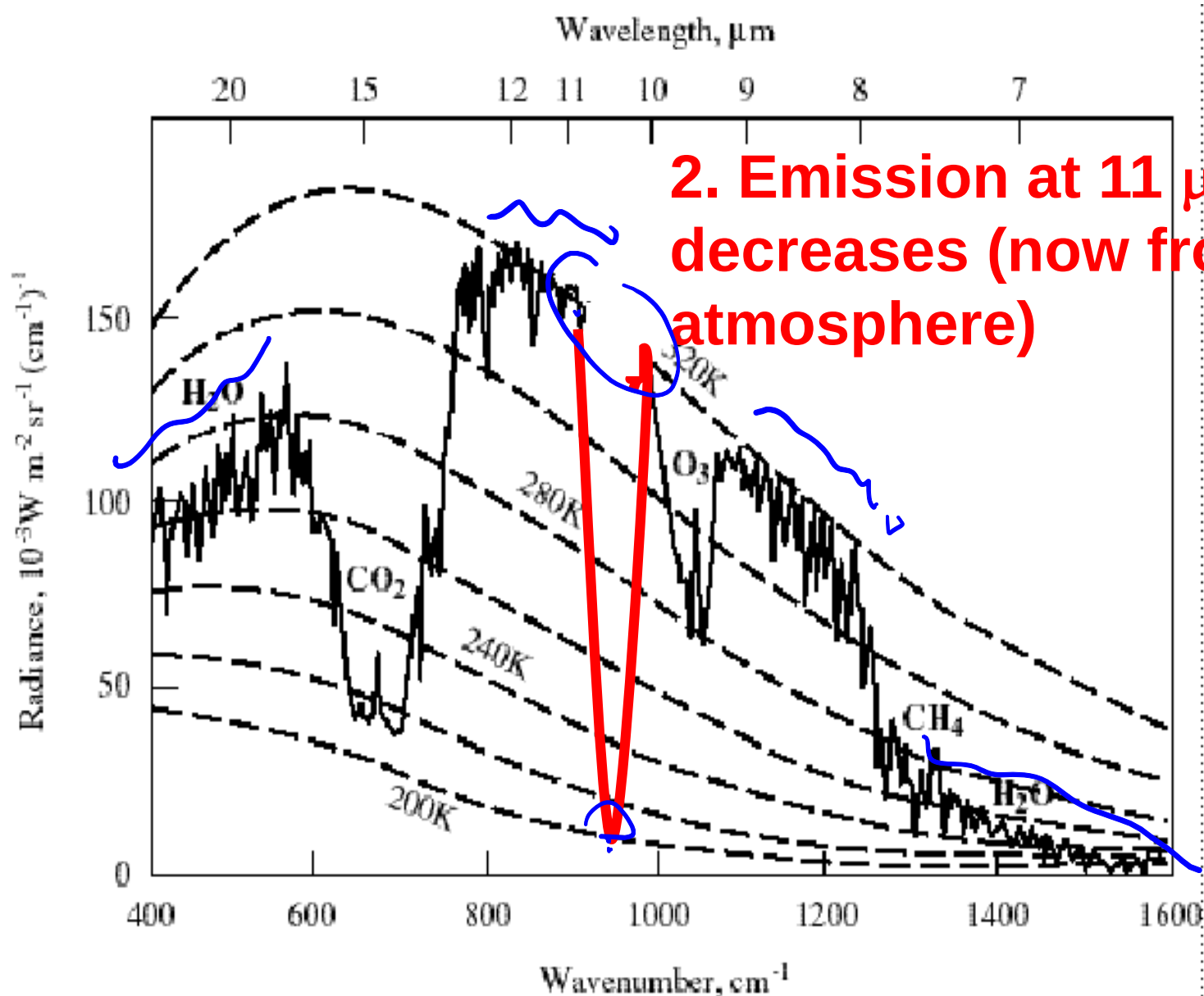
Previous 

Total Results: 0

Addition of a GHG Absorbing at 11 μm



Addition of a GHG Absorbing at 11 μm

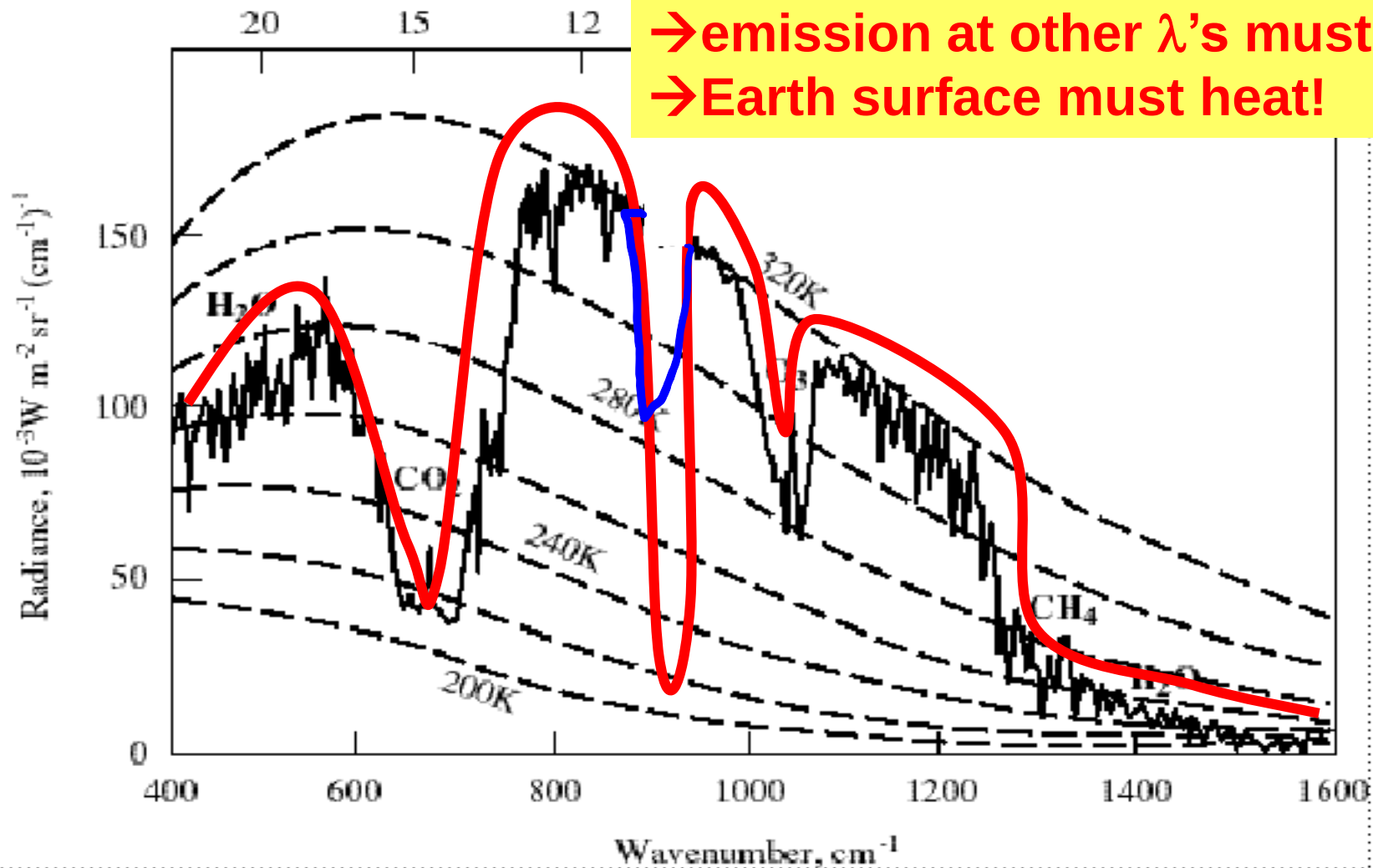


2. Emission at 11 μm decreases (now from a cold atmosphere)

Addition of a GHG Absorbing at 11 μm

3. New equilibrium:

- total emission must be same
- emission at other λ 's must increase
- Earth surface must heat!



An Analogy Perhaps?

[squeeze toy video](#)