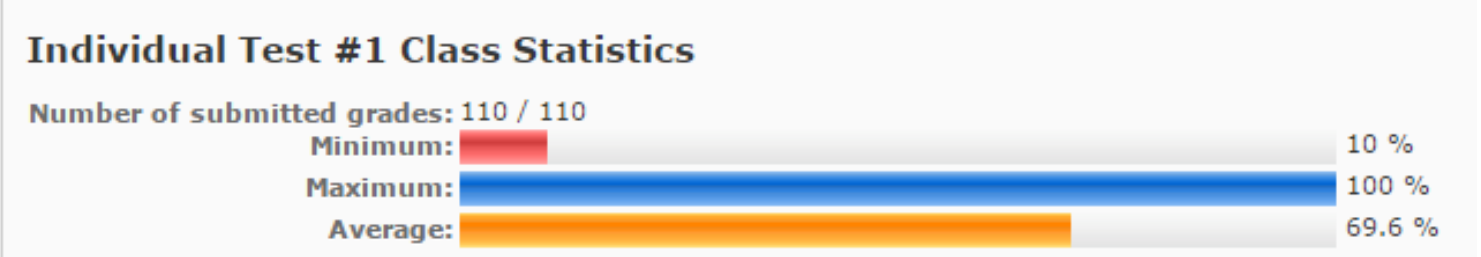
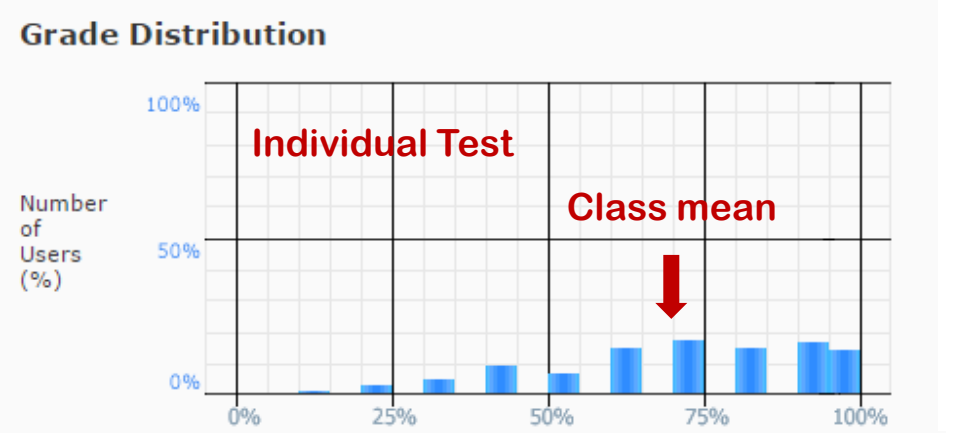
Topic # 6 ATMOSPHERIC STRUCTURE & CHEMICAL COMPOSITION Part II

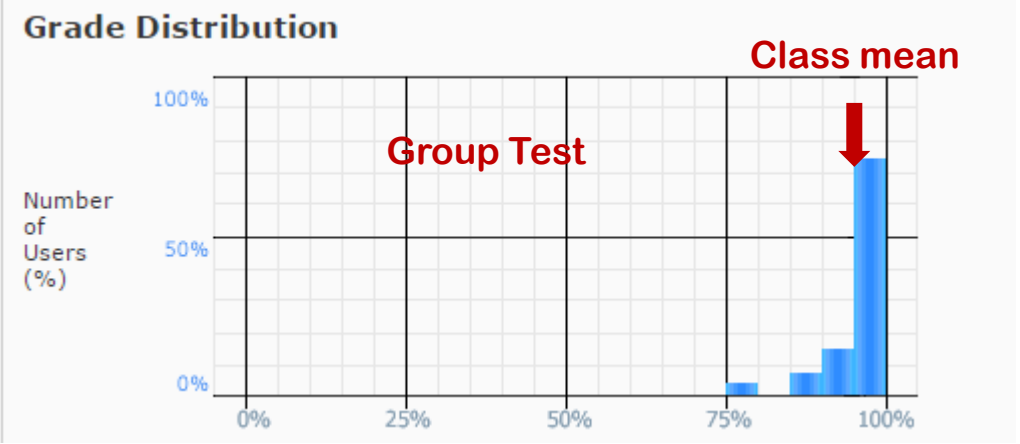
Plus wrap up of
some other topics



THE POWER OF COLLABORATIVE LEARNING!



REMEMBER:
Your group is there to HELP YOU LEARN by working out problems together that & helping each other understand concepts



ABOUT THE LEARNING PHILOSOPHY UNDERLYING THIS COURSE

FAQ #2: http://www.ltrr.arizona.edu/kkh/natsgc/faq.htm#2.

This course is designed to help you learn the course material in ways that are different from traditional lecture courses. . . .

Class time is valuable: Class should be active w/ hands-on activities so that students can be **engaged in their own learning**

- Students learn best when they **come to class prepared** (by reading, Self tests &RQs) to which new material is added

- Students learn best when they **have a common "starting place"** for deepening their understanding (why Dr H reviews concepts)

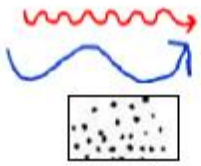
- **A group of people working together** cooperatively can **solve complex problems more easily and at a higher level** than an individual working alone

- To achieve success in group activities, **each individual has to be perceived as someone with something to offer**, and **each individual is responsible for preparing and contributing his or her own individual knowledge.**

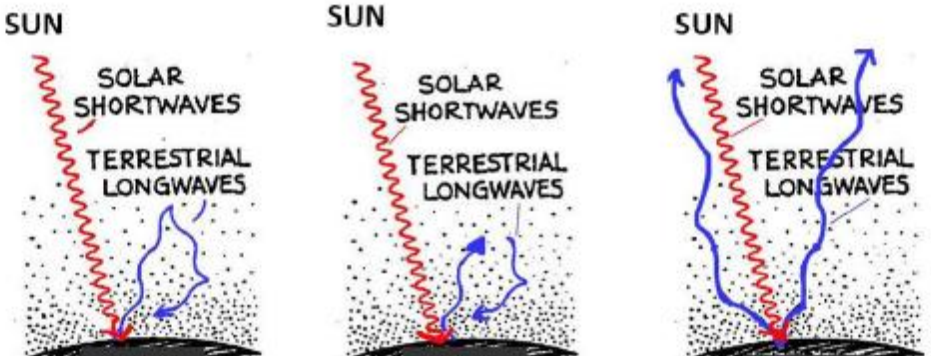
GROUP WORK SELF TEST

SOLAR vs TERRESTRIAL RADIATION CLASS CONCEPTS SELF TEST

KEY:

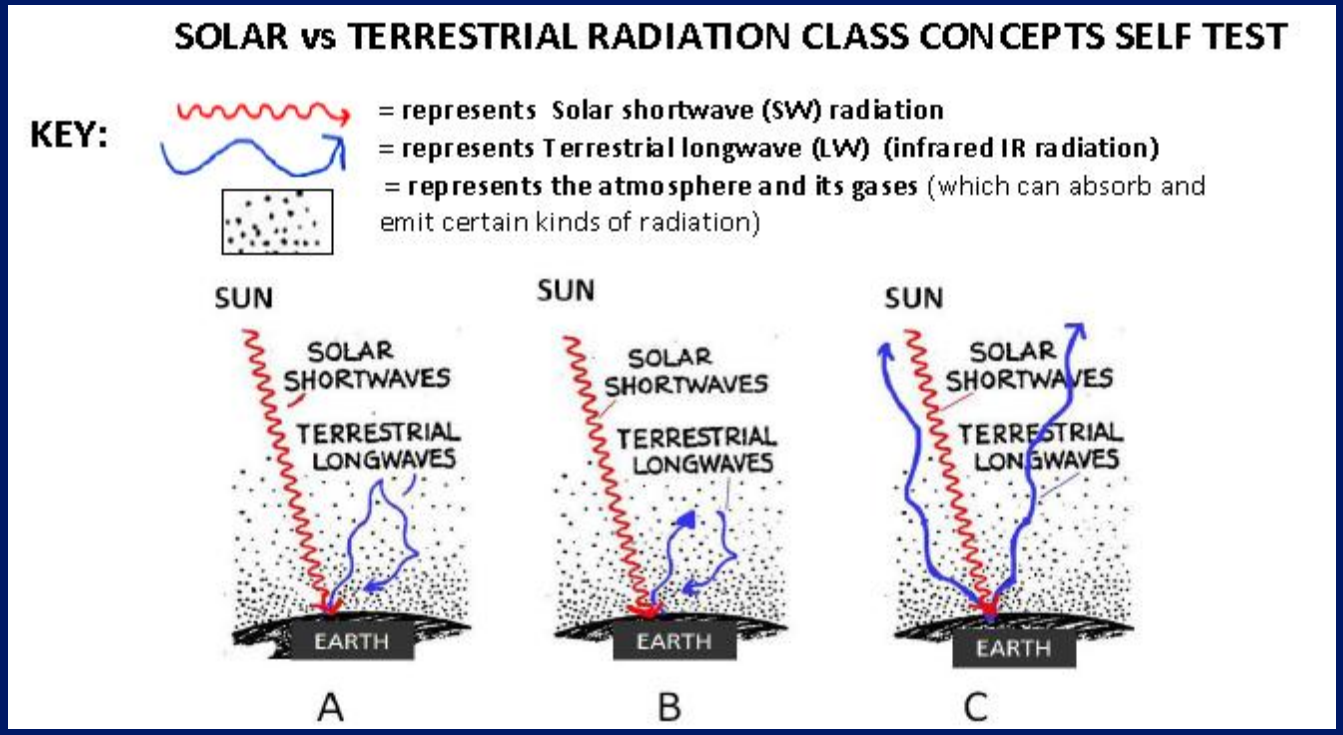


= **represents Solar shortwave (SW) radiation**
= **represents Terrestrial longwave (LW) (infrared IR radiation)**
= **represents the atmosphere and its gases** (which can absorb and emit certain kinds of radiation)



5 minute GROUP WORK: Answer Q7 – Q11

ANSWERS



All 3 are illustrating ABSORPTION of incoming Solar SW by the EARTH's surface followed by outgoing RADIATION of LW Infrared from the EARTH's surface !

Q7. Which diagram above shows SW (solar radiation being reflected back to space?

A B C **None of them**

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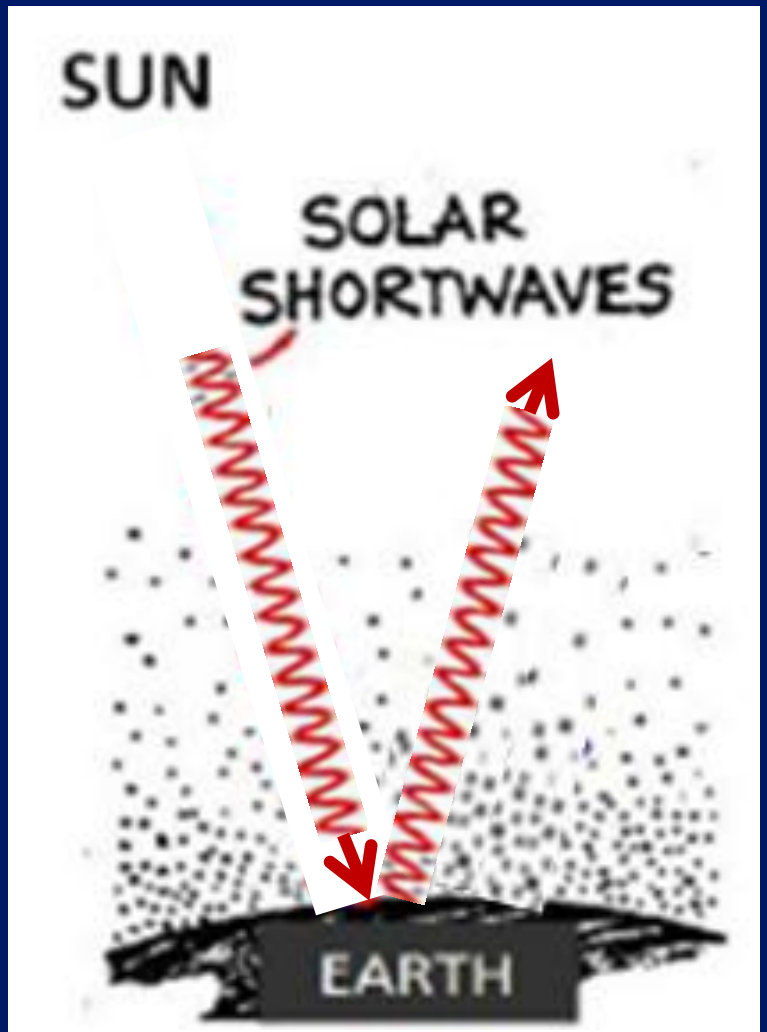
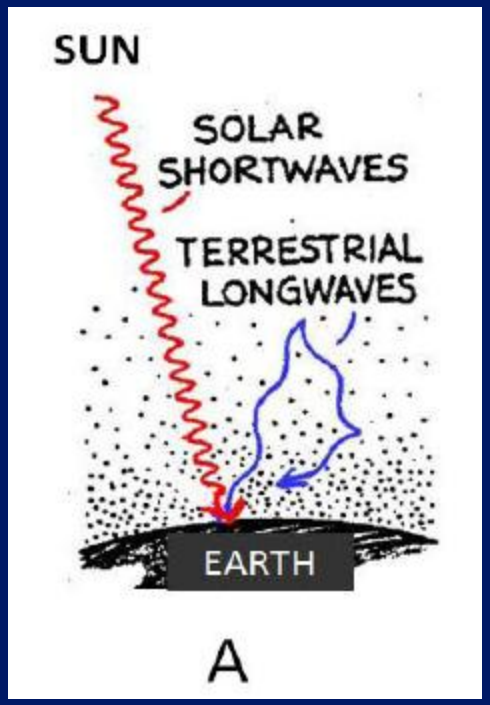


NO ABSORPTION

Here's the correct diagram to show SW Solar being reflected back to space!



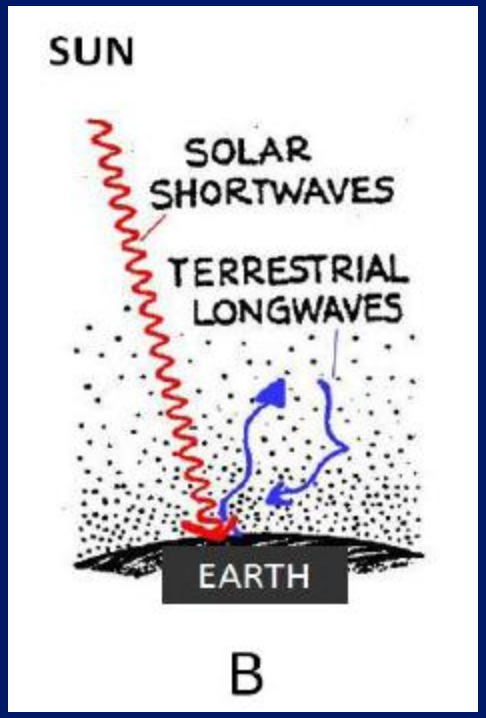
Q8. Diagram A shows LW (IR) terrestrial radiation "bouncing off" (or reflecting) the gases in the atmosphere and being sent back to Earth's surface. (i.e. being reflected back to the surface by the gases without being absorbed by them.)

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

Yes **No** Why or Why not?

The LW (IR) radiation is absorbed by the GHG's and then re-radiated (or re-emitted) back down to the Earth's surface to warm it. The IR is NOT reflected. IF IT'S REFLECTED IS NOT ABSORBED.

DON'T USE "BOUNCING or "REFLECTING" to describe the Greenhouse Effect process: GH gases ABSORB & RE-RADIATE!



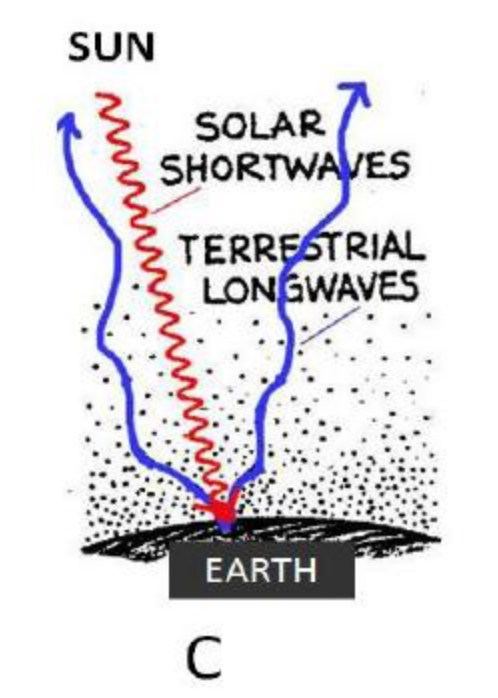
Q9. Diagram B shows LW (IR) terrestrial radiation being <u>absorbed and then emitted back down</u> by the gases in the atmosphere.

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

Yes **Why or Why not?**

(although it's not quite complete – more on this later)

LW (IR) being absorbed by GH Gases, and then emitted out again, (back down to the surface of the Earth) is exactly how the GH Effect operates.



Q10. Diagram C shows LW (IR) terrestrial radiation going right through the atmosphere out to space.

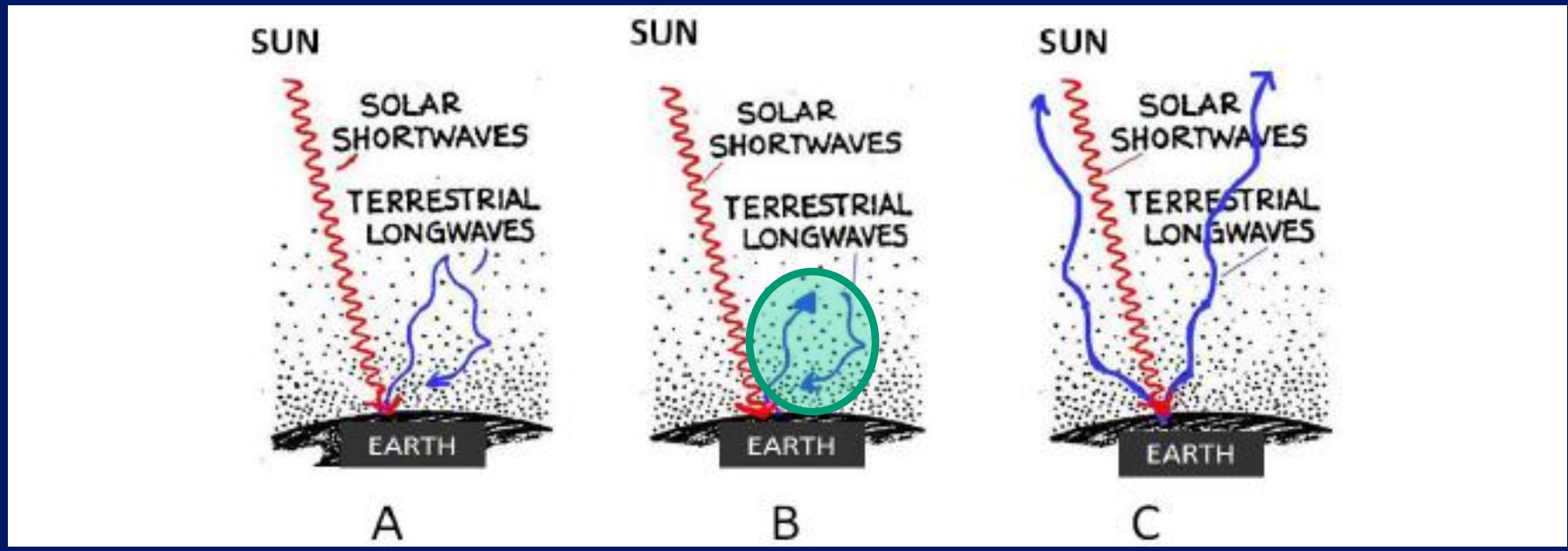
Is this an accurate depiction of how the Greenhouse Effect works?

Yes **No** Why or Why not?

Diagram C shows ALL the IR leaving the Earth's surface and NOT being absorbed at all !

If this happened the Earth's temperature would be below freezing!

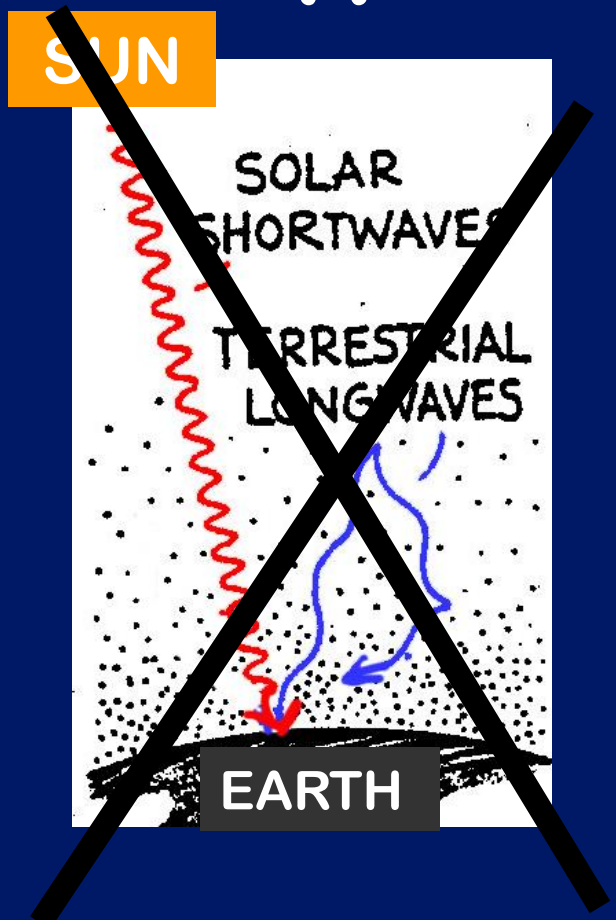
Q11. On the diagram that you think best depicts the processes involved in the GREENHOUSE EFFECT, CIRCLE the specific part of the diagram that represents the Greenhouse Effect:



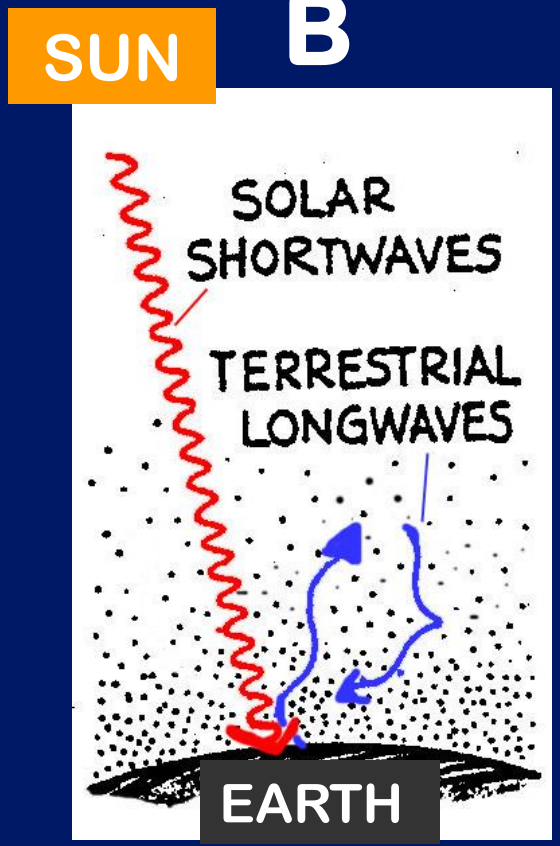
DO NOT CIRCLE any part of the SUN's incoming SW!
(Shortwave Radiation = IR + VIS)
SW is NOT part of the GH Effect!

Most accurate depiction of the GH Effect?

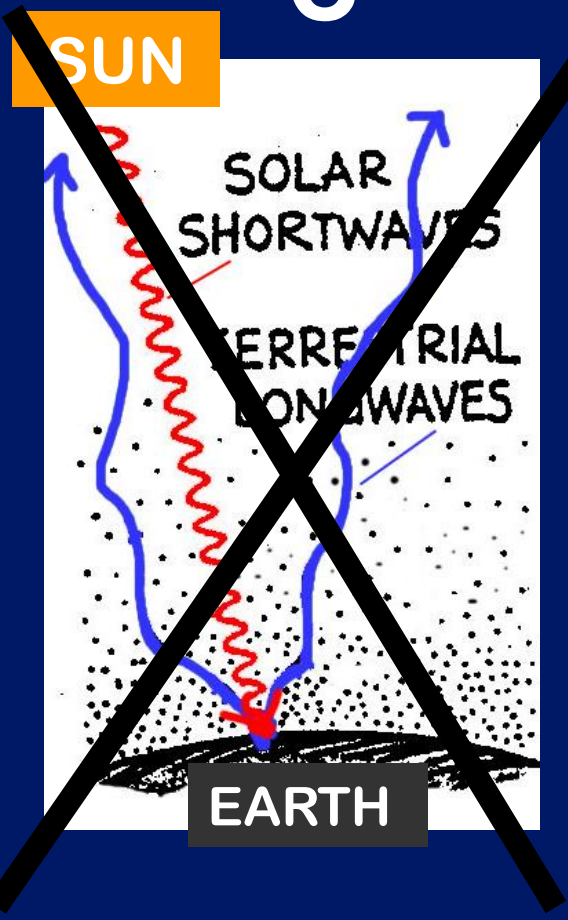
A



B



C



B is close, but actually, NONE of these is exactly correct . . .

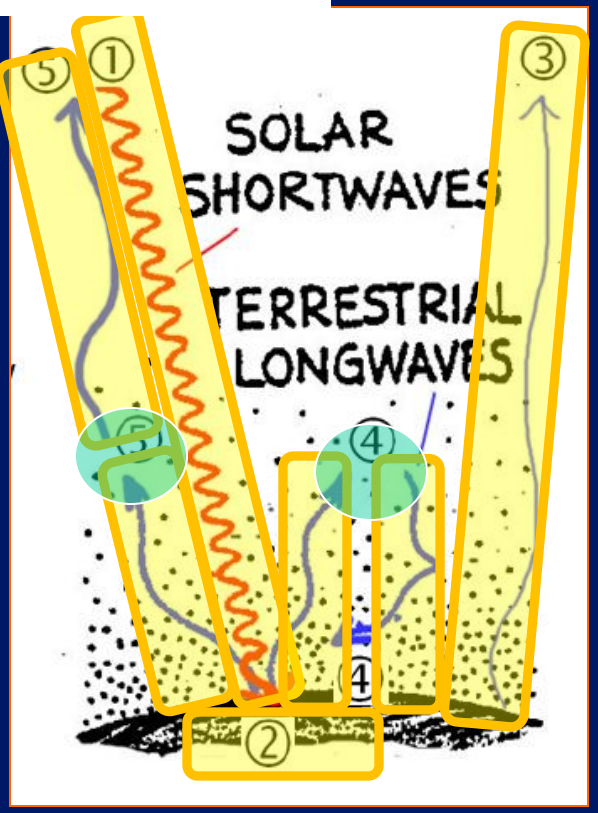
for a better version:

see the bottom of p 29 in Class Notes.

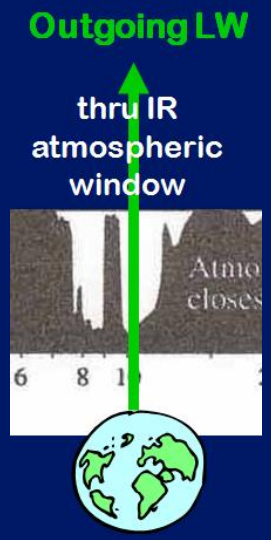
THINKING MORE DEEPLY . . .

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

How? Through the UV-VIS Atmospheric Window!



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)

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

Absorption & re-emission by GH gases

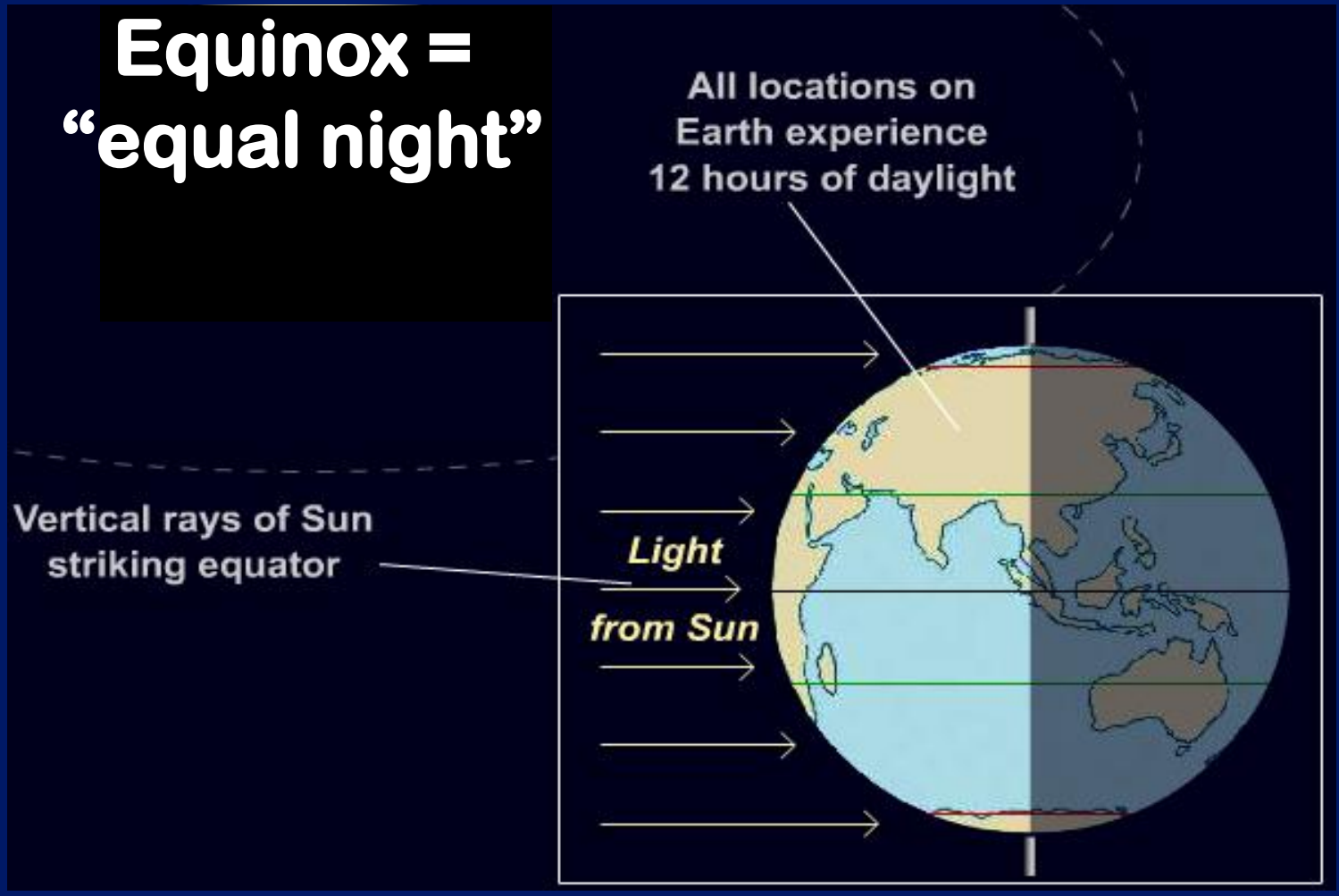
Absorption & re-emission by GH gases

② The Earth absorbs SW that reaches the surface

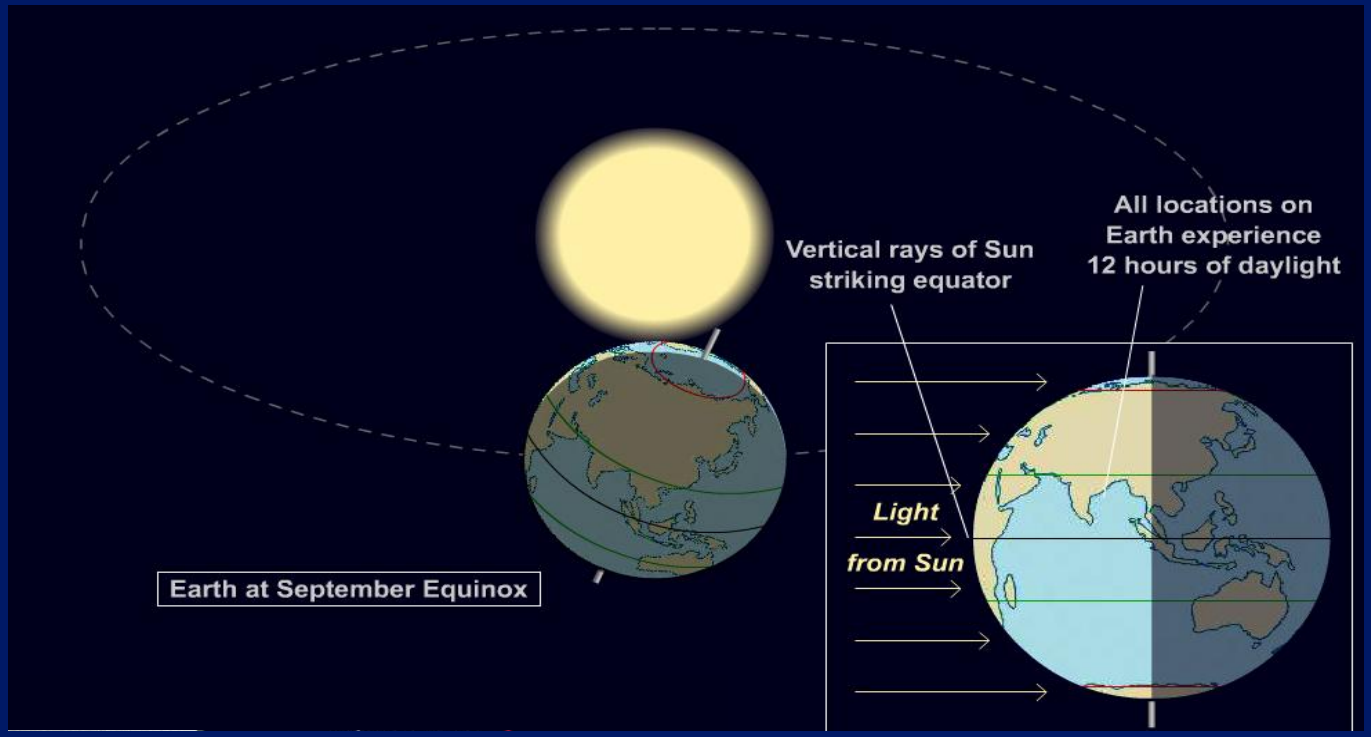
Bottom of p 29

HAPPY SEPTEMBER EQUINOX!

23 Sep 2015 @ at 1:22 AM Tucson Time

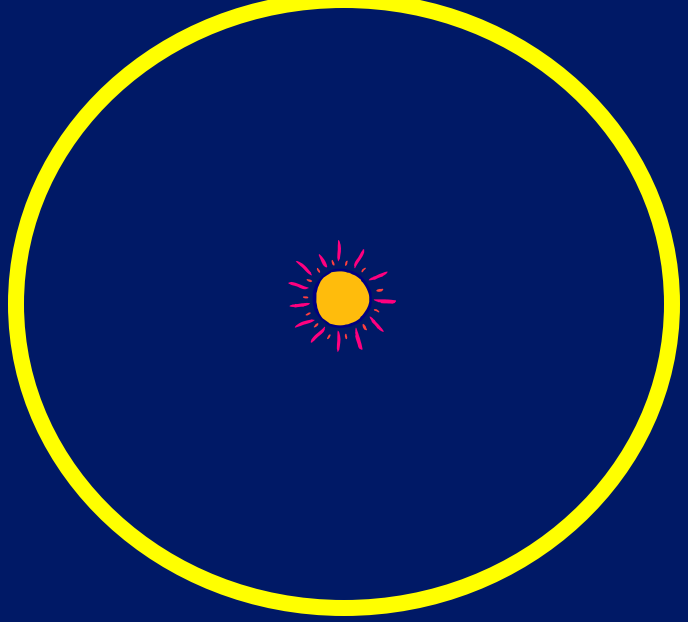


Today is the "Astronomical" "First Day of Fall" in the Northern Hemisphere!

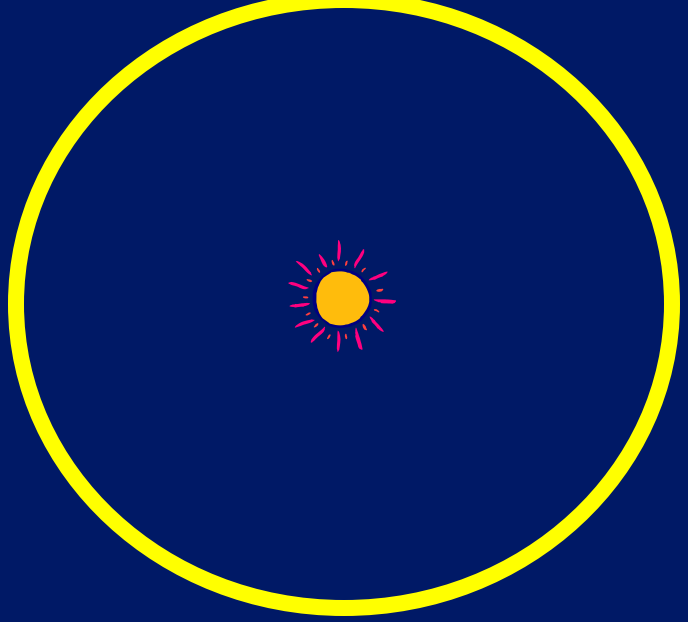


You can view the animation yourself at:

http://mesoscale.agron.iastate.edu/agron206/animations/01_EarthSun.html

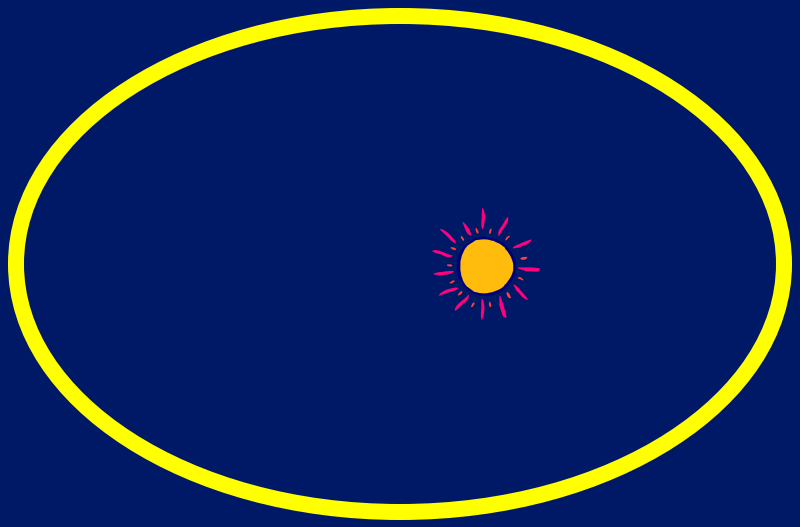


(1) Draw a **circular ORBIT**
on the whiteboard & show
SUN's location then use a
phone flashlight to simulate Sun's radiation



(1) Draw a **circular ORBIT** on the whiteboard & show **SUN's** location then use a **phone flashlight** to simulate Sun's radiation

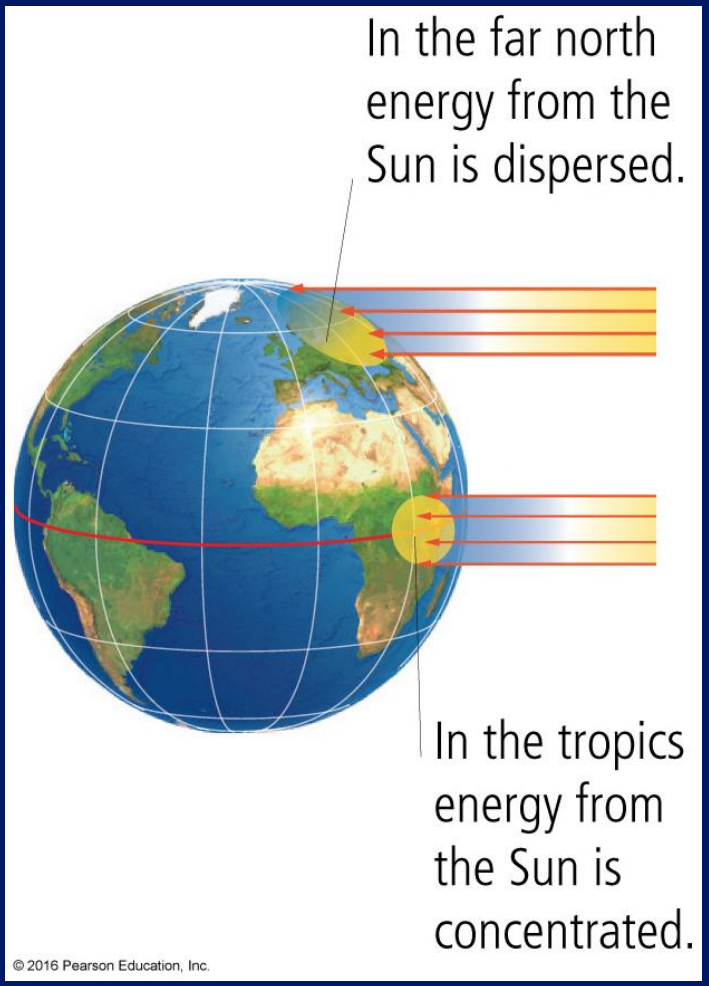
(2) Then, keeping the Earth's axis at a **constant 23 ½ angle** , and keeping the "north pole" axis 'tip' **always pointing to the "North Star"** – simulate a year of the Earth's Orbit – and discuss how the amount of radiation varies at different latitudes ➔ seasonal changes!

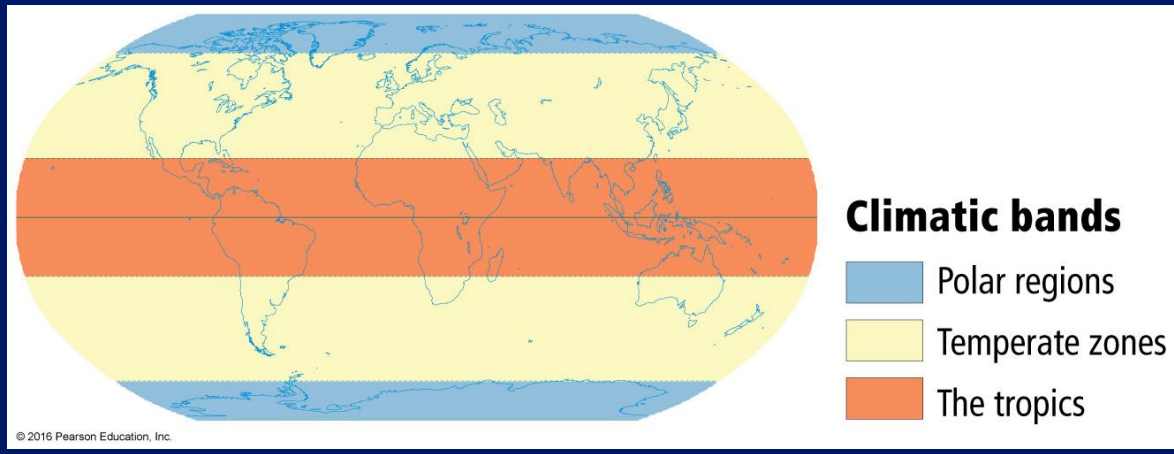


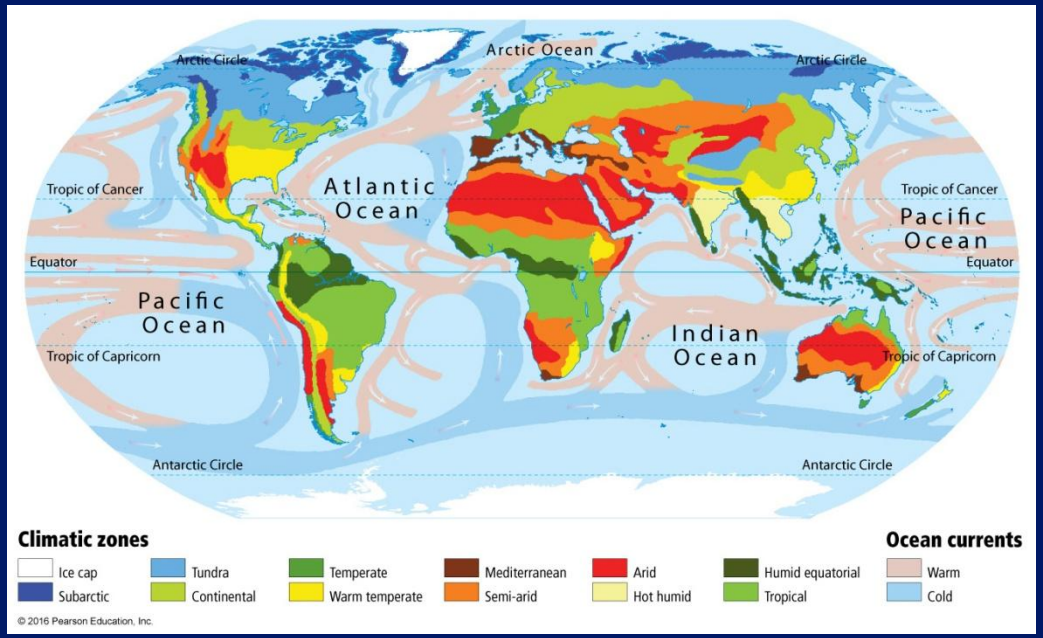
BUT . . . the Earth's orbit at this point in time is NOT circular, it's ELLIPTICAL & the SUN is NOT in the center!

How does this change the amount of Solar radiation received in different hemispheres?

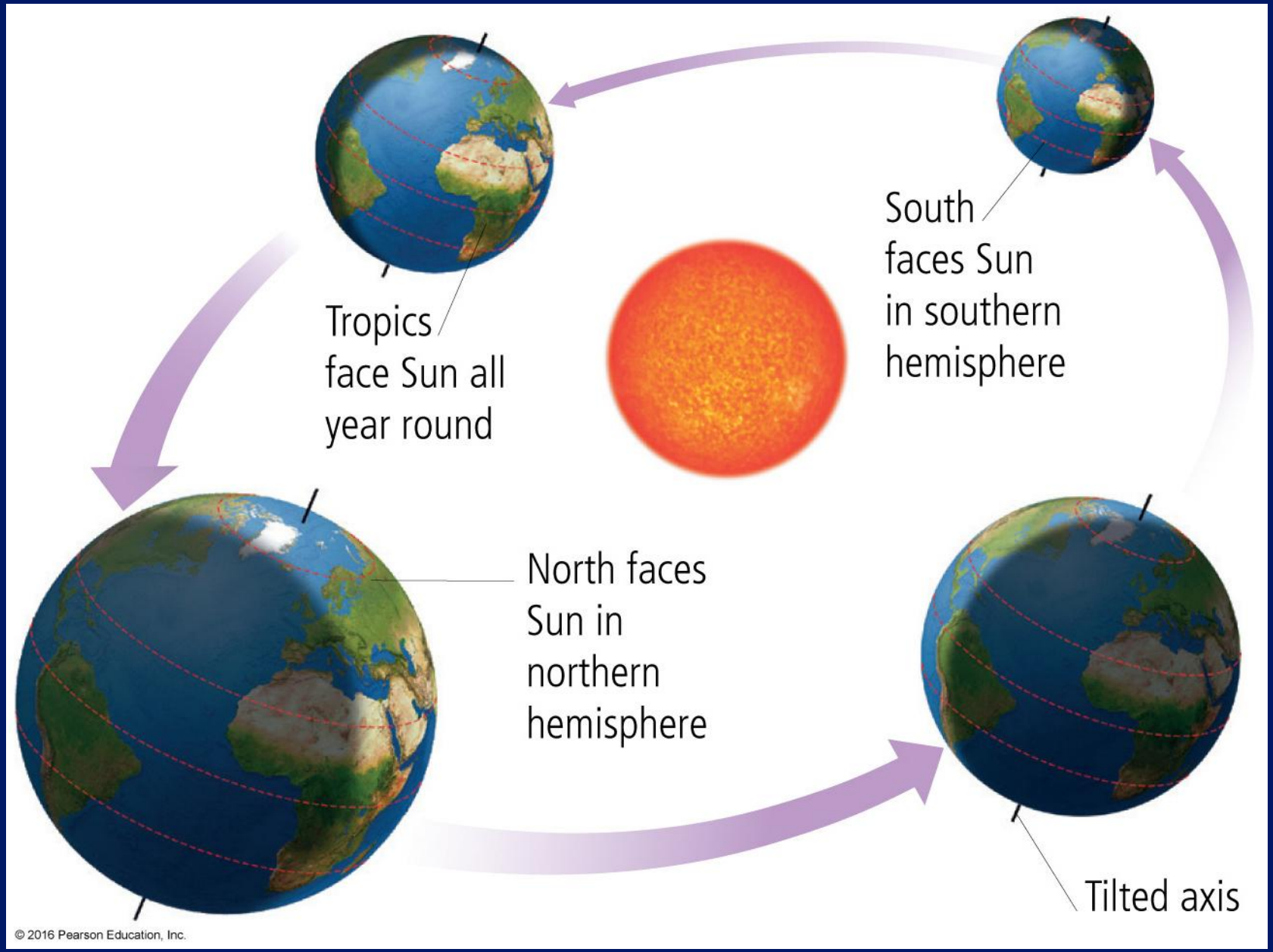
At what latitudes is this difference the most drastic?







READ: Dire Predictions pp 10-15



READ: Dire Predictions pp 10-15

We'll address more on
EARTH-SUN relationships ,
how they've changed in the past,
and how this is an important
NATURAL cause of
CLIMATE CHANGE

in Topics #10 & #11

CHECKPOINT

THINK for 15 seconds
TABLE CHAT for 15 seconds
What's your most burning question about:
EARTH-SUN RELATIONSHIPS ,
the SEASONS
and GLOBAL CLIMATE PATTERNS?

Topic # 6 ATMOSPHERIC STRUCTURE & CHEMICAL COMPOSITION

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

OBJECTIVES:

To understand:

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

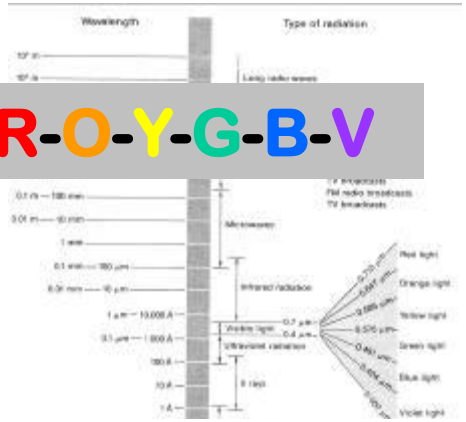
-- which GASES are in the atmosphere

-- where they are concentrated, and

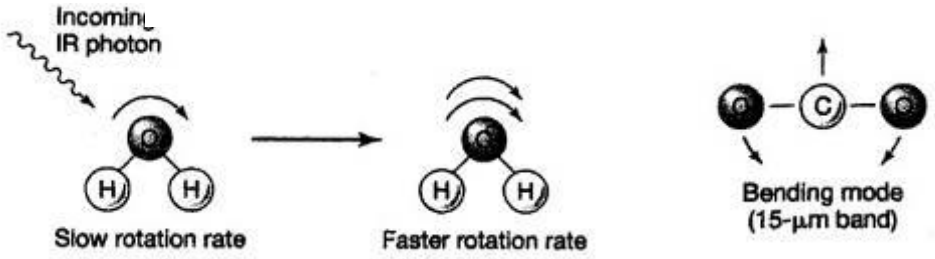
-- why gases at different levels are linked to the Greenhouse Effect and also Ozone Depletion

(which are NOT the same thing!!!)

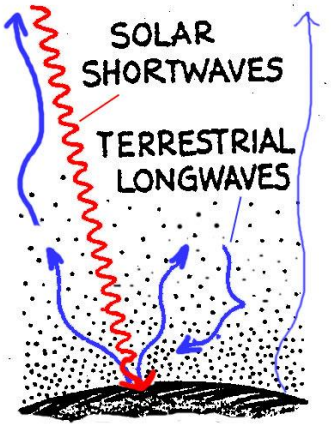
Things you've seen before that will all come together under this topic:

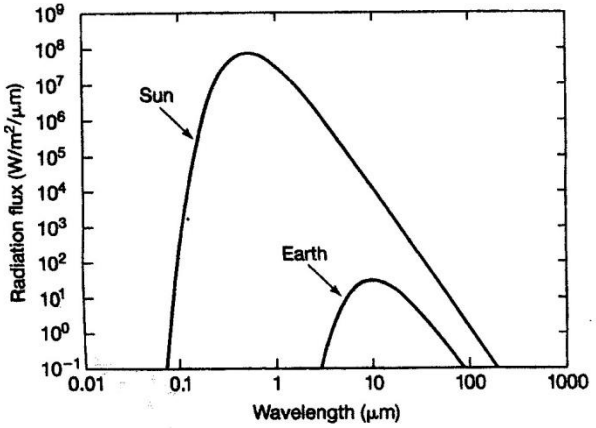


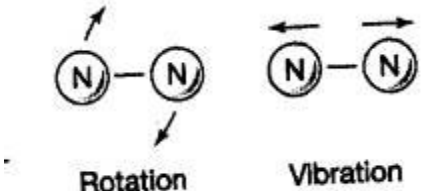
$$E = \sigma T^4$$

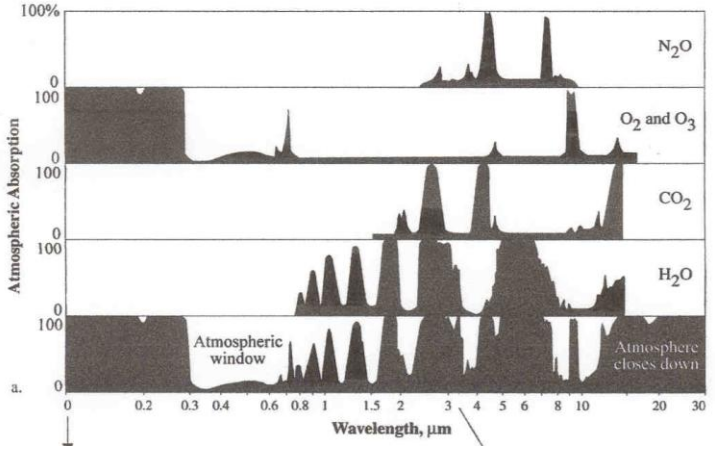


$$E = h c / \lambda$$







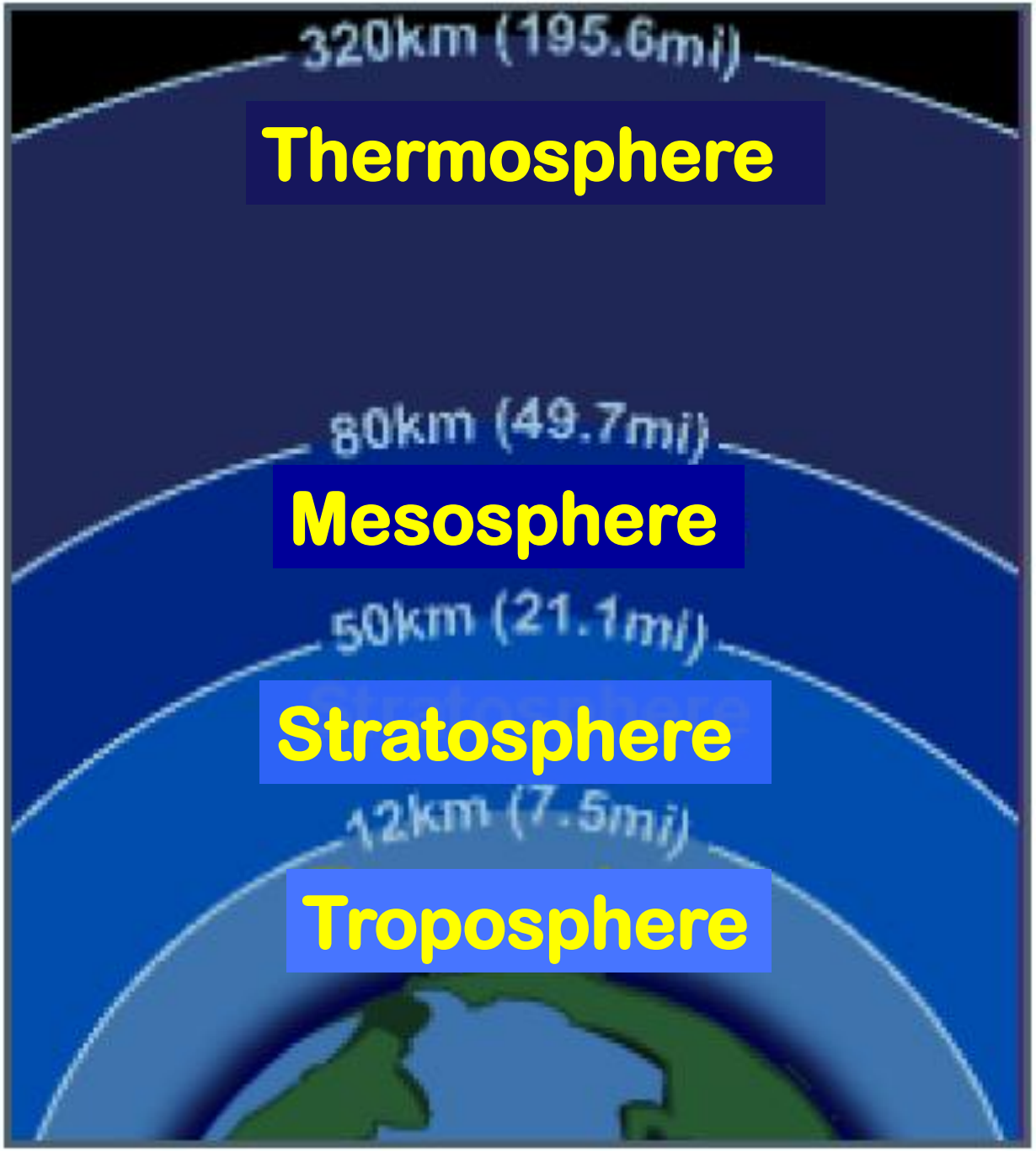


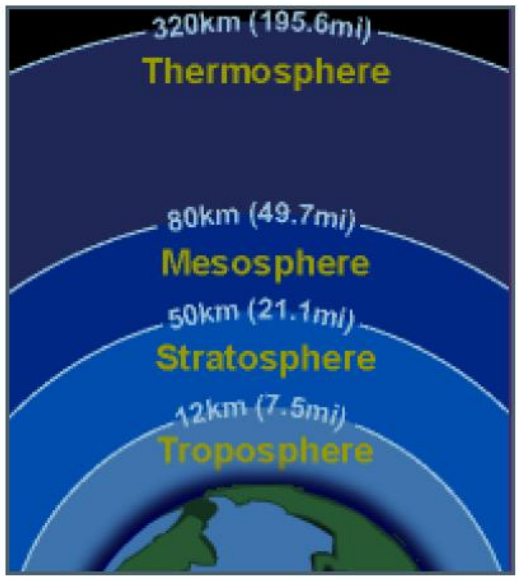
$$\lambda_m = a / T$$

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

~ Adlai Stevenson

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





The orbits of many satellites lie within the exosphere.

Exosphere
Outermost layer of the atmosphere. Extends to about 10,000 km (6,000 miles).

Thermosphere
Extends to about 640 km (400 miles).

Mesosphere
Rises from about 50 to 80 km (30 to 50 miles) above the surface. Air becomes cooler as the altitude increases.

Stratosphere
Extends upward to a height of about 50 km (30 miles). Contains atmospheric ozone layer. Temperature increases with altitude through the stratosphere, inhibiting vertical air currents, and making the stratosphere highly stable, in contrast to the troposphere.

Troposphere
Layer in contact with Earth's surface. Extends from the surface to about 8 to 17 km (5 to 10 miles). Air temperature decreases with altitude, leading to instability. Less dense air sits below more dense air, which results in air movements and storm generation. "Weather" takes place almost exclusively within the troposphere.

Sea level

Mesopause
Boundary between the mesosphere and the thermosphere.

Stratopause
Boundary between the stratosphere and the mesosphere.

Atmospheric ozone layer
Layer within the stratosphere. Absorbs ultraviolet solar radiation, so warming the surrounding atmosphere.

Tropopause
Boundary between the troposphere and the stratosphere.

Dire Predictions p 12

MAKE A GRAPH:

ALTITUDE
Kilometers (km)
above sea level)

100

0

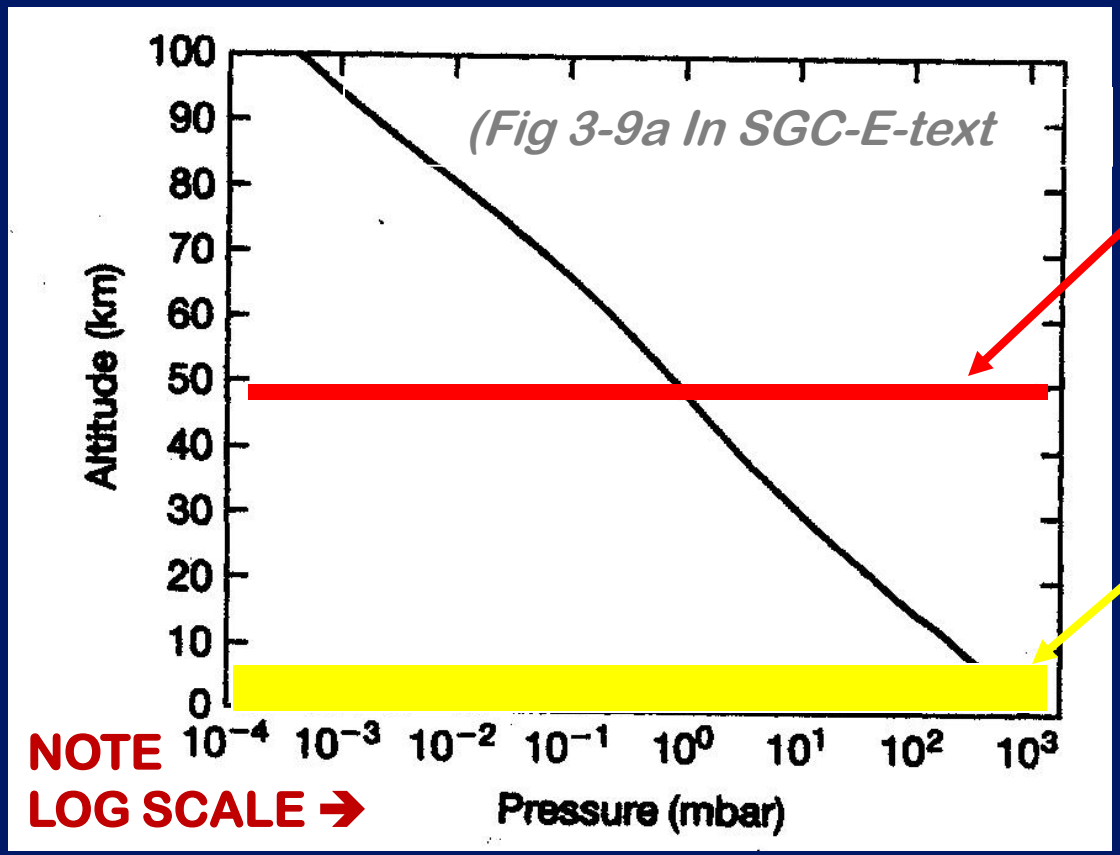
Low

ATMOSPHERIC PRESSURE

High

Atmospheric Pressure = weight of the air column above

Atmospheric Pressure & Mass Vary with Height



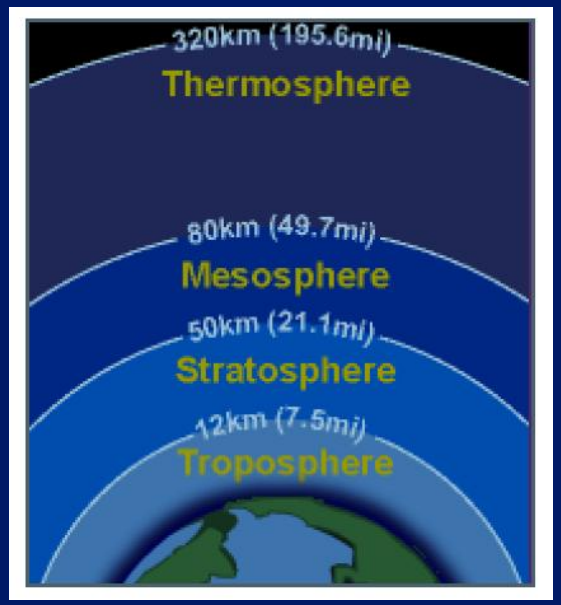
99% of mass lies below ~ 50 km (top of Stratosphere)

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

MAKE A GRAPH:

ALTITUDE

Kilometers (km) above sea level)



100

0

Thermosphere 80 km – 320 km

Mesosphere 50 km – 80 km

Stratosphere 12 km – 50 km

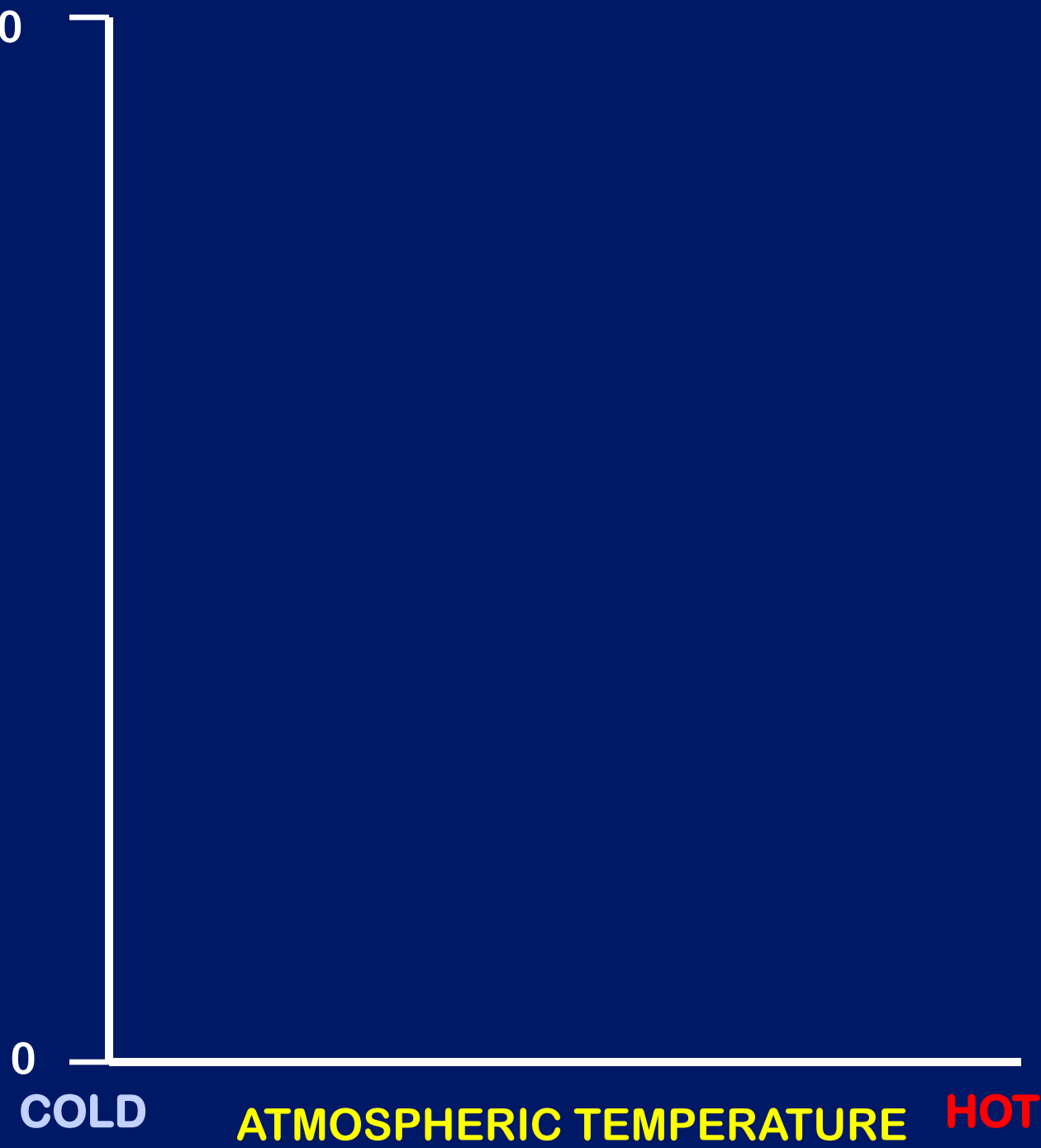
Troposphere 0 km – 12 km

Now erase pressure and sketch in the layers on your graph with a dashed line - - - - - -

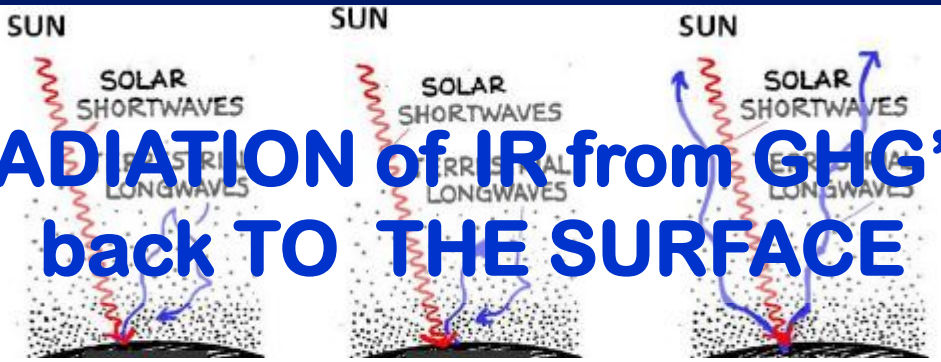
MAKE A GRAPH:

ALTITUDE
Kilometers (km)
above sea level)

Sketch in Temperature curve



The ATMOSPHERE
IS PRIMARILY HEATED FROM BELOW
(by IR energy radiated up from the EARTH'S SURFACE)



RADIATION of IR from GHG's back TO THE SURFACE

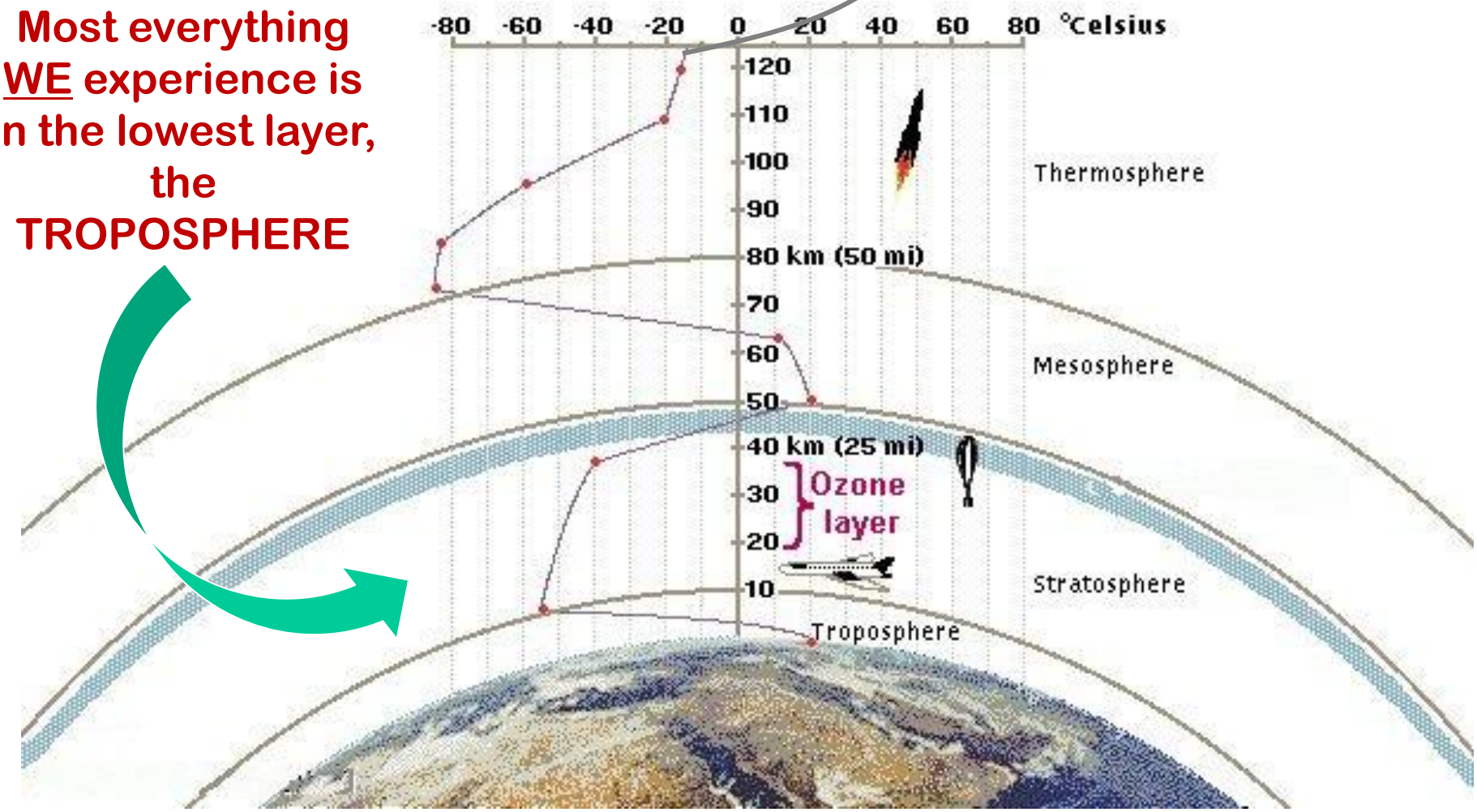
ABSORPTION of ↓ Solar SW

RADIATION of ↑ IR from surface

These layers have different thicknesses and temperatures. . .

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

This zig-zag line is showing changes in temperature with altitude



The Vertical Structure of the Atmosphere

KEY CONCEPT:

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

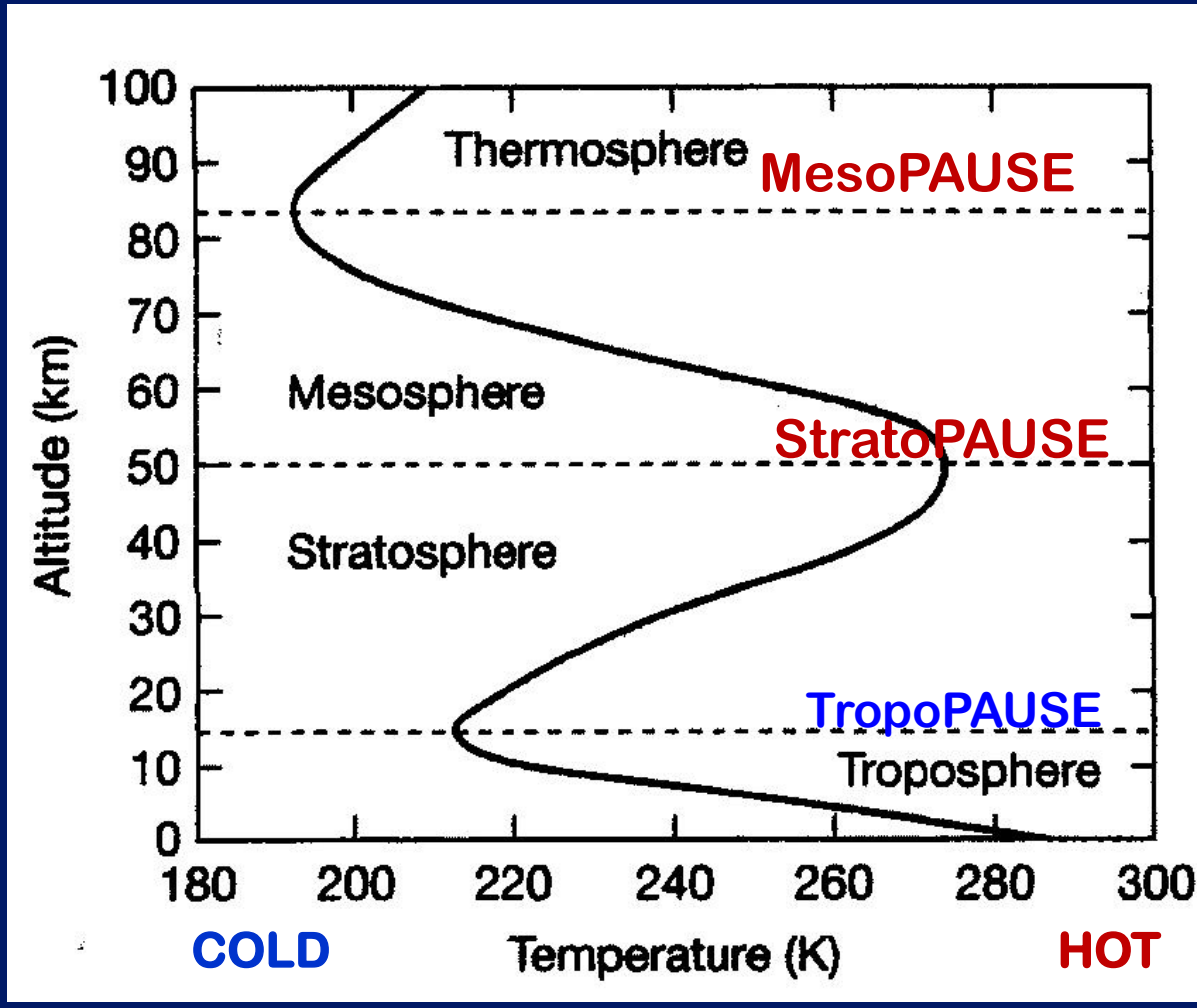
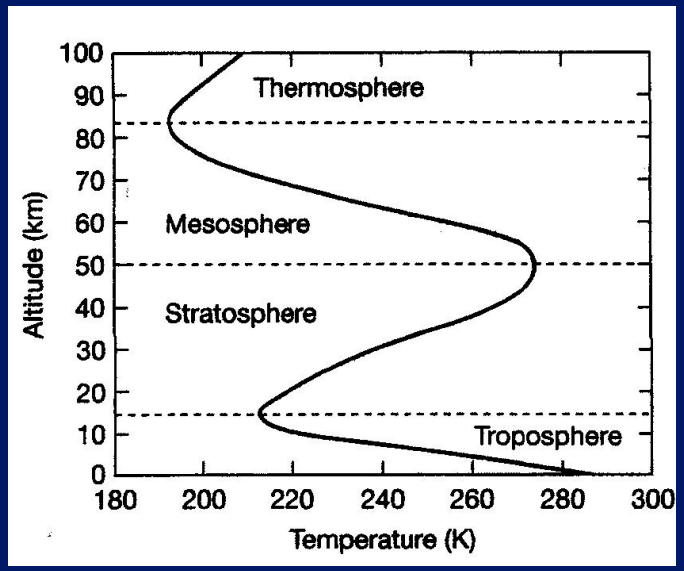


Figure 3-9b in SGC E-text



The changes in temperature with height are the result of:

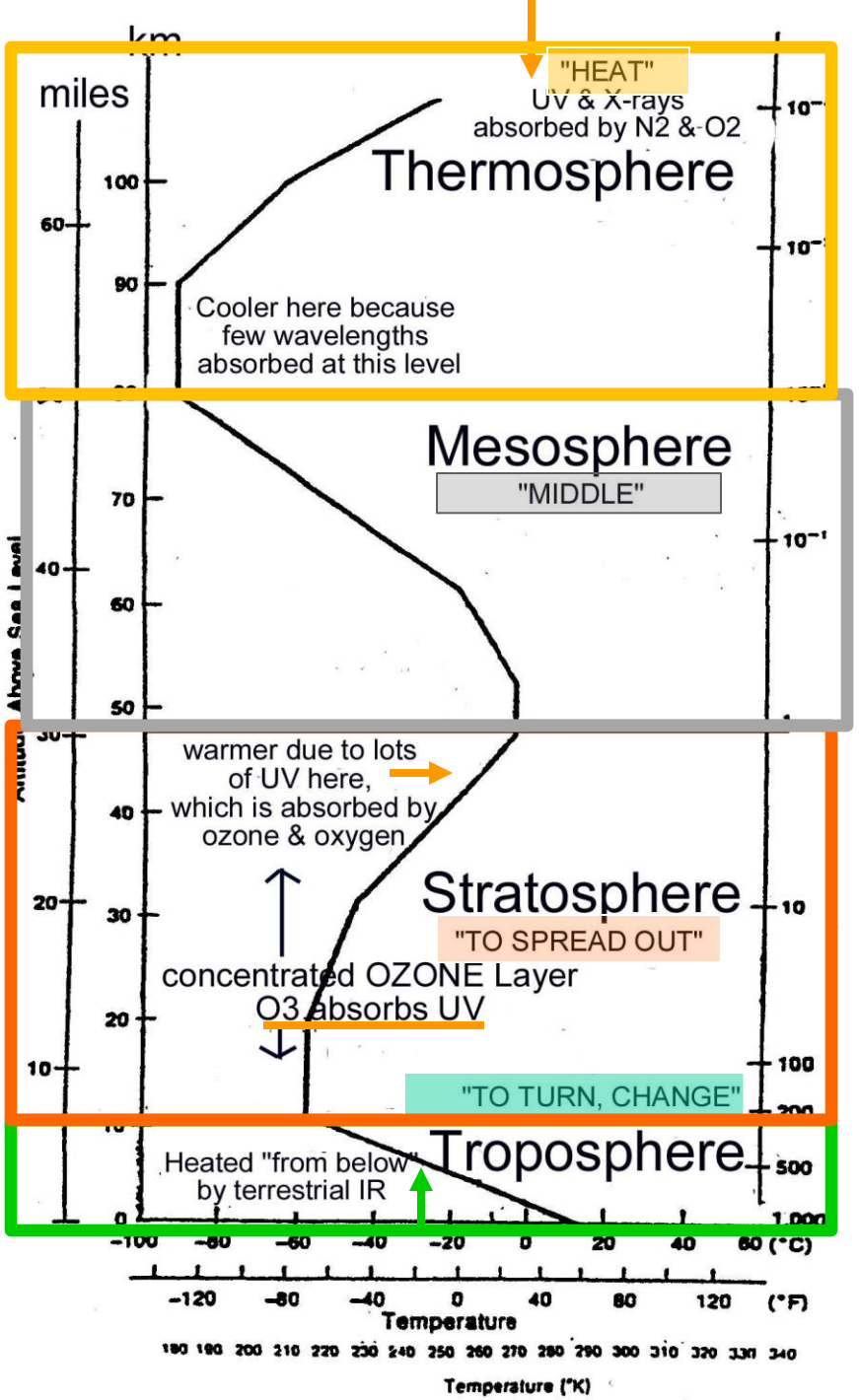
differential absorption of shortwave (SW) & longwave (LW) radiation

by atmospheric GASES concentrated at various altitudes.

SUMMARY:

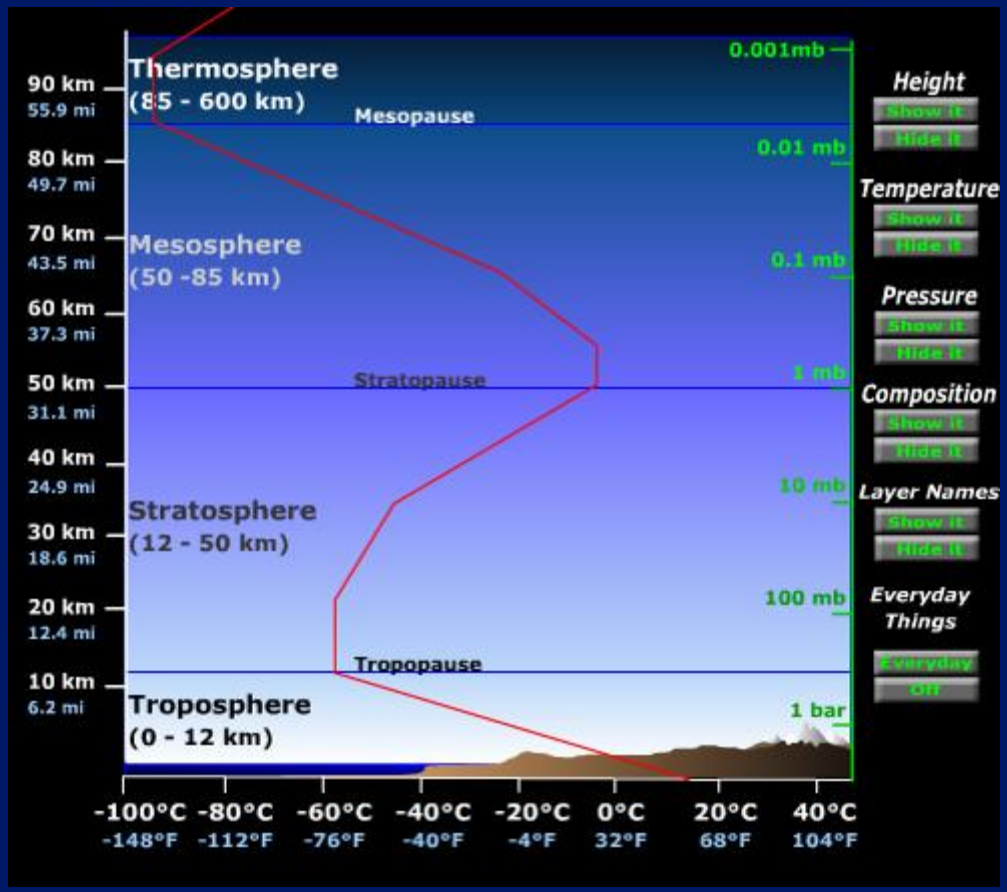
Here's why these changes in **temperature** occur :

Start at the SURFACE →



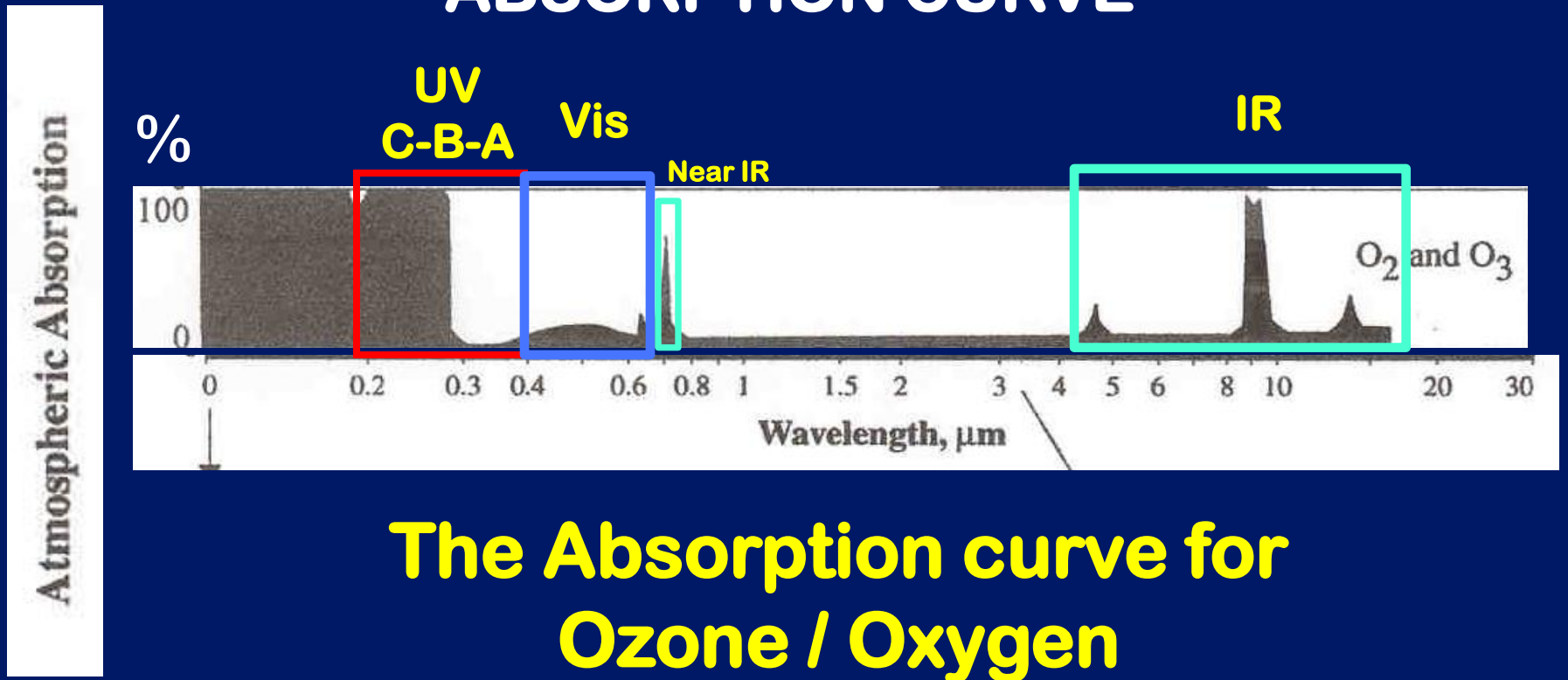
A nice online review . . .

http://earthguide.ucsd.edu/earthguide/diagrams/atmosphere/index.html



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

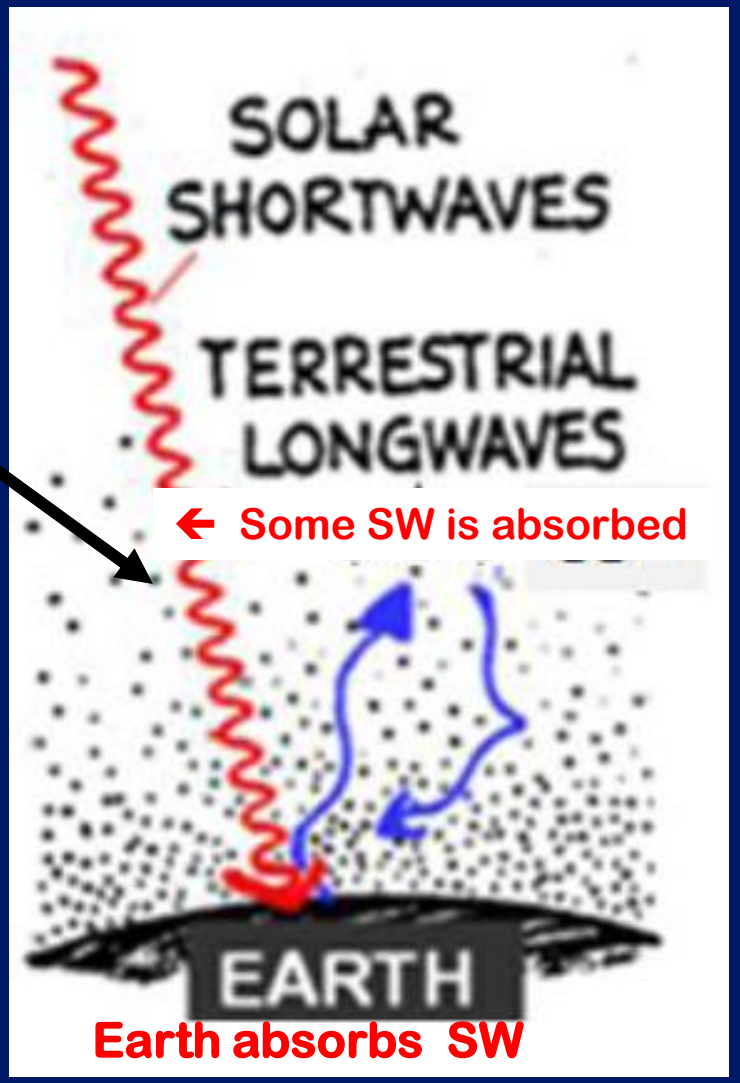


The Absorption curve for Ozone / Oxygen

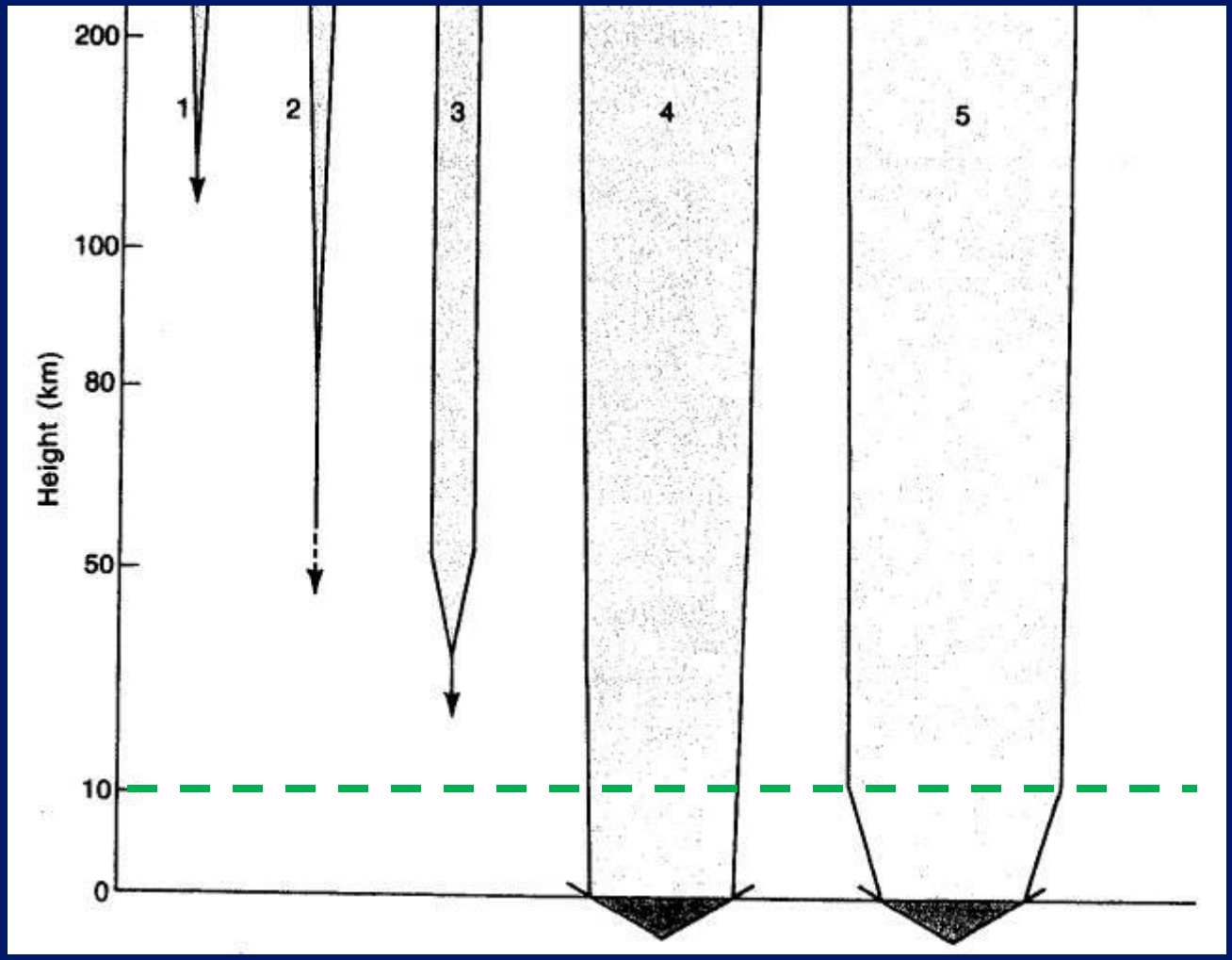
There's one more thing to correct in our the depiction of incoming Solar . . . .

<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)



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



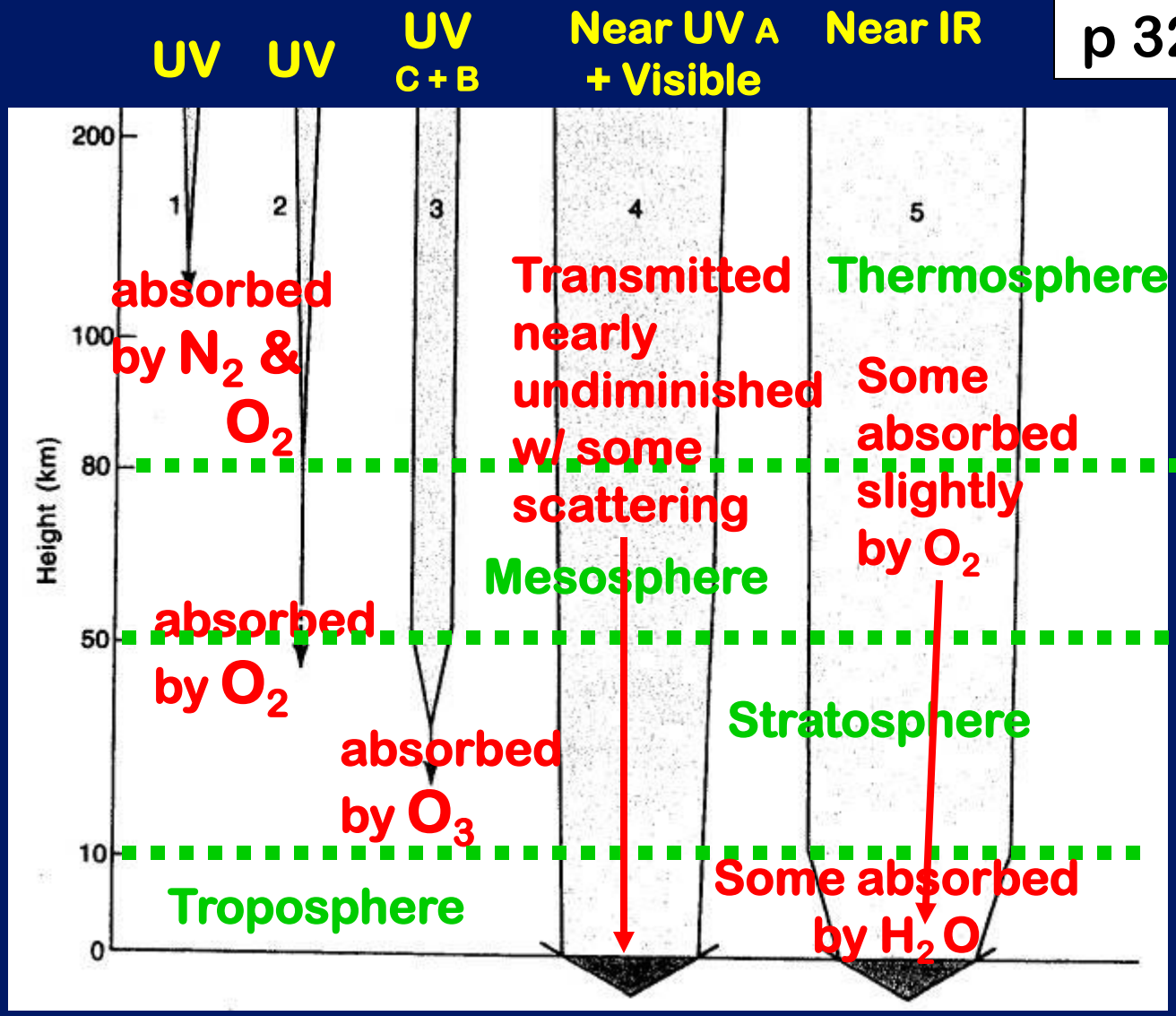
GROUP WORK:
Study this box of info & answer Q1, Q2, & Q3

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

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



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

CHECKPOINT

THINK for 15 seconds
TABLE CHAT for 15 seconds
What's your most burning question?

ATMOSPHERIC COMPOSITION

Which gases?
What concentration?
Which ones are
Greenhouse Gases (GHG)?
Where do the GHG's come from?

Which GHG's are changing in concentration due to HUMAN ACTIVITIES?

OVER THE WEEKEND
STUDY THE TABLES ON
Pages 33 & 34
to familiarize yourself with each of the GHG's

Then get ready for the
"NAME THAT GAS!"
Team Competition on Monday!

THINKING DEEPLY WRAP-UP

Participation Point Activity:

Get a blank index card from you group folder, put Name & Group # on it

Pick <u>one</u> of the following,
reflect on what you learned today about it,
& explain this in a short paragraph . . . . .➔

What we did today . . .

1) Reviewed the **LEARNING PHILOSPHY** of the course

2) Dug deeper into the pathways of **incoming solar and outgoing terrestrial radiation** and how the **Greenhouse Effect** is involved

3) Learned about **Earth-Sun Relationships** and what the an EQUINOX is – and how this causes the seasons and determines Earth's climate regions

4) Sketched the **Vertical Structure of the Atmosphere** and learned what causes it – including the role of certain gases in different layers

What to do: on the index card w/ name + Group #

Pick one of the above , reflect on what you learned today about it, & explain this in a short paragraph

SEE YOU MONDAY

ARIZONA WILDCATS

GO CATS!