REMINDER
Water topic film ➔

Arizona Daily Star
www.azstarnet.com

WATERSHED Film Screening and Panel Discussion
Sep 19, 2012, 7:00pm - 9:00pm
Loft Cinema

Narrated by Robert Redford, who also was executive producer, and directed by award-winning filmmaker Mark Decena, WATERSHED tells the story of the threats to the once mighty Colorado River and offers solutions for the future of the American West.

A panel discussion will immediately follow the free movie screening to illuminate what is being done in our community to conserve water and create this new water ethic.

Today's AZ Daily Star has 2 interesting articles: one on our solar future & the other on an issue re: our state-mandated energy-efficiency plan

Southwest's solar future hinges on distribution

Recommend 0 Tweet 0 +1 0 Share Print Email

TEP wants ACC vote on energy-saving plan

COMMISSION CHIEF, IN REBUKE, BLAMES UTILITY FOR DELAY

Find out all about solar in Arizona here:

arizonagoessolar.org

Did you know AZ has a "Renewable-Energy Standard" set by an elected body?

The Arizona Corporation Commission

www.cc.state.az.us

"15% by 2025"

Ruling in 2011, but back-and-forth is still going on today . . . .

Ruling gives regulators more authority than simply setting rates

Court backs Arizona renewable-energy standard

Howard Fischer Capitol Media Services | Posted: Wednesday, September 21, 2011 12:00 am

PHOENIX - State utility regulators are free to require utilities to buy or generate power from solar, wind and other sources, even if that costs their ratepayers more, the Arizona Supreme Court ruled Tuesday.

In a brief order, the justices upheld a decision by the state Court of Appeals tossing out a challenge by the Goldwater Institute to the "renewable-energy standard" adopted by the Arizona Corporation Commission. That order gave no explanation.

But in leaving the lower court decision untouched, the justices essentially accepted the commission's argument that its powers are broader than simply setting the rates that companies can charge.

The commission has defended the requirement to use more solar, wind and other renewable sources, saying it ensures that utilities have adequate supplies from various sources. And commission Chairman Gary Pierce said that is certainly within the purview of the panel.

Pierce said, though, that foes are free to ask the Legislature to trim the commission's powers.

Goldwater attorney Clint Bolick said, that with the high court ruling, that remains the only legal option. But he was not optimistic lawmakers are willing to go along.

Central to the fight is the requirement for state-regulated utilities to get 15 percent of the power they sell from renewable sources by 2025.

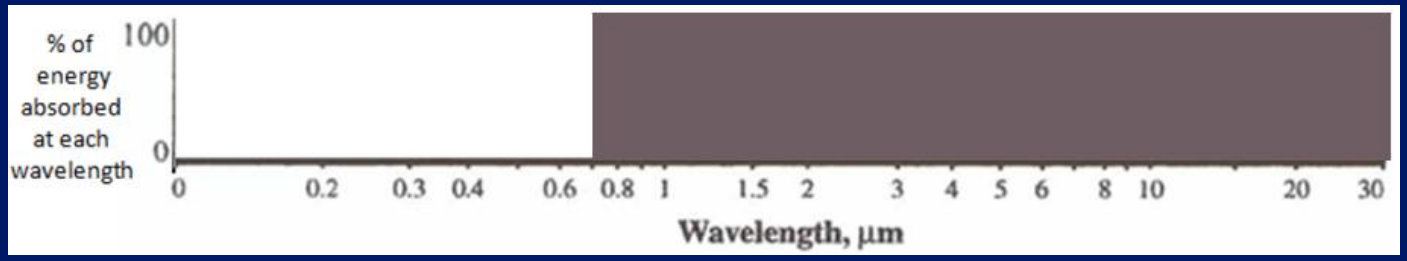
http://azstarnet.com/business/local/article_119eb0f7-df28-5c30-9277-fe12502ccb50.html

Fire up your CLICKERS for some questions to solidify the concepts from the last few classes:

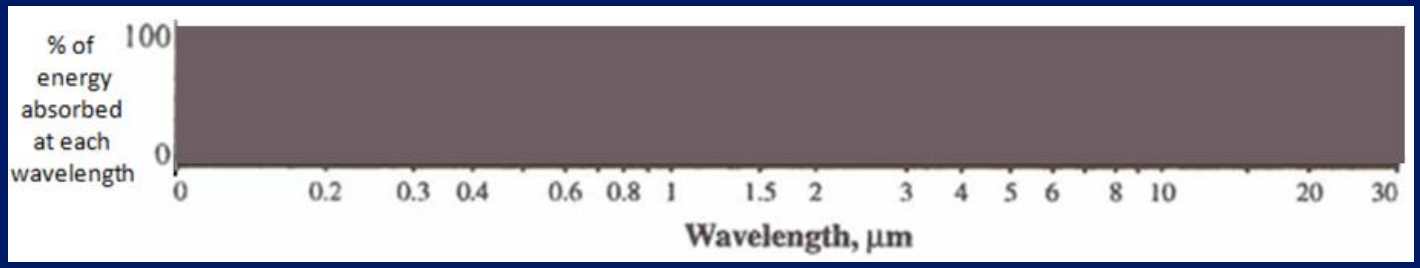
CHANNEL 32

Q-A Which of the following absorption curves represents a hypothetical atmosphere that has a "perfect" greenhouse effect ?

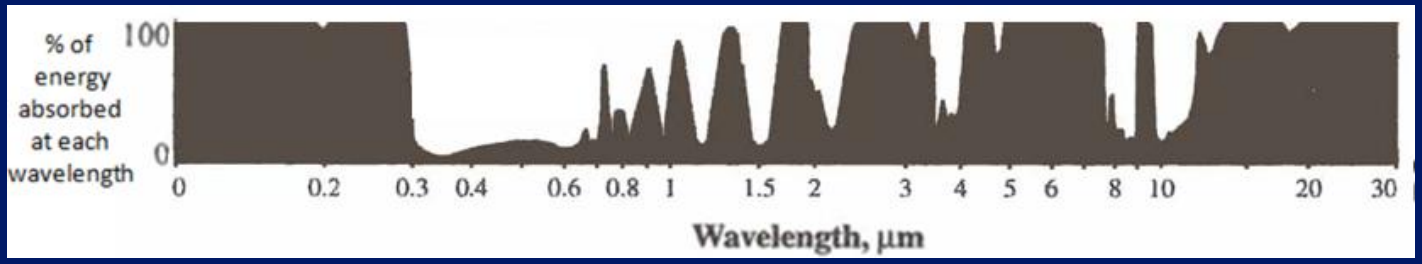
1.



2.



3.



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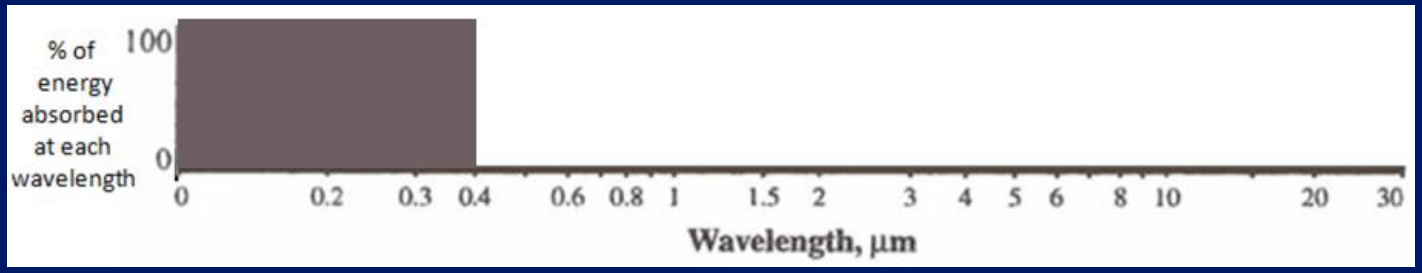

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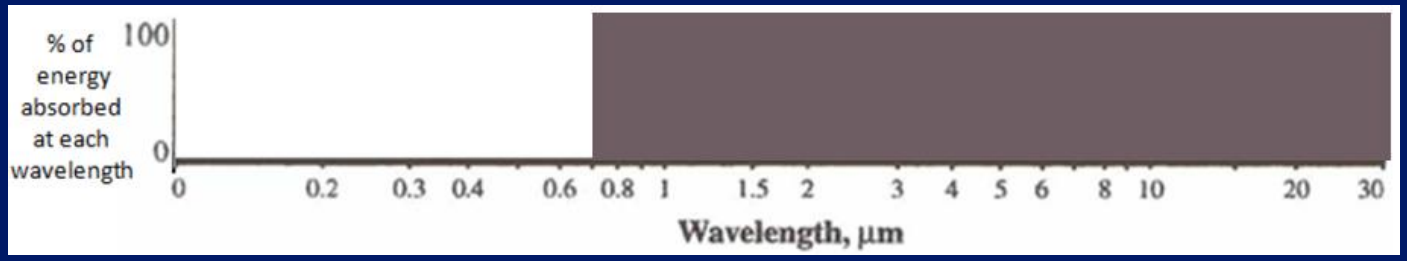

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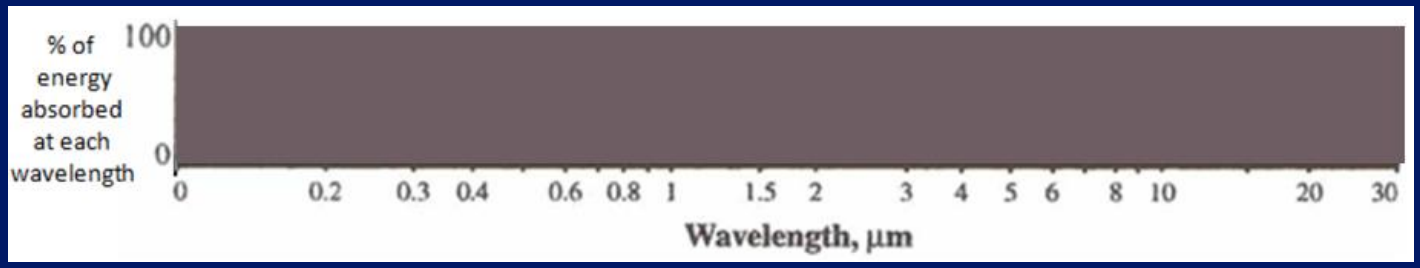

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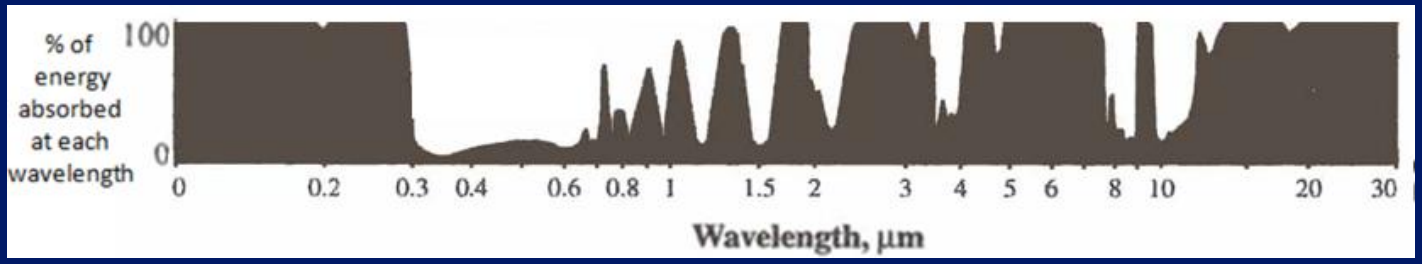
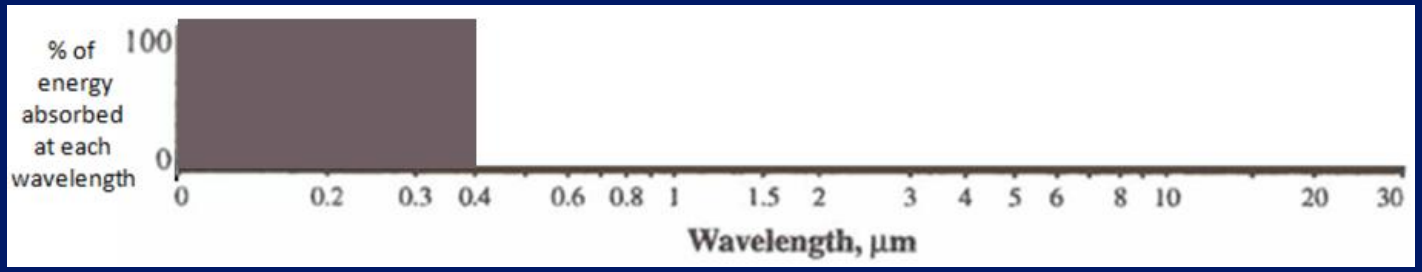
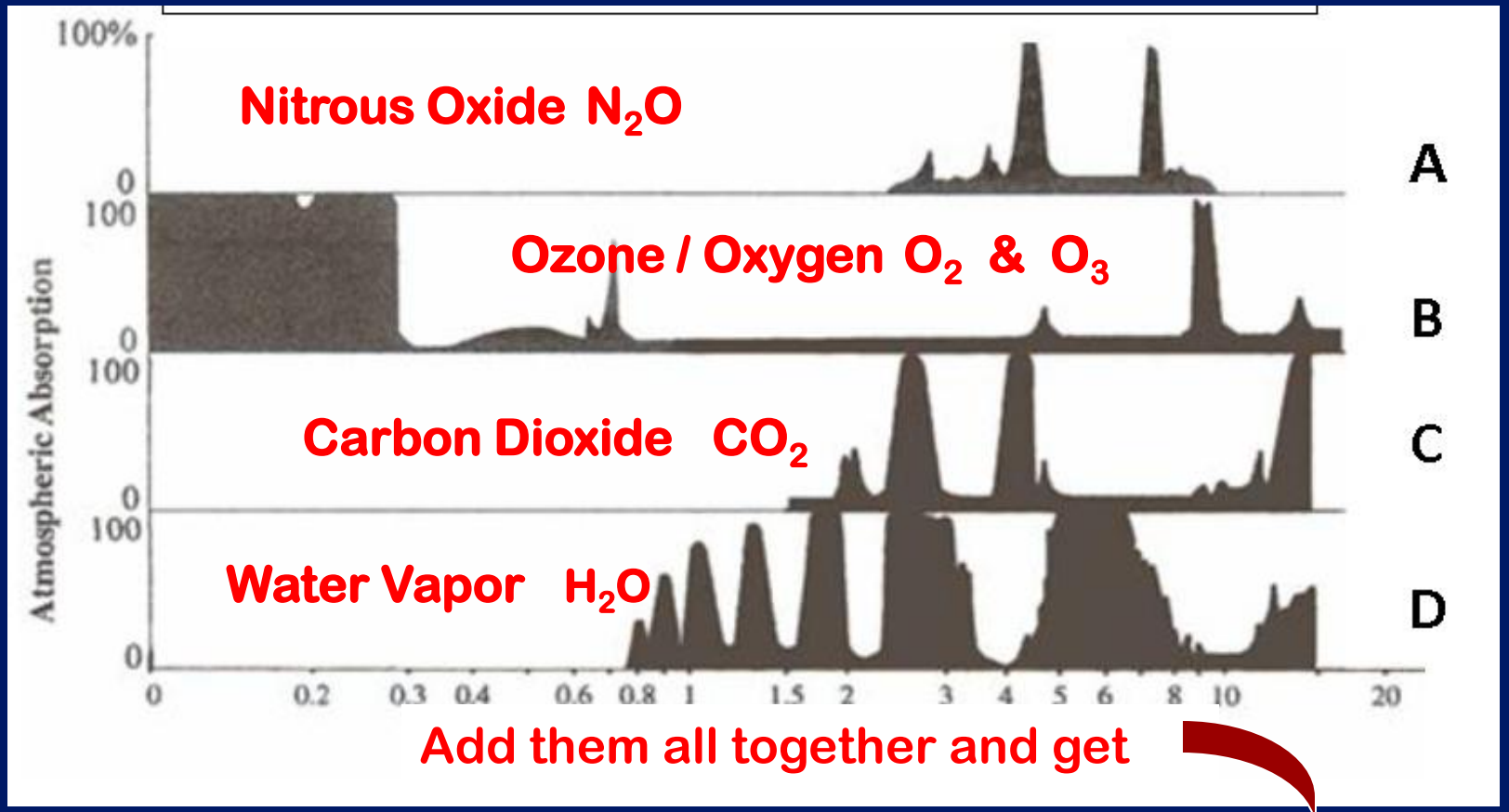


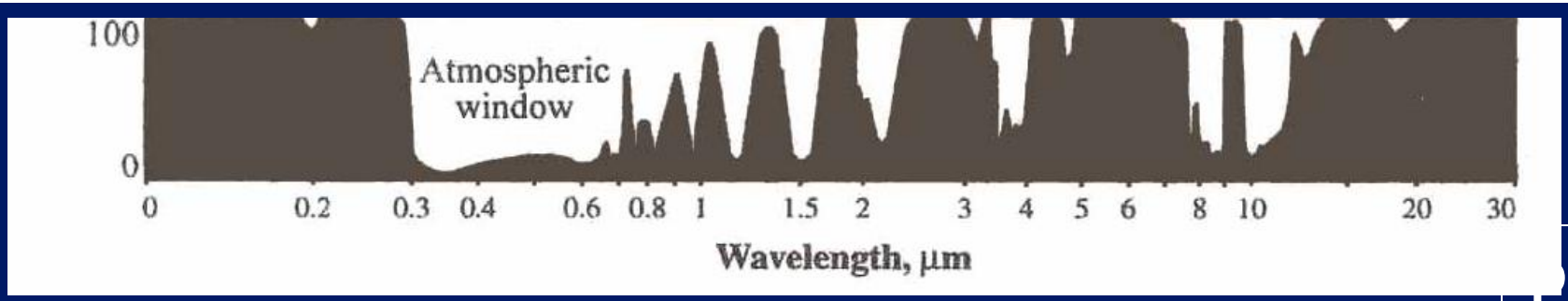
4.





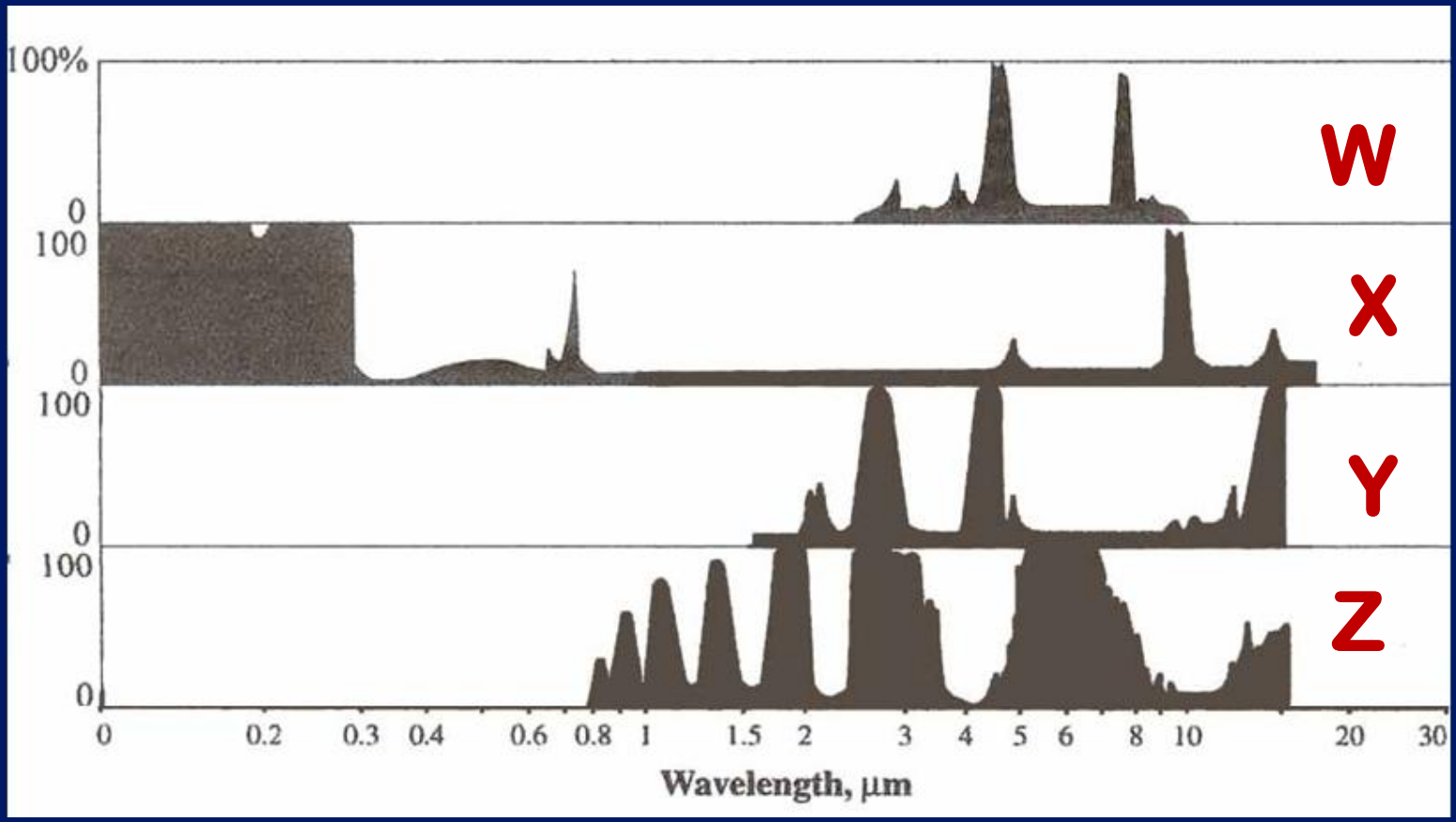
Add them all together and get

One graph showing absorption by ALL the atmospheric gases !



Q-B – Which of the following absorption curves is for a GAS that is NOT a greenhouse gas!

1: W **2**: X **3**: Y **4**: Z **5**: NONE of THEM



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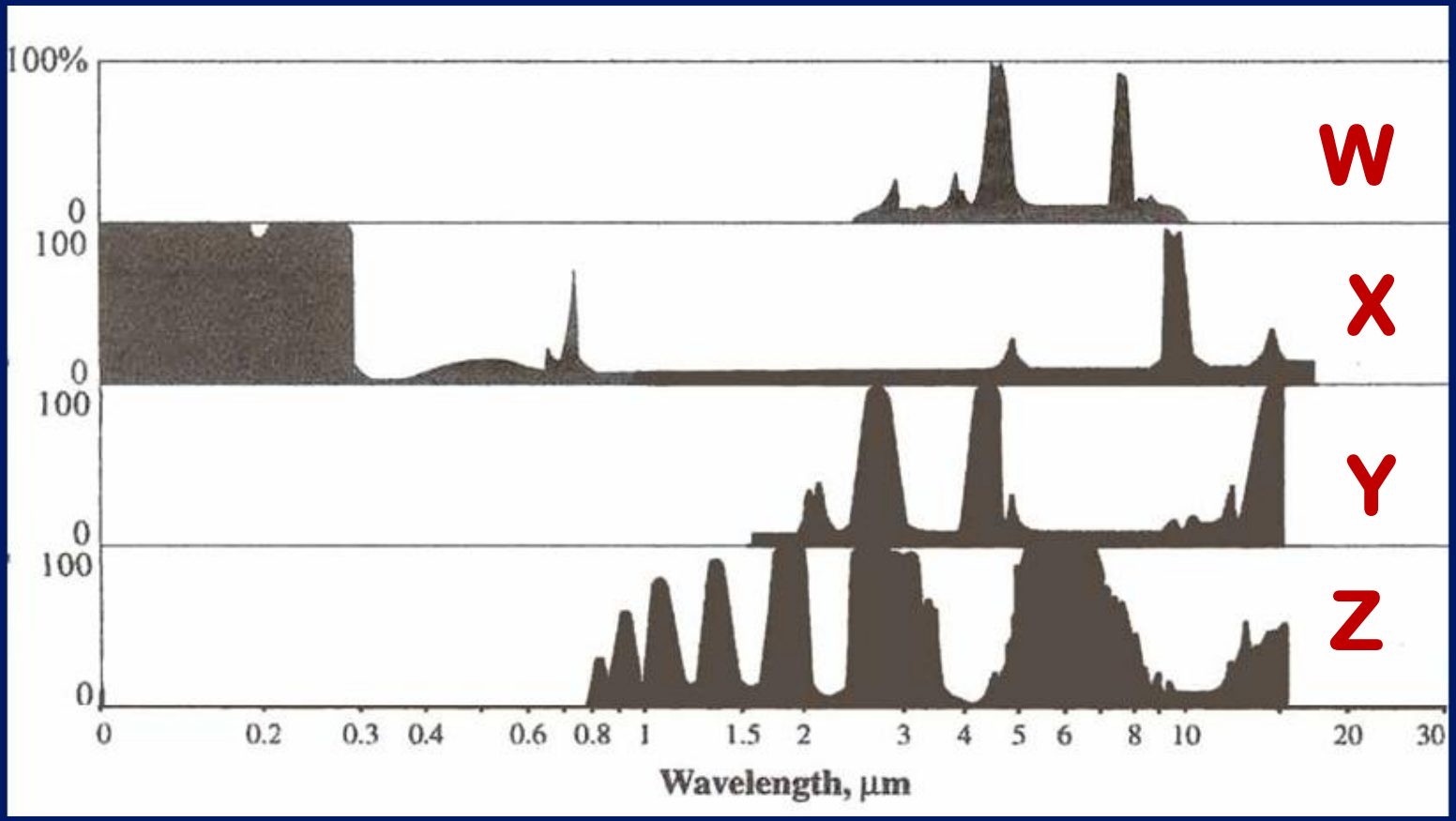
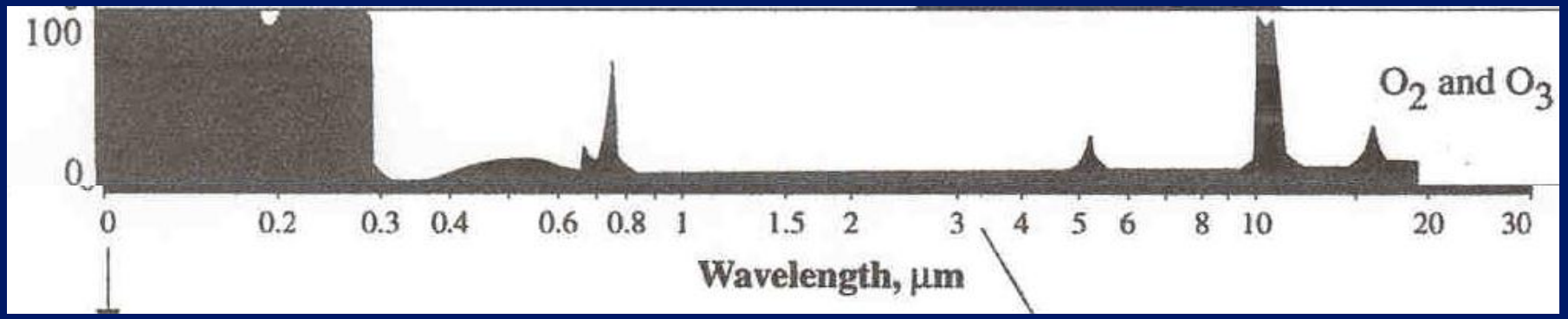


Q3. HOW IS OZONE unique???



1) It absorbs only UV – hence it's NOT a GHG

2) It absorbs almost ALL visible wavelengths

3) It absorbs BOTH UV and IR so IS a GHG

4) It absorbs BOTH UV and IR so is NOT GHG

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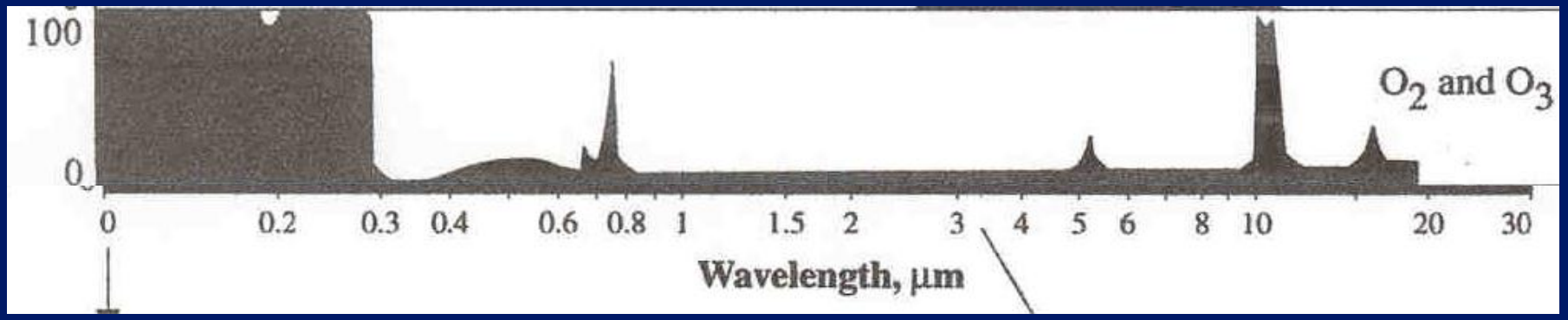

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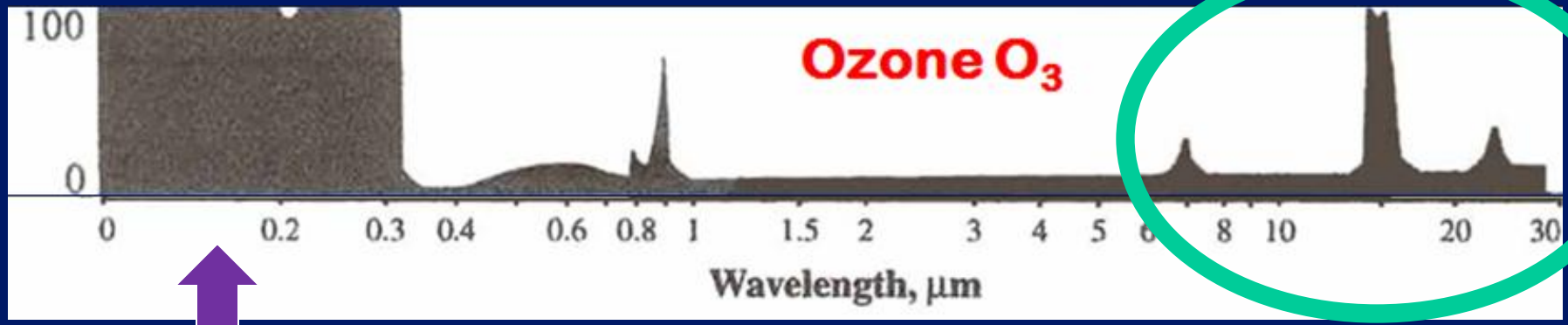
3) It absorbs BOTH UV and IR so IS a GHG

4) It absorbs BOTH UV and IR so is NOT GHG

But only the IR absorption makes it a GHG!!

Absorption in this part of the absorption curve (IR wavelengths) indicates that OZONE is a greenhouse gas . . . .



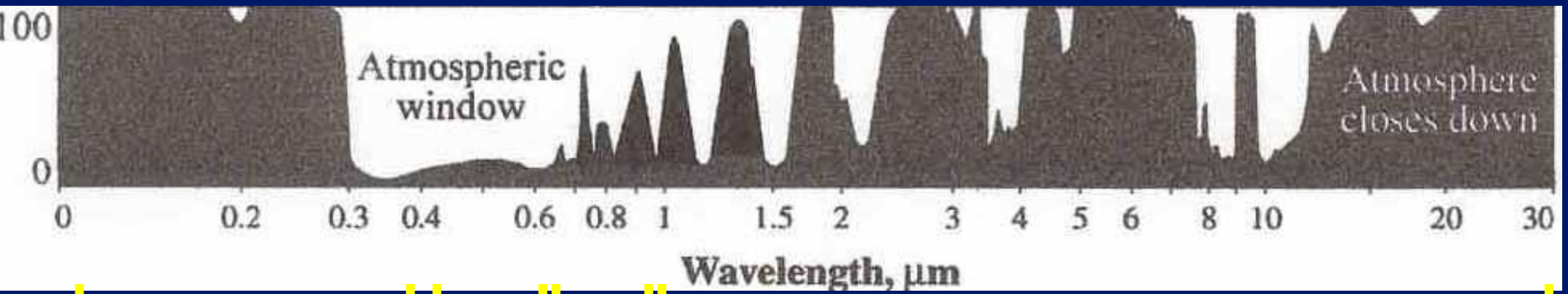
. . . even though OZONE also absorbs radiation in the UV part of the spectrum!

Absorption by ALL the gases in the atmosphere put together –

i.e. curve for the "Whole Atmosphere"

Window #1 with very little absorption!

Window #2 with very little absorption!



UV

Visible

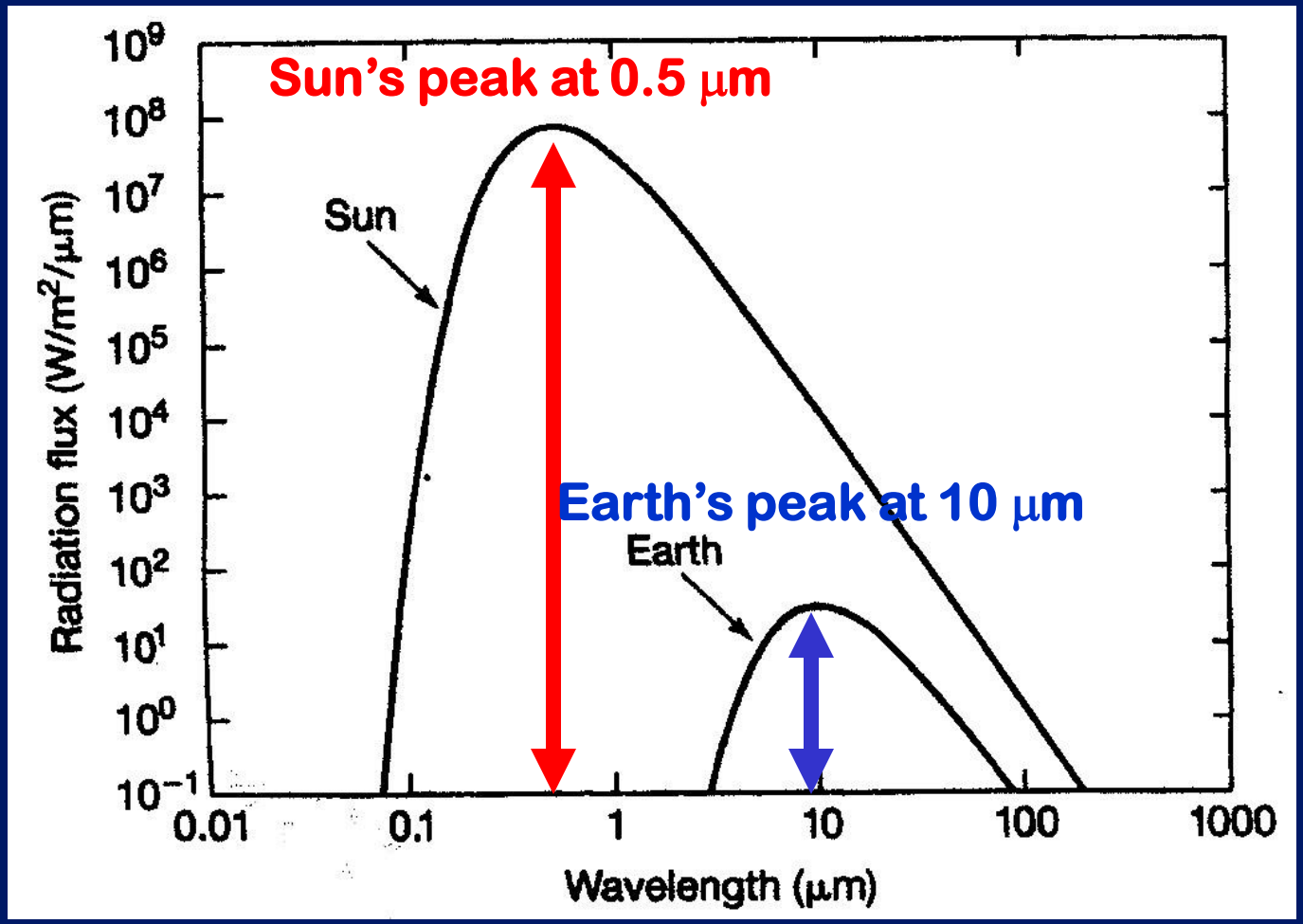
NIR

Far IR

Bottom row p 34

Incoming
SW SOLAR (UV + Vis) window

Outgoing
LW TERRESTRIAL (IR) window

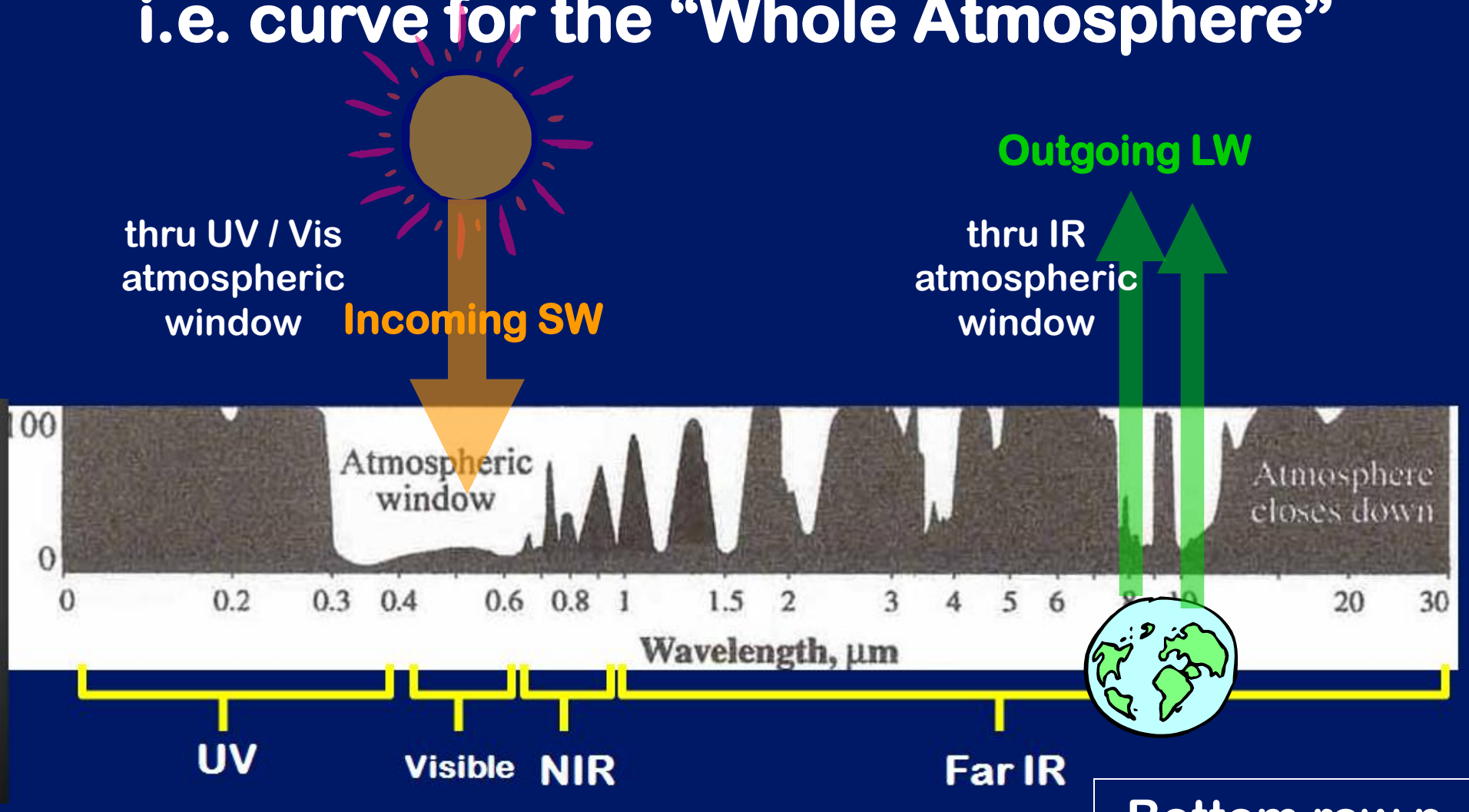


REMEMBER THIS???

Review p 30

Absorption by ALL the gases in the atmosphere put together –

i.e. curve for the "Whole Atmosphere"



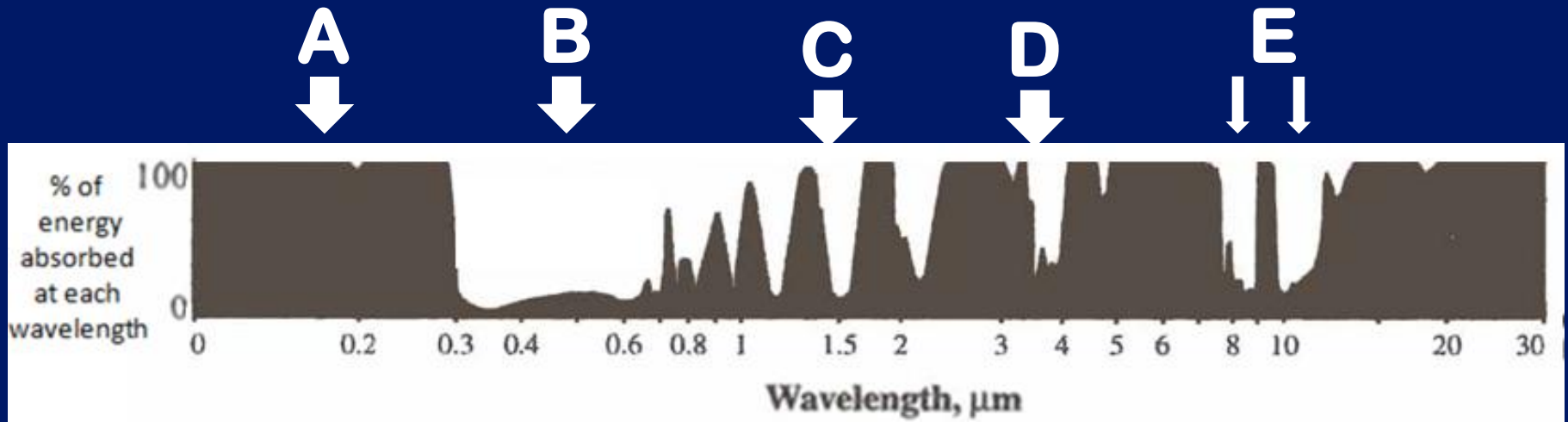
Bottom row p

Q-C - Here's the absorption curve for ALL the gases in the atmosphere put together, i.e. curve for the **"Whole Atmosphere"**

We just talked about two **"windows"** in the curve that indicate at what wavelengths radiation easily comes **IN** to the surface of the Earth or escapes **OUT** to Space.

Where are these two windows?

1: A + B **2: B + E** **3: C & D** **4: D + E**



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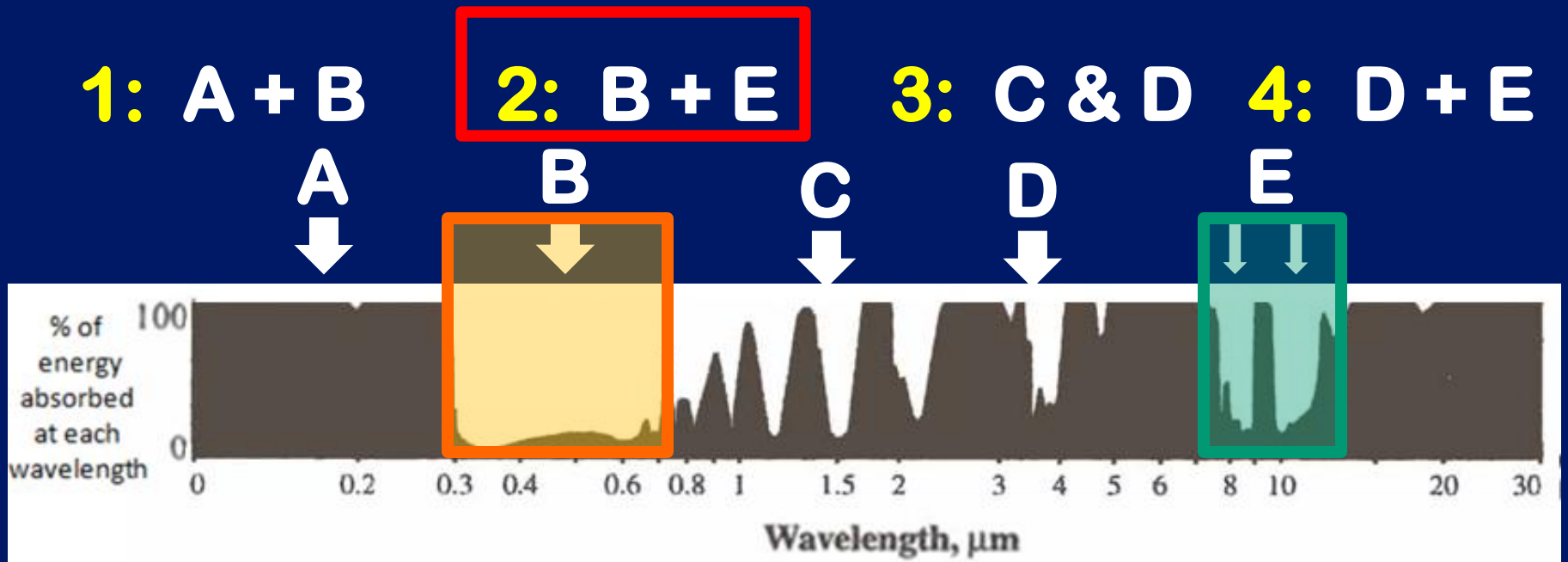
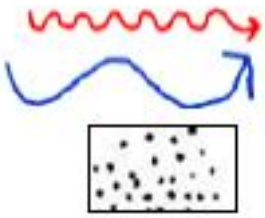


SOLAR vs TERRESTRIAL RADIATION CLASS CONCEPTS SELF TEST

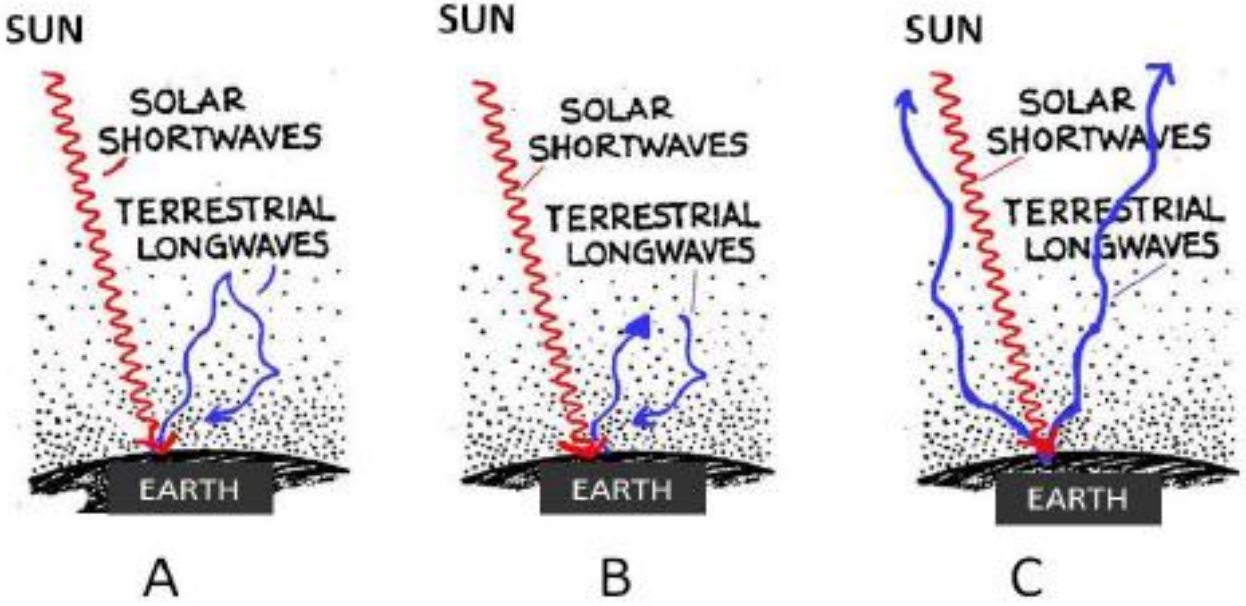
KEY:



= represents Solar shortwave (SW) radiation

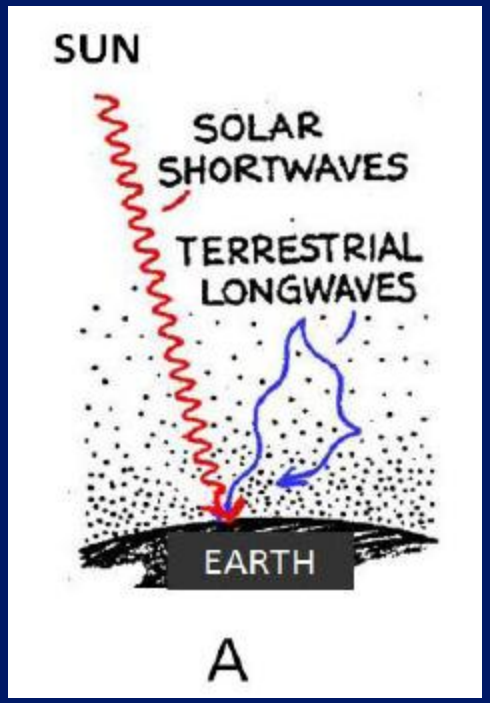
= represents Terrestrial longwave (LW) (infrared IR radiation)

= represents the atmosphere and its gases (which can absorb and emit certain kinds of radiation)



Q1. Which diagram above shows SW (solar radiation being reflected back to space?

A **B** **C** **None of them**



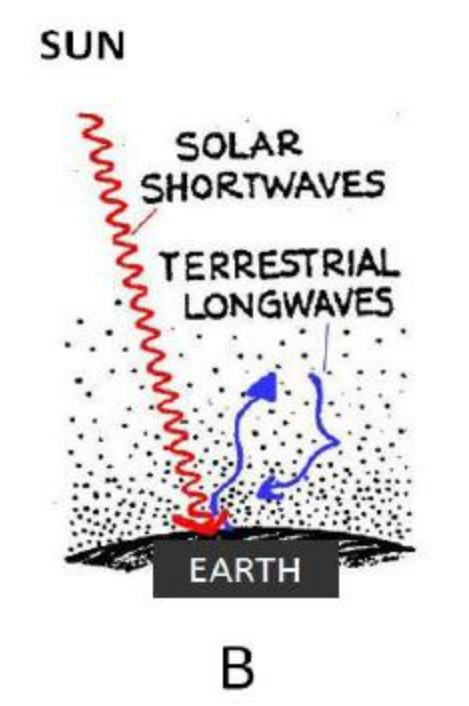
A

Q2. Diagram A shows LW (IR) terrestrial radiation "bouncing off" the gases in the atmosphere and being sent back to Earth's surface.

(i.e. being reflected back to the surface by the gases without being absorbed by them.)

Is this an accurate depiction of how the Greenhouse Effect works?

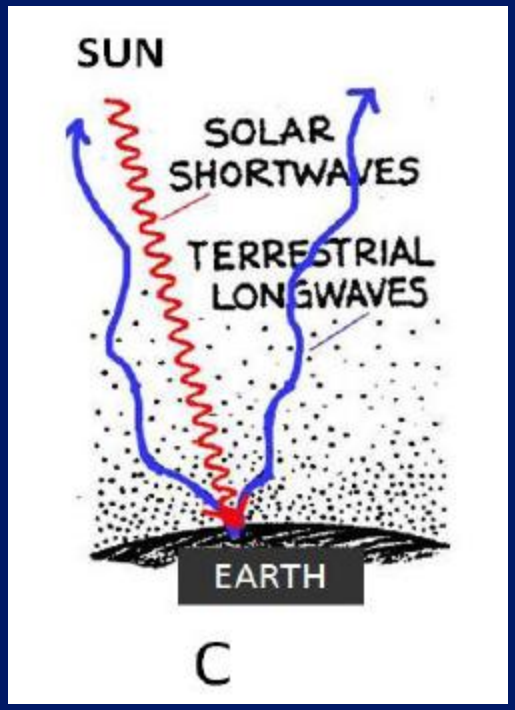
Yes **No** Partly



Q3. Diagram B shows LW (IR) terrestrial radiation being absorbed and then emitted back down by the gases in the atmosphere.

Is this an accurate depiction of how the Greenhouse Effect works?

Yes No Partly

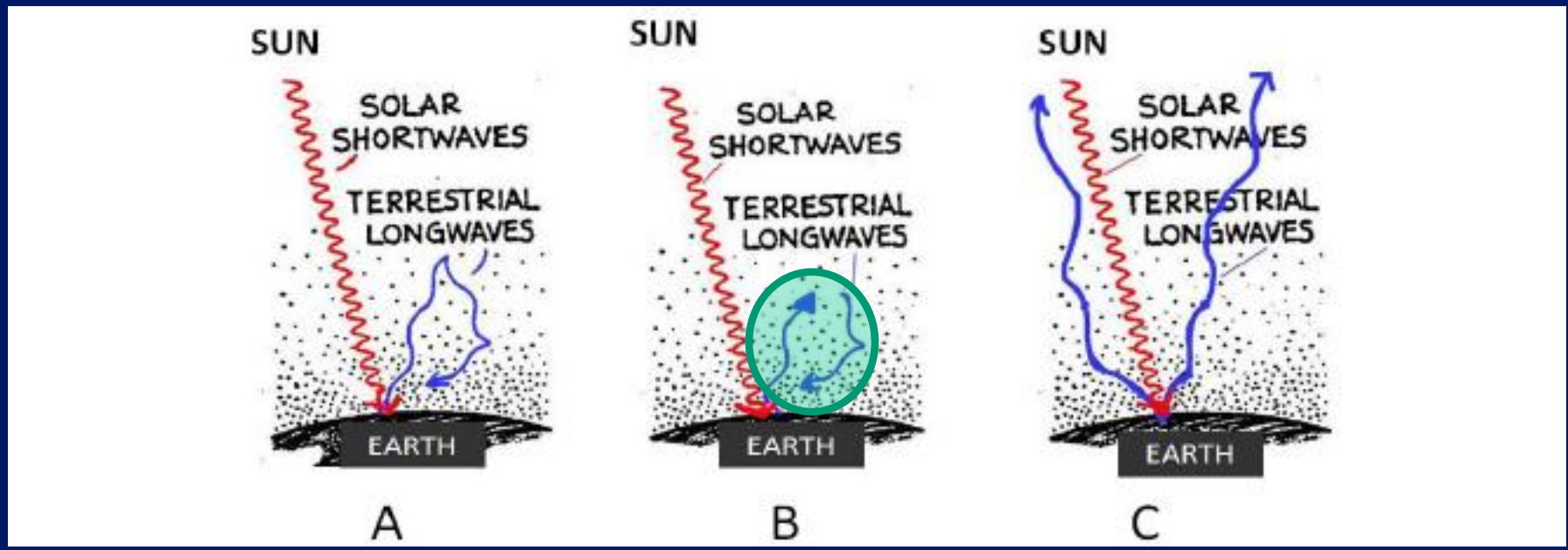


Q4. Diagram C shows LW (IR) terrestrial radiation going right through the atmosphere out to space.

Is this an accurate depiction of how the Greenhouse Effect works?

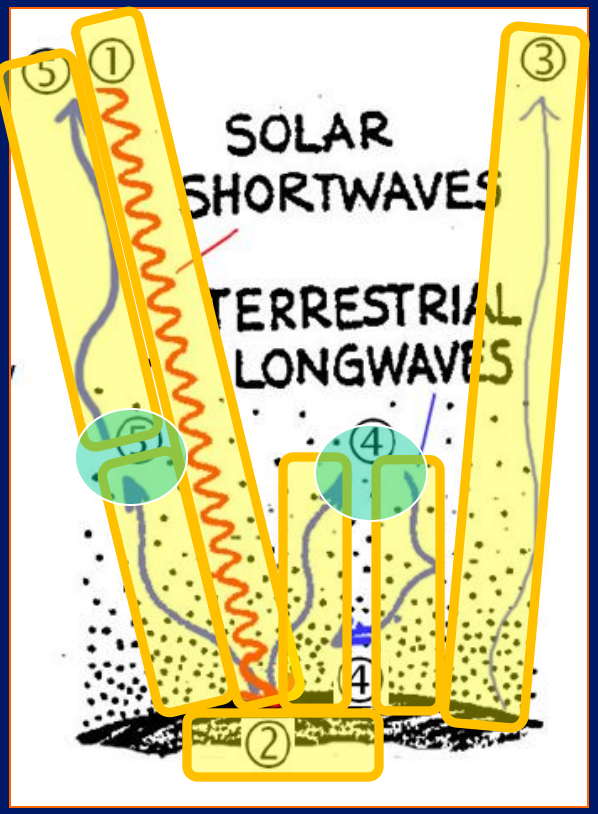
Yes **No** Partly

Q5. On the diagram that you think best depicts the processes involved in the GREENHOUSE EFFECT, CIRCLE the specific part of the diagram that represents the Greenhouse Effect:



① Some Incoming SW radiation from the SUN goes right <u>through</u> the atmosphere to Earth (w/o being absorbed)

③ Some IR radiation is emitted from the Earth's surface right <u>out</u> to space through "IR window"



⑤ Some IR radiation is absorbed by GH gases in the atmosphere, but is emitted <u>out</u> to space (not back to Earth)

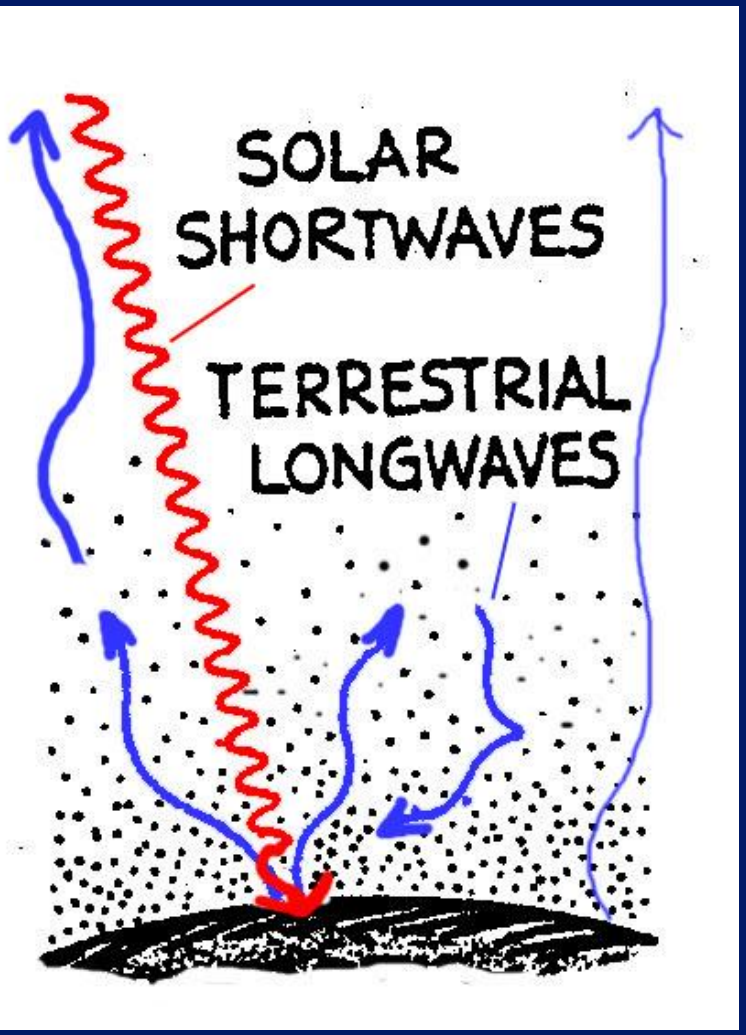
Absorption & re-emission by GH gases

④ Some IR radiation is absorbed by GH gases in the atmosphere and emitted <u>back</u> to Earth

Absorption & re-emission by GH gases

② The Earth absorbs SW that reaches the surface

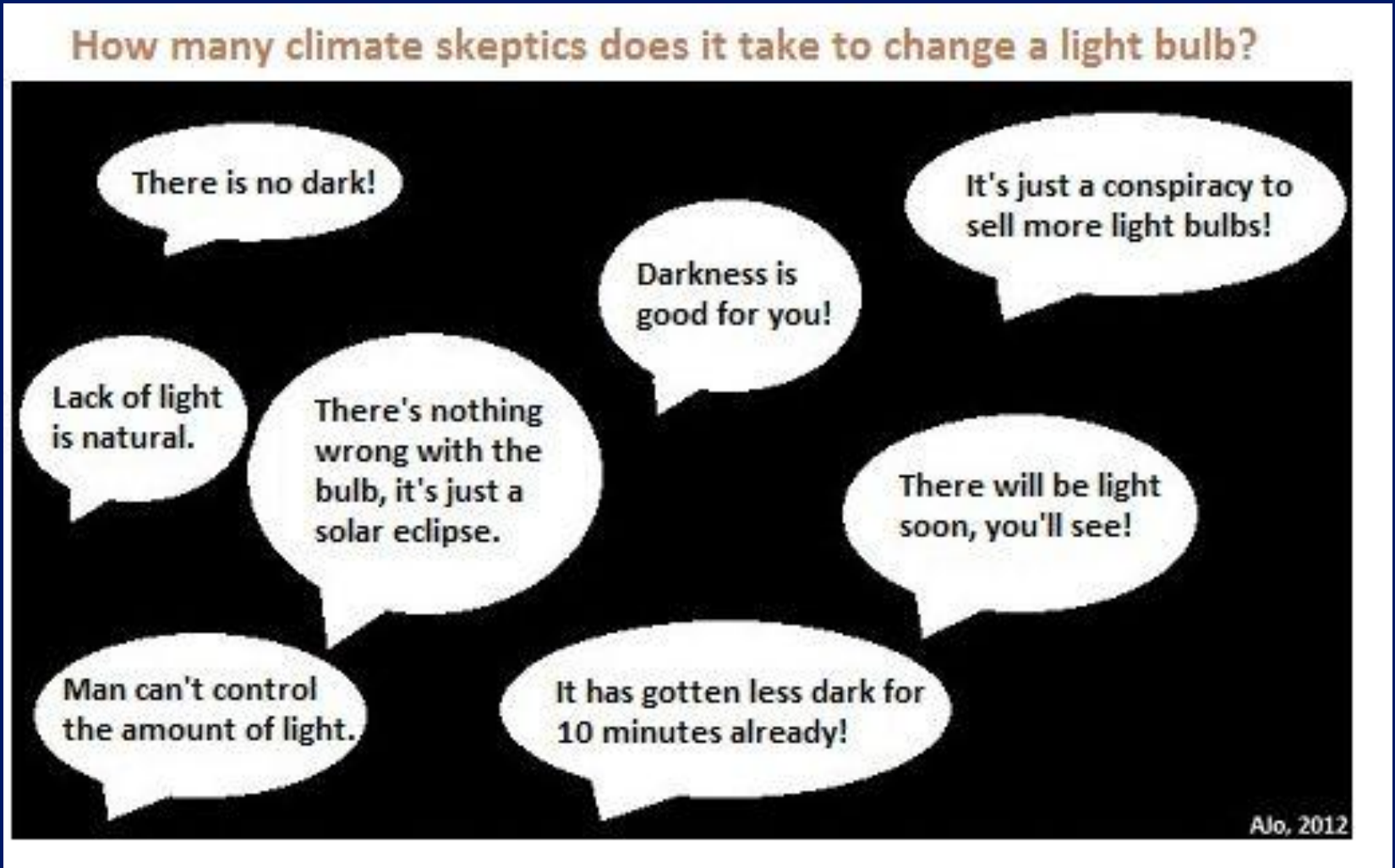
WHAT PROCESSES ARE MISSING?



- ABSORBED (and EMITTED)
- TRANSMITTED
- SCATTERED, or
- REFLECTED . . . .

- by dust and other particles
- by clouds
- by the gas molecules themselves!

More on scattering and reflection later . . .

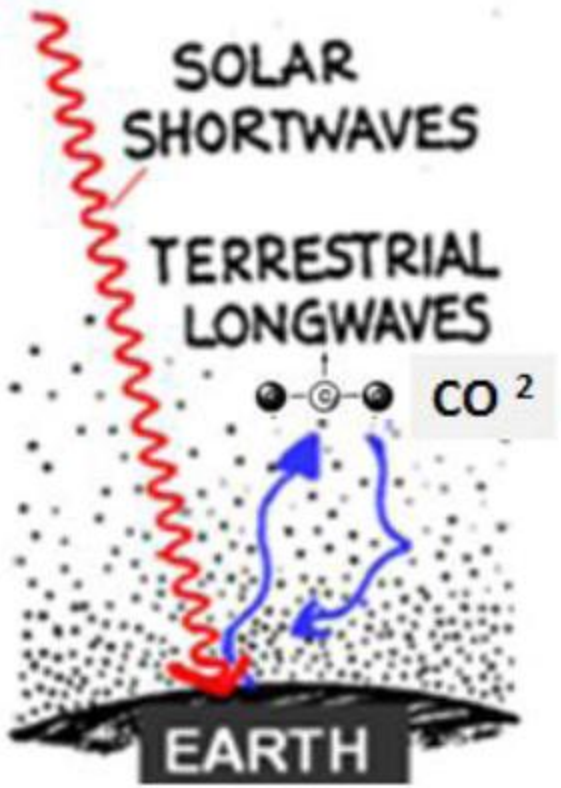


“Flipping the switch doesn’t necessarily turn on the light!”

INDICATOR INTERLUDE . . .

Denier Argument #29:

"Increasing CO2 has little to no effect"



How would you respond?

Skeptical Science
Getting skeptical about global warming skepticism

www.skepticalscience.com

How do we know more CO_2 is causing warming?

The skeptic argument...

"Increasing CO2 has little to no effect on enhancing the GREENHOUSE EFFECT because the amount is so small compared to the amount of other gases in the atmosphere.

Therefore the increase in human-produced CO2 (as seen in the Keeling Curve) is NOT the cause of recent global warming!!

http://www.skepticalscience.com/empirical-evidence-for-co2-enhanced-greenhouse-effect.htm

How would you respond?

"Thinking more deeply" symbol →

A **KEY POINT** to respond with
is embedded in the box on
**"IMPLICATIONS OF LAW #6
FOR GLOBAL CLIMATE CHANGE"**
on p 33

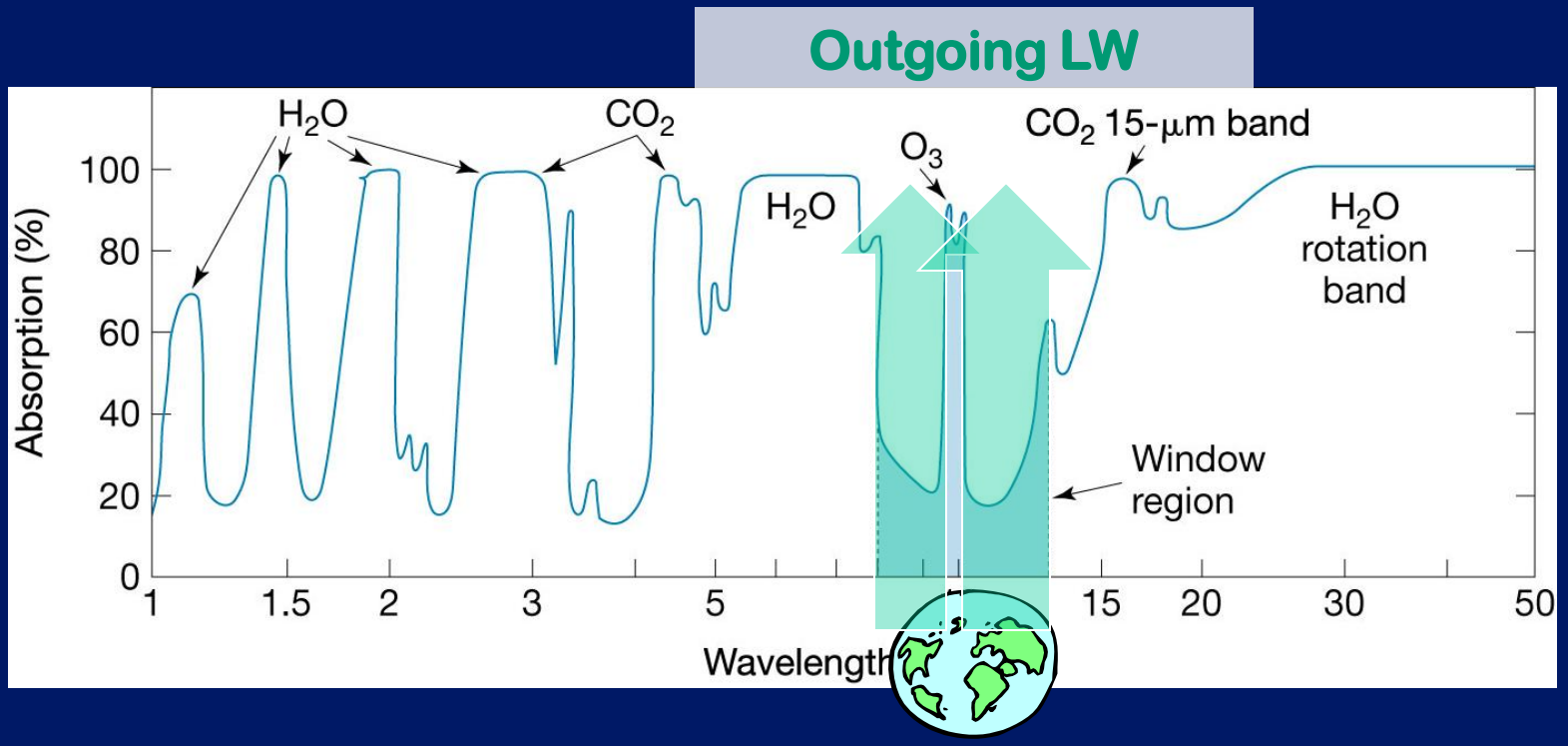
Read the box . . .
then think a bit . . .
Which items (a - f) have relevant info
for responding to this skeptic's
argument?

c) GREENHOUSE GASES both absorb and emit electromagnetic radiation in the infrared (IR) part of the spectrum – **once IR is absorbed by the greenhouse gases in the atmosphere, it can be emitted back to the Earth's surface to heat it all over again!!**

This is called the **GREENHOUSE EFFECT!**

f) Since 15 μm is close to the peak of Earth's outgoing radiation, (10 μm), this absorption band keeps a lot of Earth's longwave radiation from escaping to space.

➔ A gas has the most effect if it absorbs in a "window" of wavelengths where the atmosphere is fairly transparent (and the IR would otherwise escape to space!)



H_2O, O_3, and CO_2
are all very close to the outgoing IR window
Therefore they are effective in absorbing
outgoing IR wavelengths of energy!

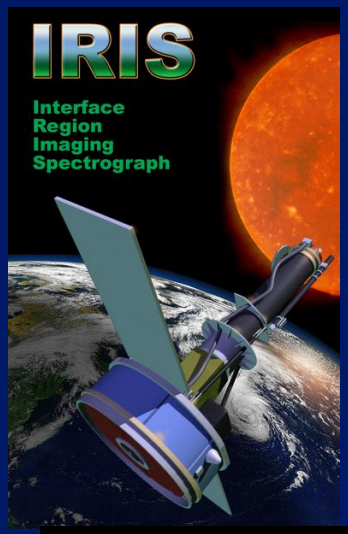
But . . . is there enough volume of these "trace gases" to REALLY make a difference in the Greenhouse Effect and therefore increase the temperature?

GIVE ME MORE EVIDENCE!

IS this GH Effect measurable??

RESPONSE TO SKEPTIC:

Less IR going to space



Interface Region Imaging Spectrograph

1970s TODAY

More IR radiating downward

FOURIER TRANSFORM INFRARED SPECTROSCOPY (FTIR) ANALYSIS

- An enhanced greenhouse effect from CO2 has been confirmed by multiple lines of empirical evidence:

- Satellite measurements of infrared spectra over the past 40 years observe less energy escaping to space at the wavelengths associated with CO2.

- Surface measurements find more downward infrared radiation warming the planet's surface.

- This provides a direct, empirical causal link between CO2 and global warming.

Topic # 7
ATMOSPHERIC STRUCTURE
&
CHEMICAL COMPOSITION

All about the GASES IN THE ATMOSPHERE, esp. GREENHOUSE GASES!

Class Notes pp 37- 41

OBJECTIVES:

To understand:

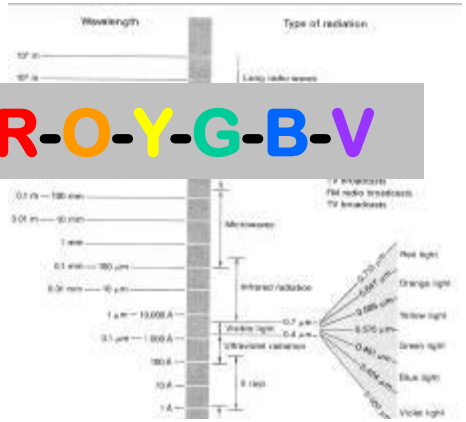
-- the VERTICALSTRUCTURE of the atmosphere & its relationship to temperature

-- which GASES are in the atmosphere

-- where they are concentrated, and

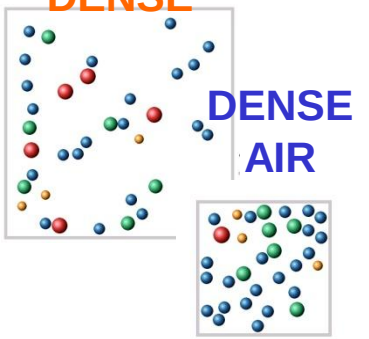
-- why gases at different levels are linked to the Greenhouse Effect & Ozone Depletion

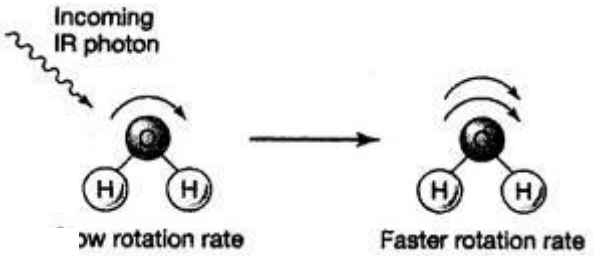
Things you've seen before that will all come together under this topic:

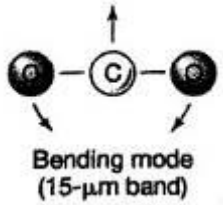


R-O-Y-G-B-V

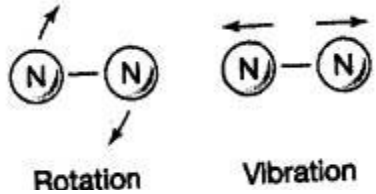
$$E = \sigma T^4$$

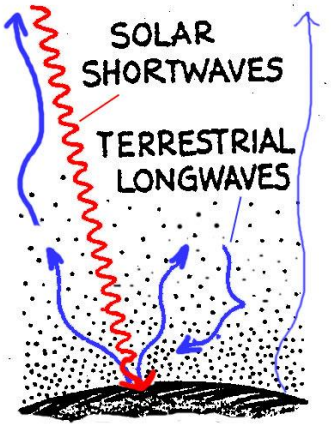


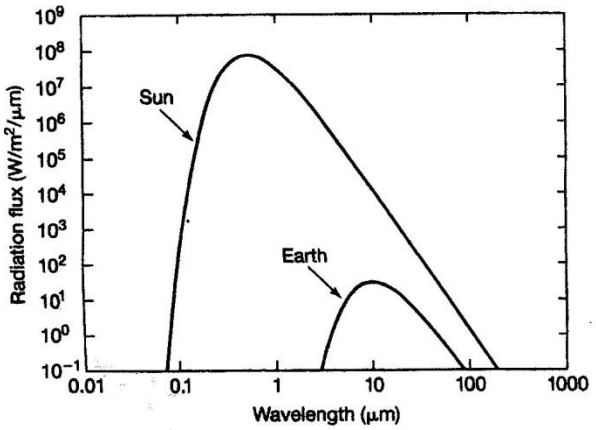


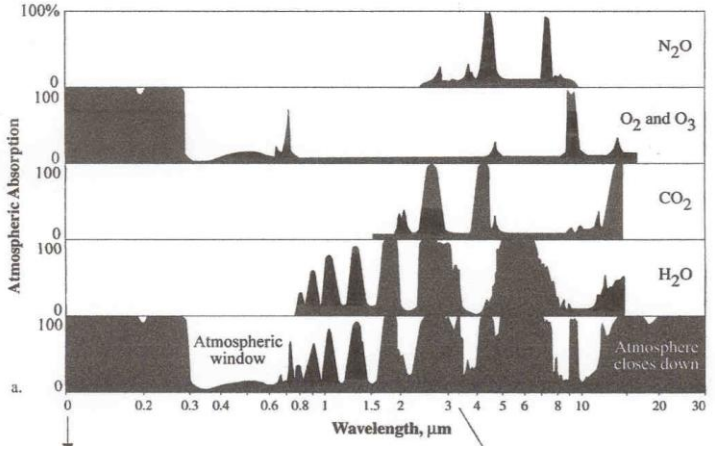


$$E = h c / \lambda$$









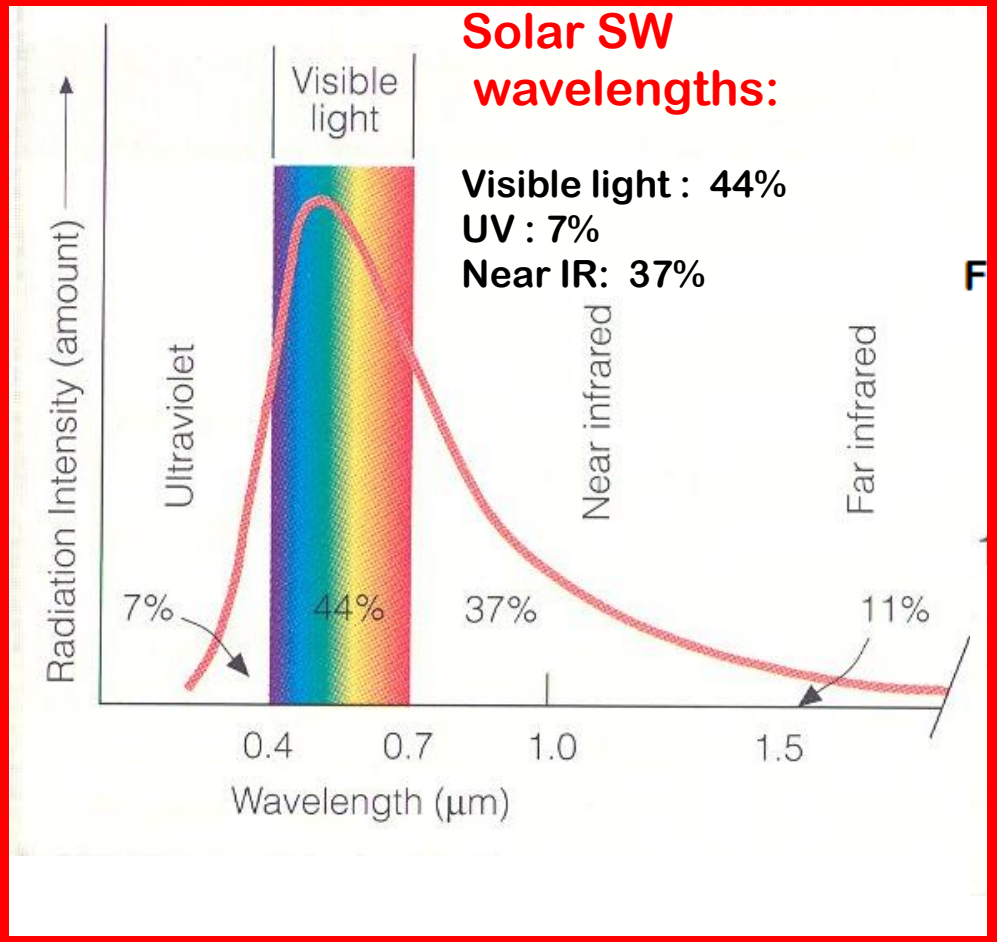
$$\lambda_m = a / T$$

We travel together, passengers in a little space-ship, dependent on its vulnerable supplies of air and soil.

~ Adlai Stevenson

Recall . . . .

Shortwave SOLAR radiation (SW) = UV + VIS + Near IR

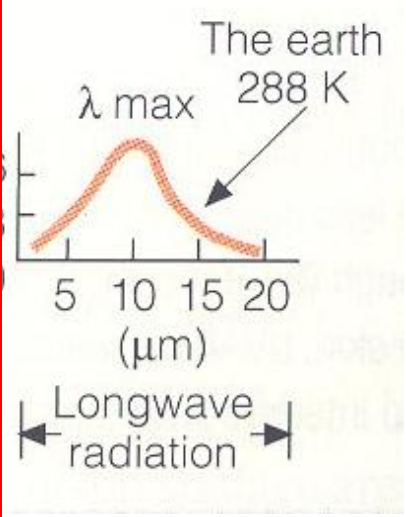


Solar SW wavelengths:

Visible light : 44%
UV : 7%
Near IR: 37%

Terrestrial (Earth) radiation wavelengths:

F r IR, with a maximum at ~ 10 μm

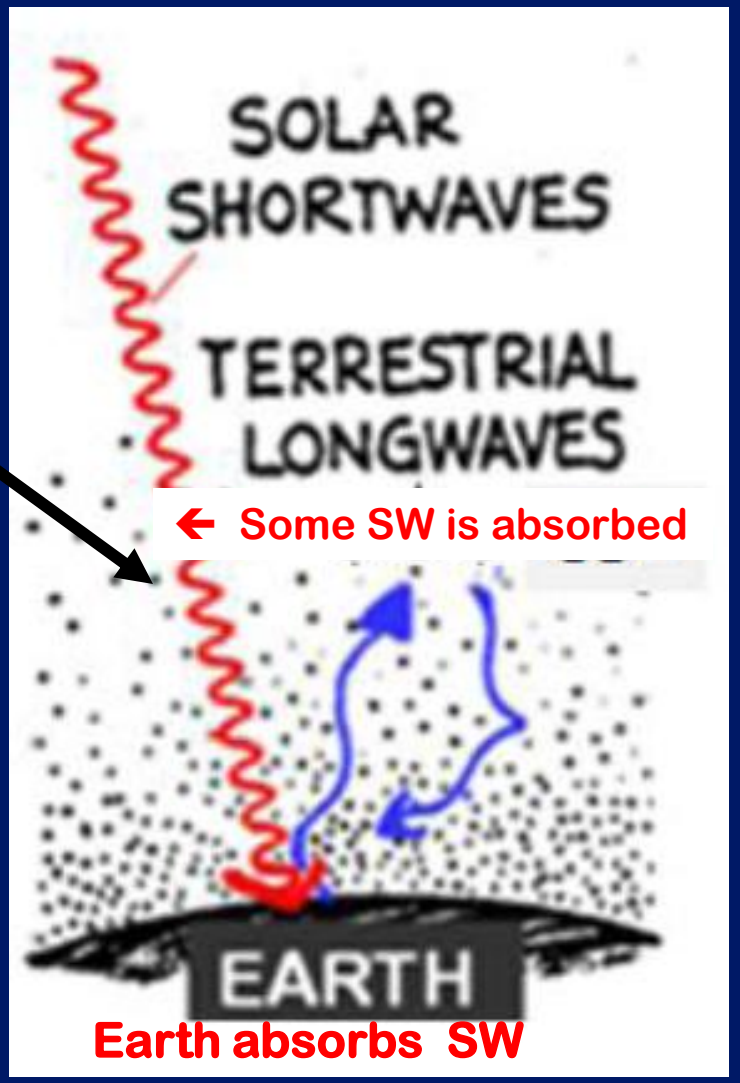


Review p 34

There's one more thing to correct in our the depiction of incoming Solar . . . .

<u>Some</u> SW radiation gets absorbed on its way down to the surface!

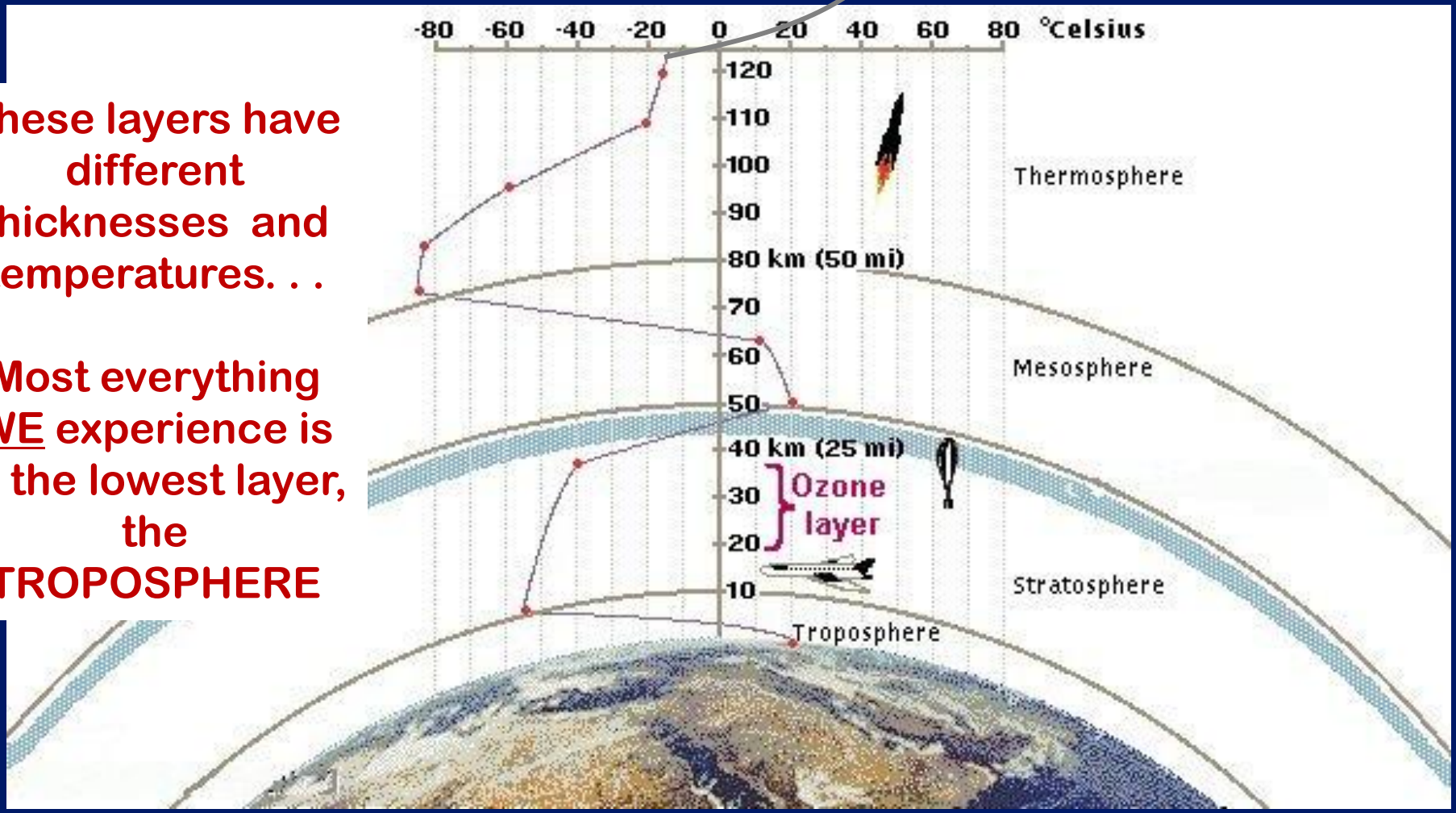
(in addition to terrestrial LW (IR) radiation being absorbed in the GHE)



The atmosphere has a "structure" of different named layers . . . .

These layers have different thicknesses and temperatures. . .

Most everything <u>WE</u> experience is in the lowest layer, the TROPOSPHERE



The Vertical Structure of the Atmosphere

KEY CONCEPT:

The atmosphere's vertical structure is defined by CHANGES in the trend of TEMPERATURE with height.

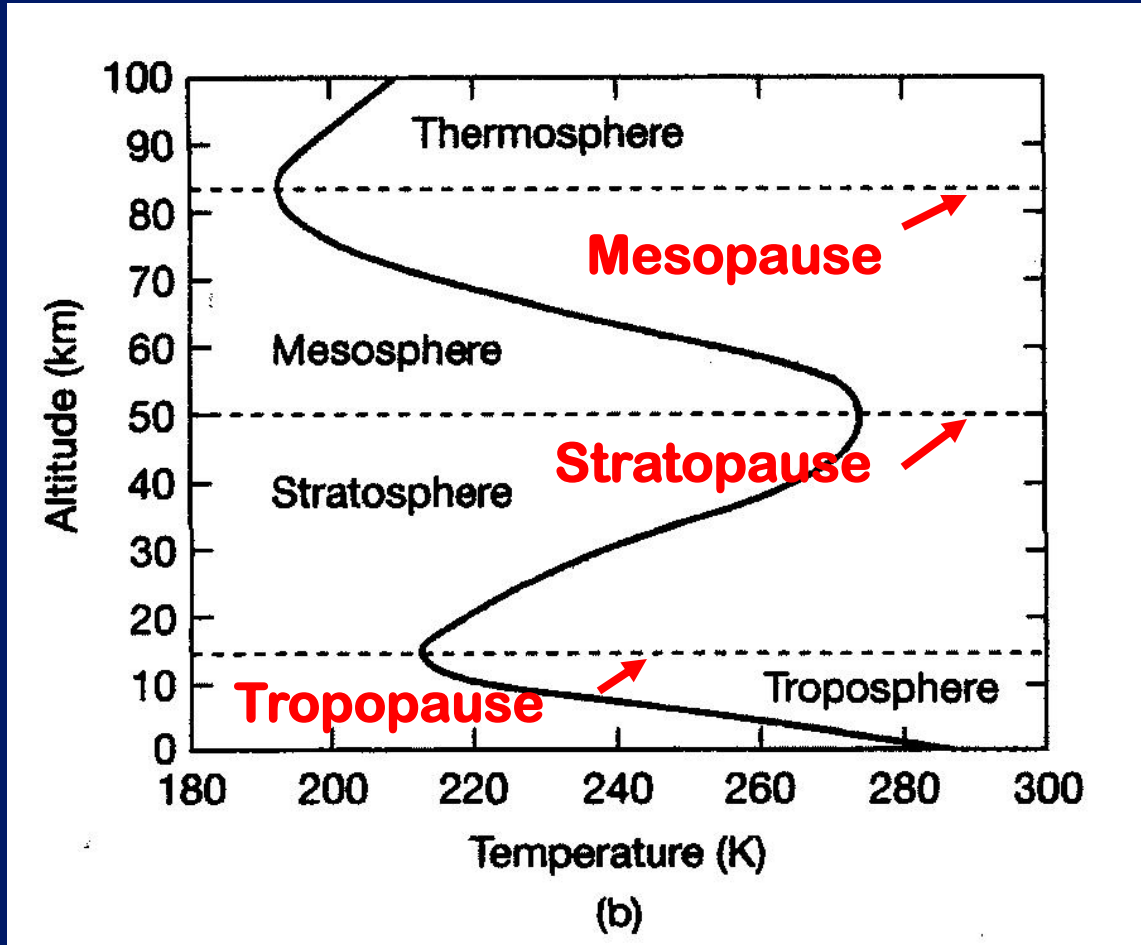


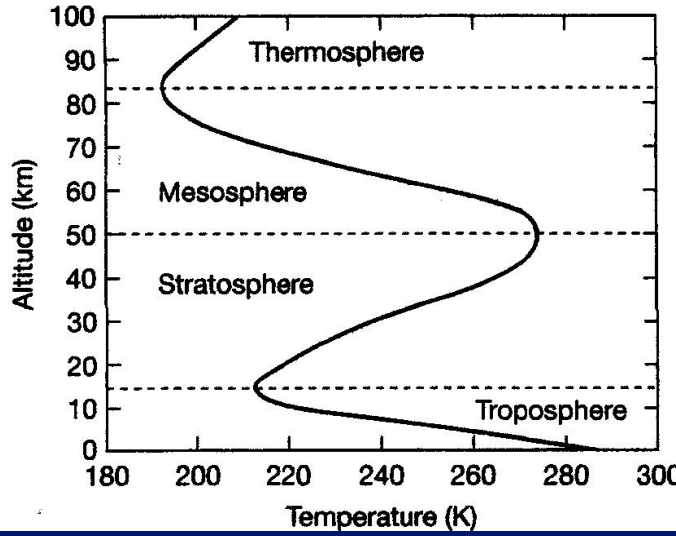
Figure 3-9b in SGC E-text

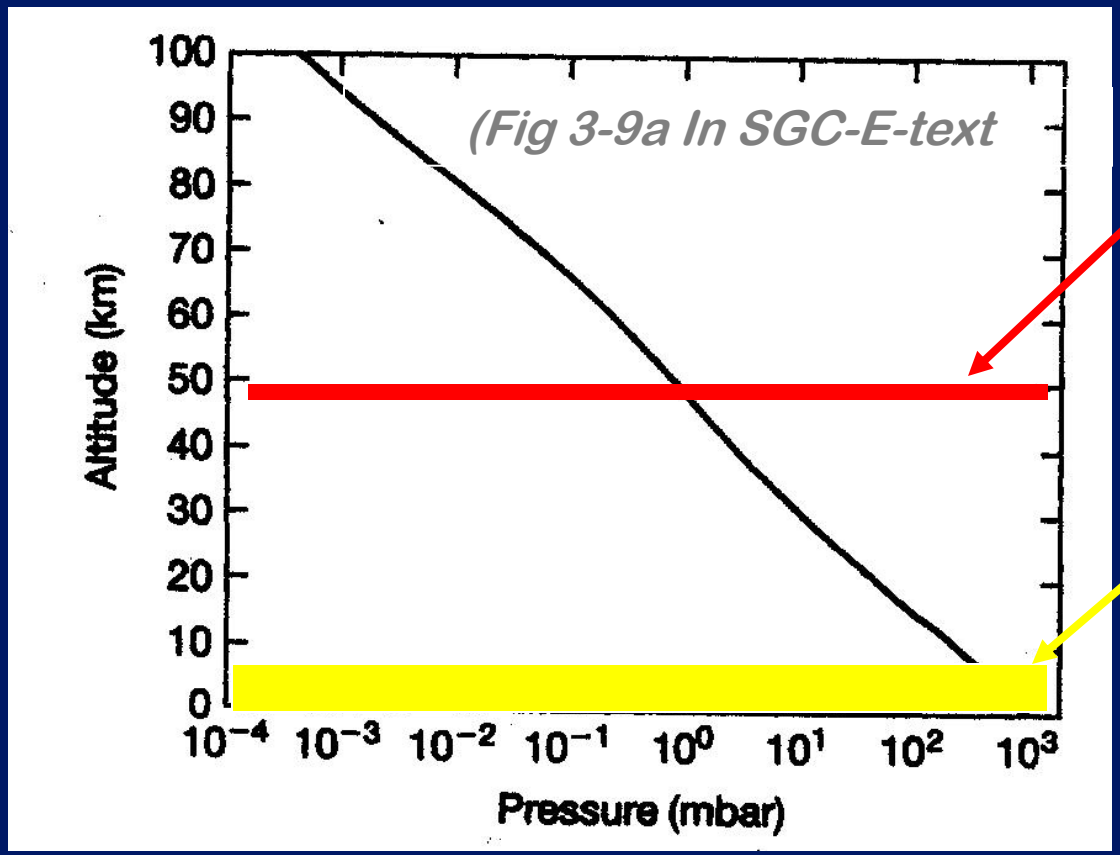
“TRy Sally’s Maroon THermals”

. . . or
think up
your own!

Atmospheric Pressure = weight of the air column above

Atmospheric Pressure & Mass Vary with Height





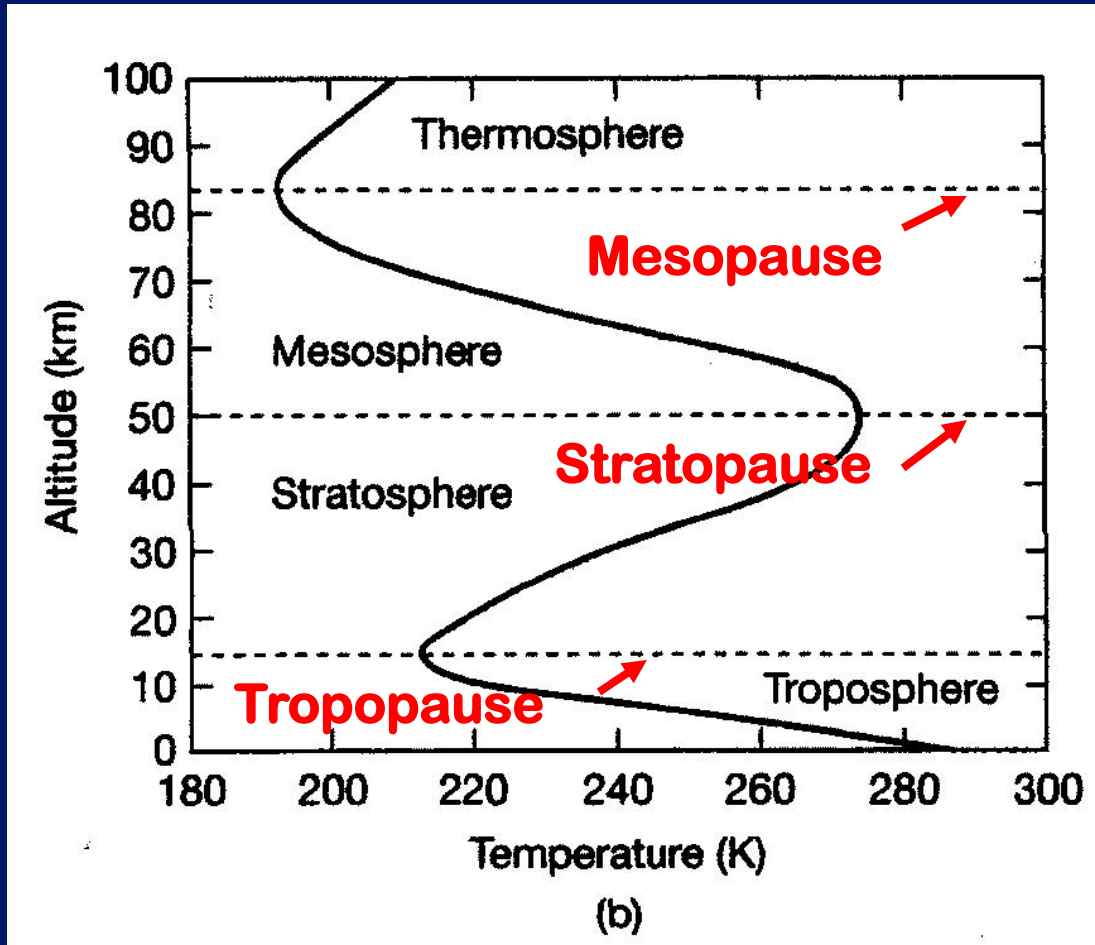
99% of mass lies below ~ 50 km (top of Stratosphere)

50% of mass lies below ~ 6 km (middle Troposphere)

The Vertical Structure of the Atmosphere

Why the zig-zags in the

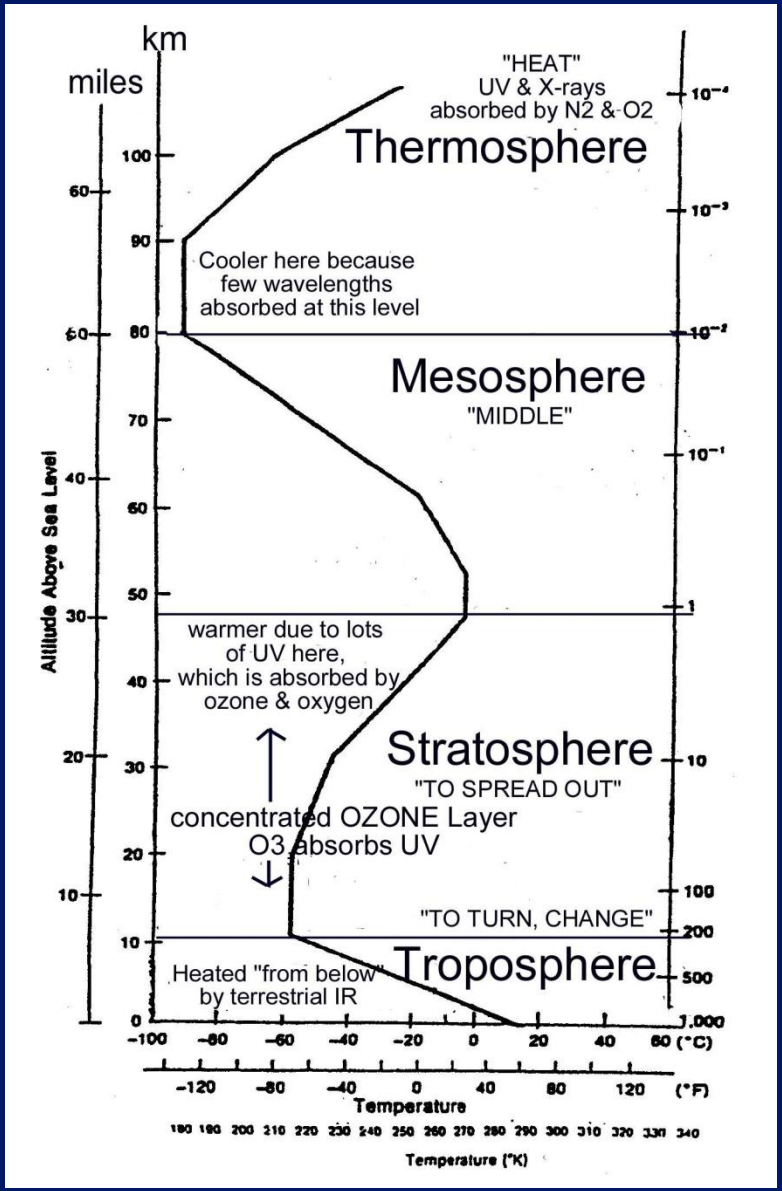
temperature / height graph?



The changes in temperature with height are the result of:

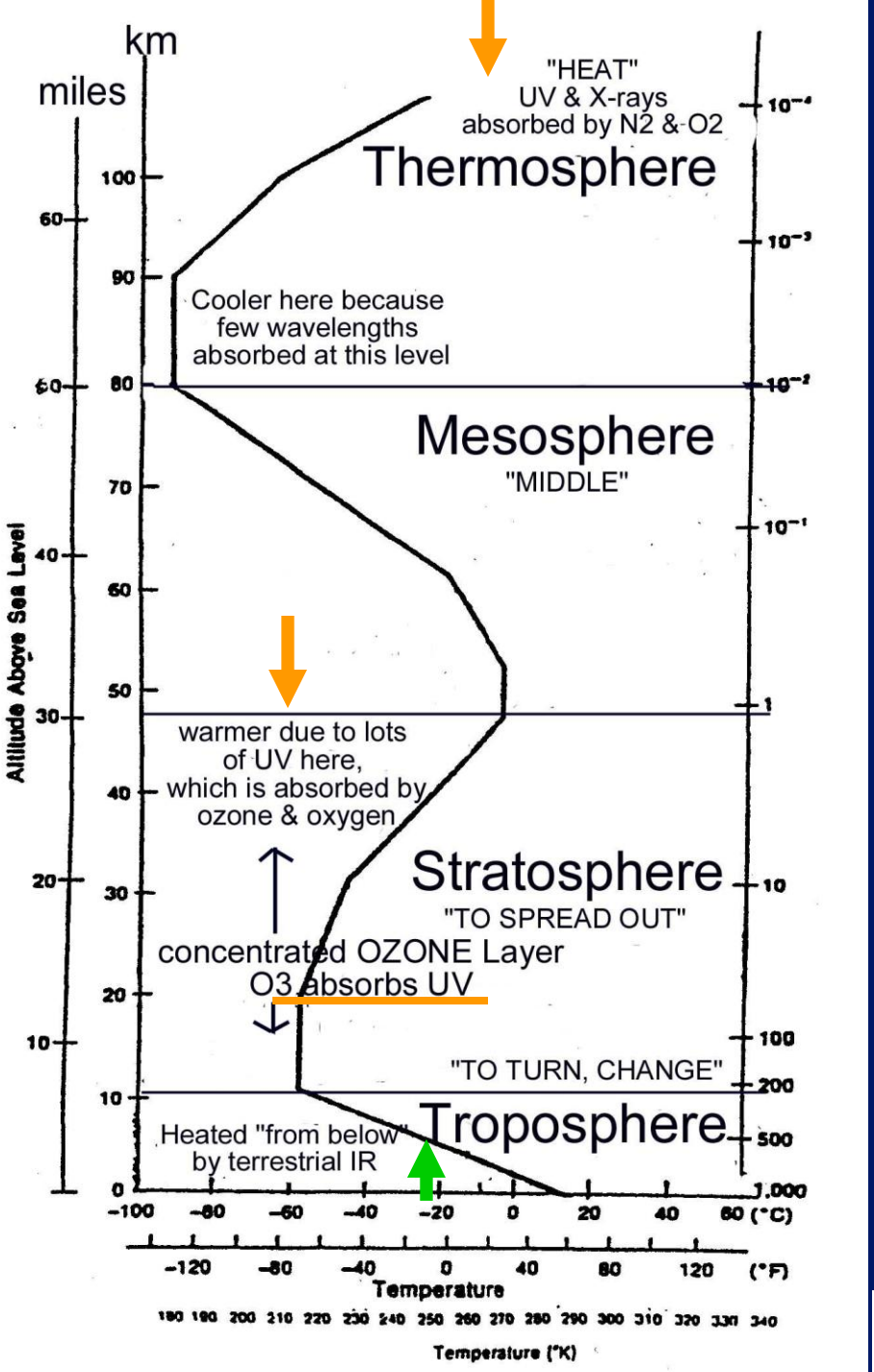
differential absorption of shortwave (SW) & longwave (LW) radiation

by atmospheric GASES concentrated at various altitudes.

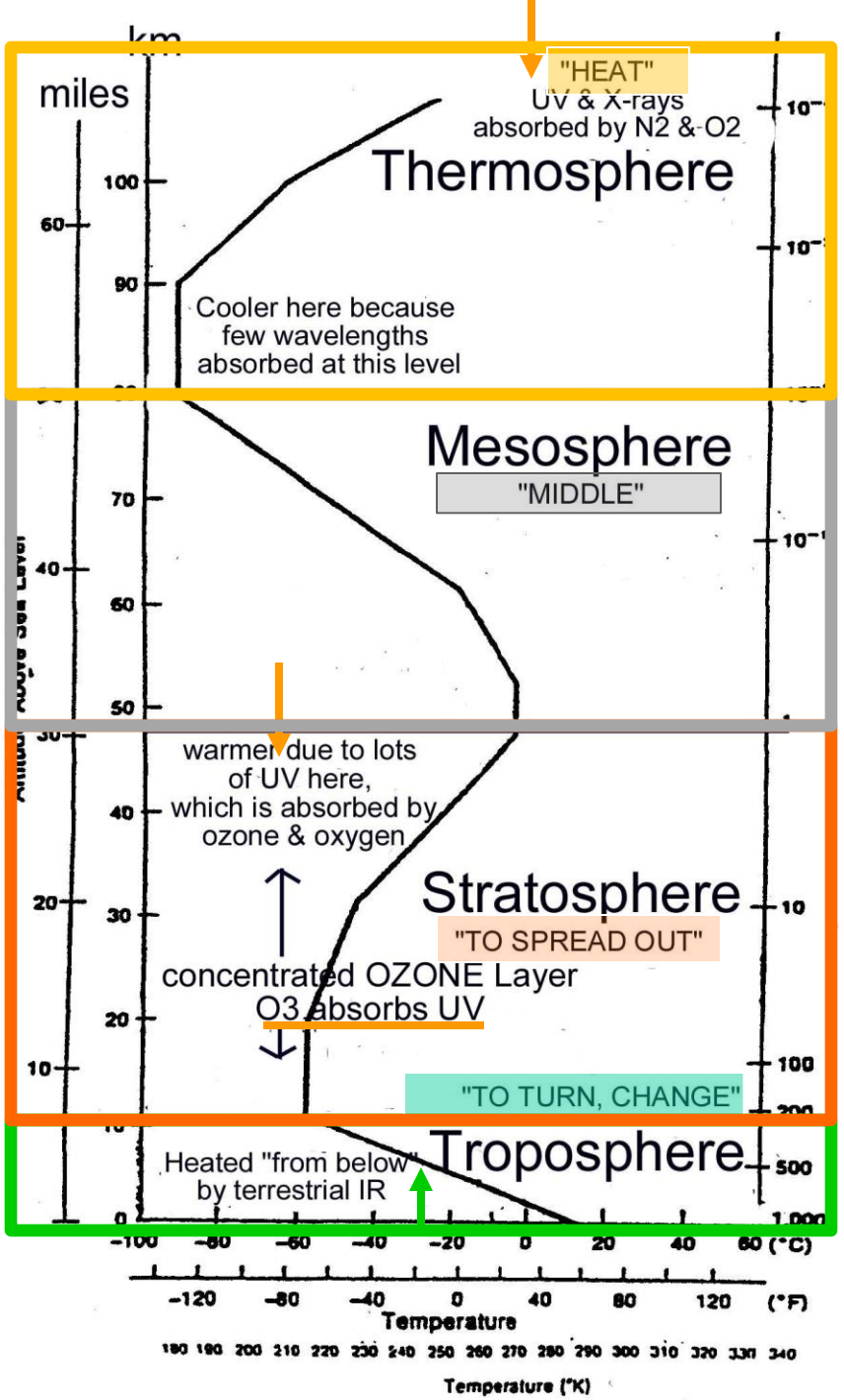


Incoming solar SW (mostly visible & near IR + UV)

Outgoing terrestrial LW (Far IR) radiated from Earth's surface

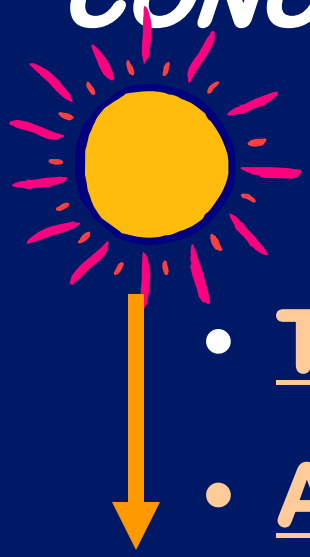


Here's why these changes in **temperature** occur ➔



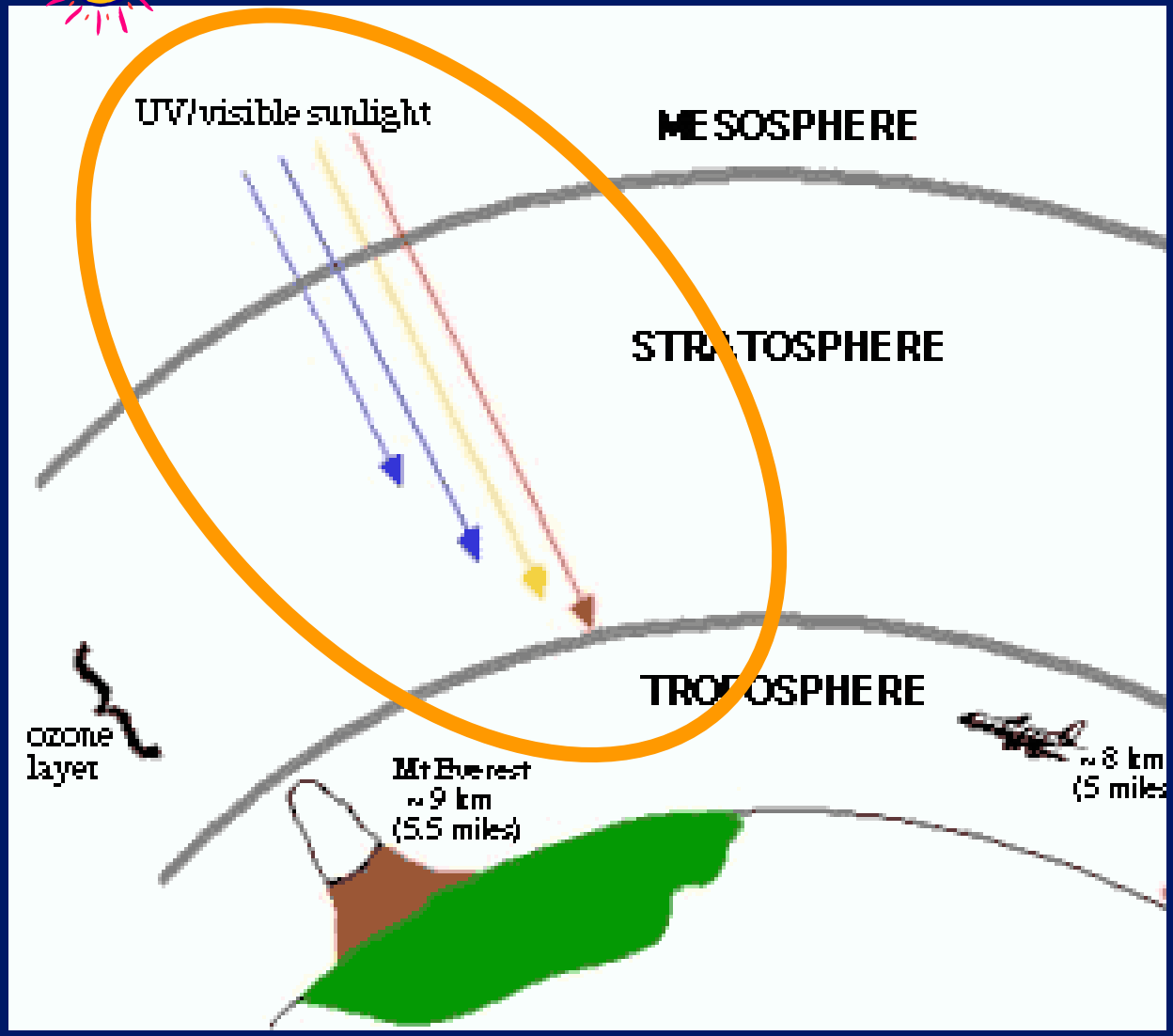
KEY CONCEPT:

On its way to the Earth's surface, several things can happen to incoming SOLAR RADIATION:



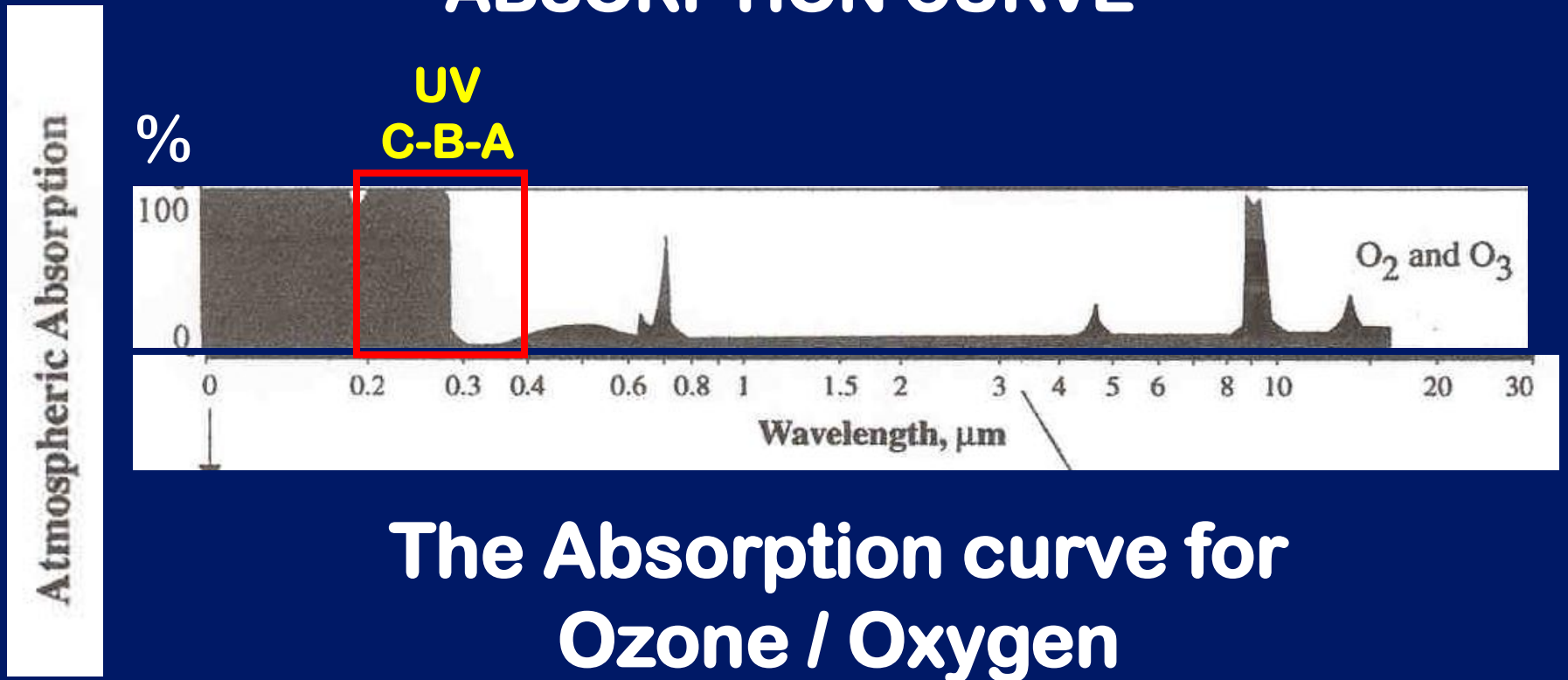
- **TRANSMITTED (to Earth's surface)**
- **ABSORBED (by gases, dust, clouds)**
- **SCATTERED / REFLECTED**
  - **Reflected back to space**
  - **Scattered (and indirectly transmitted to Earth's surface)**

Let's look closer at the incoming shortwave (SW) radiation (UV, Visible & "near IR")



REVIEW: The pattern of electromagnetic wavelengths that are **absorbed** & **emitted** by a particular atom (or combination of atoms)

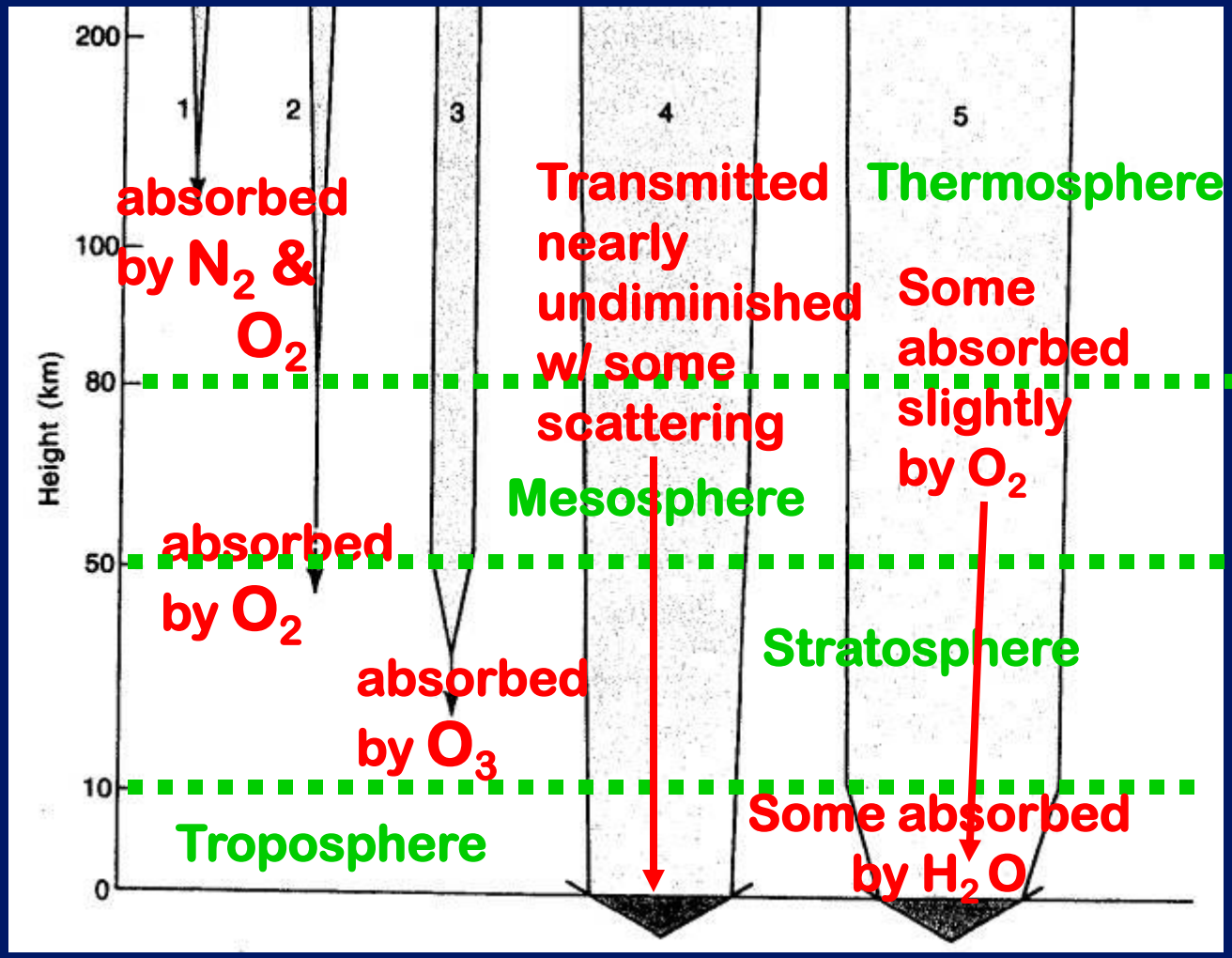
is called its ABSORPTION SPECTRUM or its ABSORPTION CURVE



The Absorption curve for Ozone / Oxygen

UV rays < .32 µm very harmful to life on Earth arrows 1, 2 + 3

How incoming SOLAR radiation of different wavelengths gets TRANSMITTED or ABSORBED by different gases on its way to the Earth's surface



1. UV, $\lambda < 0.12$ µm, absorbed by N_2 and O_2 in upper atmosphere
2. UV, $0.12\ \mu m \leq \lambda < 0.18$ µm absorbed by O_2
3. UV, $0.18\ \mu m \leq \lambda < 0.34$, µm absorbed by O_3 in ozone layer
4. Near UV and visible, $0.34\ \mu m \leq \lambda < 0.7$ µm transmitted nearly undiminished except for scattering
5. Near IR, $0.7\ \mu m \leq \lambda < 3.0$ µm , absorbed slightly by O_2 and in troposphere by H_2O

Reminder: *Ultraviolet radiation:* *UVC = 0.20 - 0.29* *UVB = 0.29 - 0.32* *UVA = 0.32 - 0.40* µm

. . . To be continued on Friday . . . with a review of the material at the end that was somewhat rushed.