

Topic # 15
OZONE DEPLETION
IN THE
STRATOSPHERE

see pp 81-85 in Class Notes

“[The Ozone Treaty is] the first truly global treaty that offers protection to every single human being.”

**~ Mostofa K. Tolba,
Director of the UN Environment Programme**

OZONE STORY = A very interesting illustration of the scientific process!

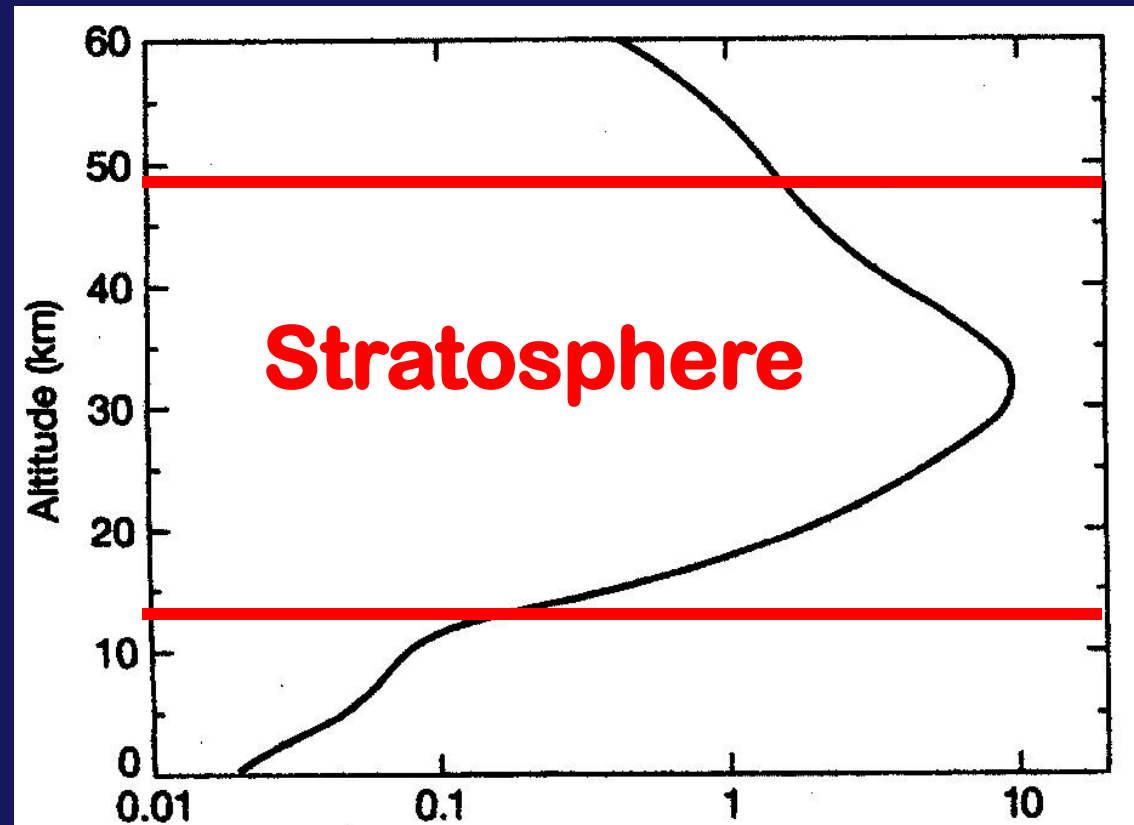
The THEORY that the ozone layer in the stratosphere might be damaged by human intervention PRECEDED the actual OBSERVATION of the ozone hole.

Yet, when the hole WAS observed (via satellite) it was almost “missed” because it wasn’t expected . . .

But let’s begin with the stratospheric ozone layer itself

WHERE IS THE OZONE LAYER?

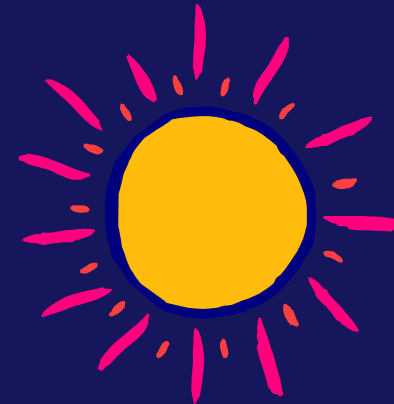
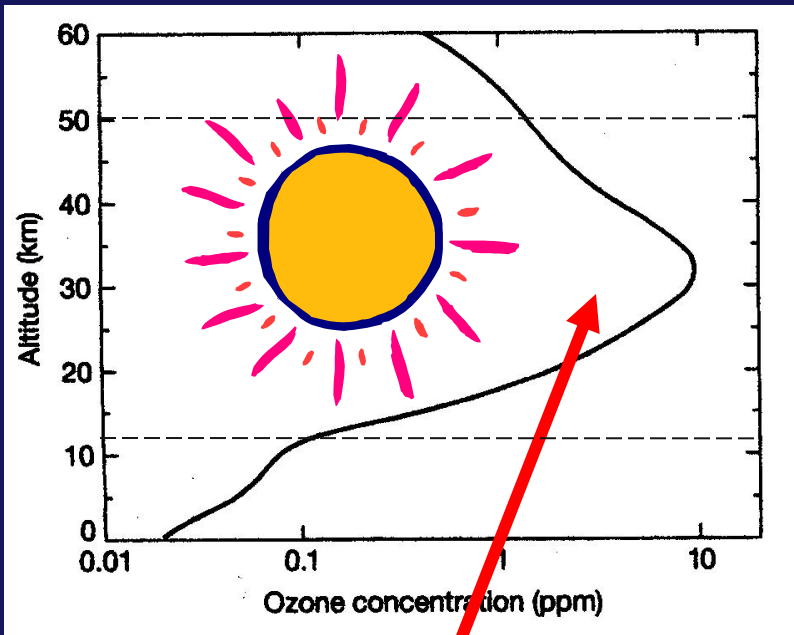
SGC
Fig. 3-11



Ozone Concentration (ppm)



OZONE: Sources



Ozone is produced naturally in photochemical reactions in the stratospheric ozone layer --“good ozone” -- is decreasing!

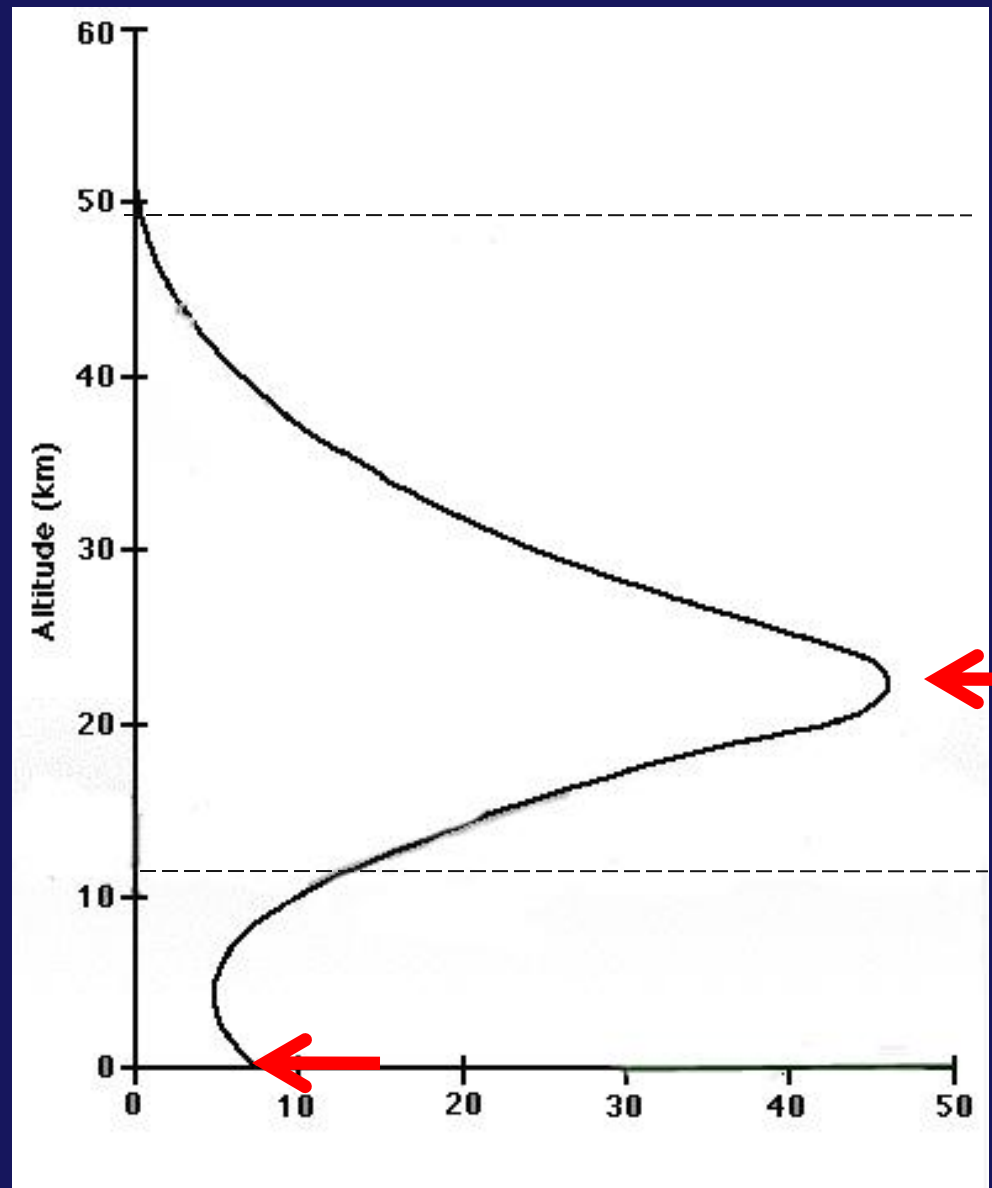


However, ozone has increased in troposphere due to photochemical smog reactions -- “bad ozone”

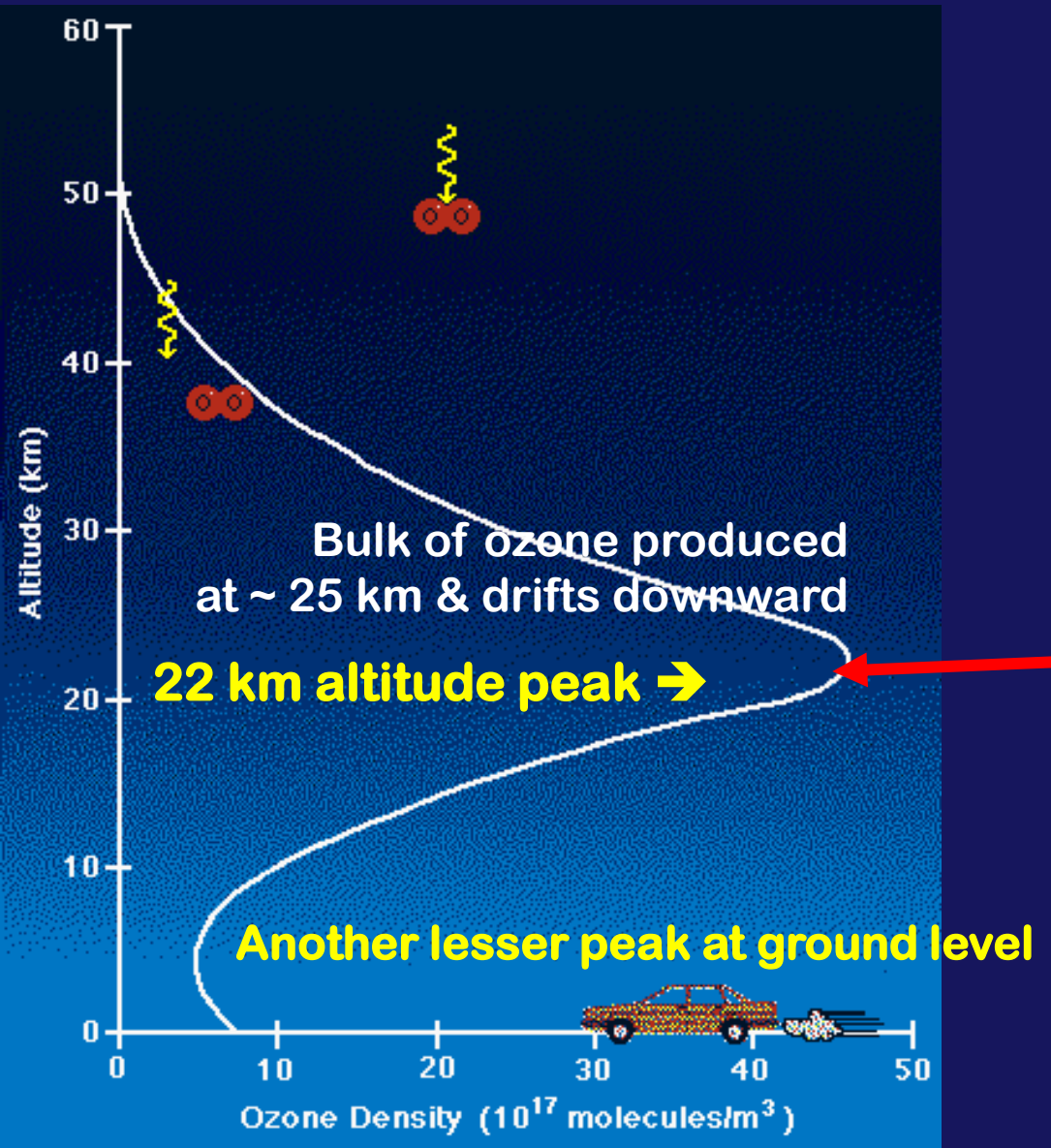
review

Here's a different version of the figure →

Shows 2 peaks, a major peak in O₃ density in the **stratosphere**, a smaller secondary peak in the **lower troposphere**



Ozone Density
(10^{17} molecules / m³)



First we'll focus on the "GOOD" ozone located in the STRATOSPHERE (the ozone that is being depleted leading to an ozone "hole")



THE OZONE LAYER IN THE STRATOSPHERE -- **WHY IT'S THERE**

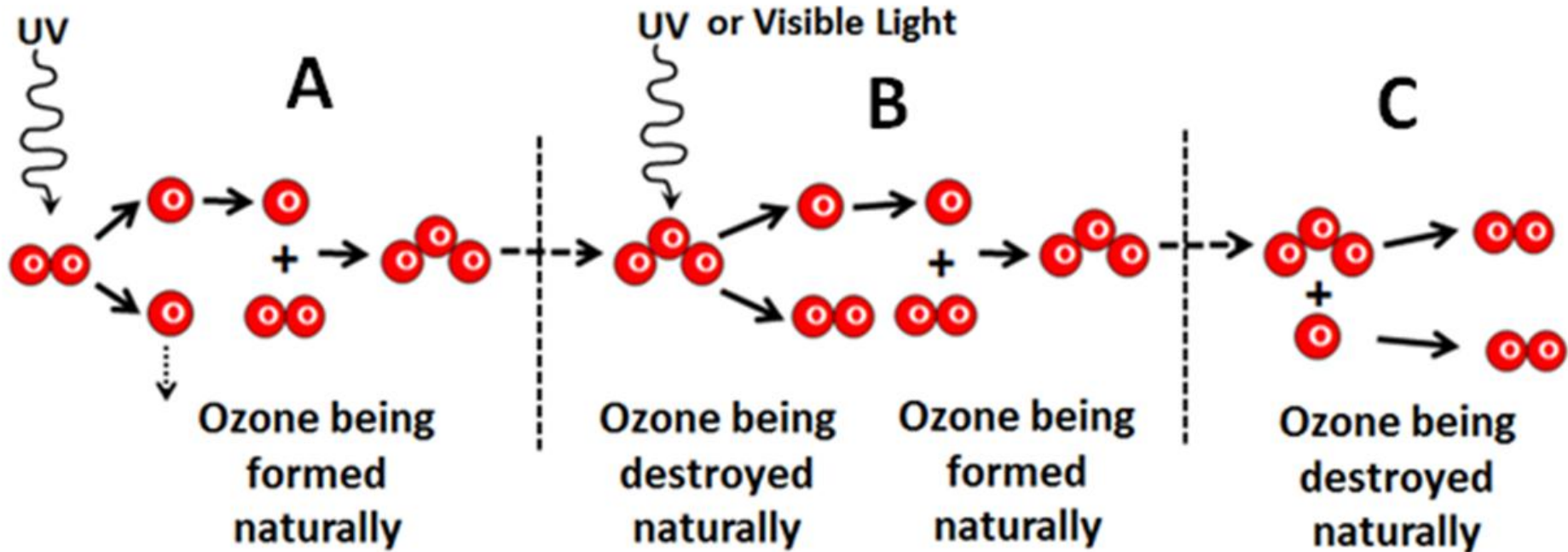
Due to: the natural
“Chapman Mechanism”
(a series of photochemical reactions)

THE CHAPMAN MECHANISM

(first proposed in 1930s)

- ozone is continuously produced and destroyed
- through **PHOTOCHEMICAL REACTIONS** in the stratosphere
- involves oxygen (O_2), molecular oxygen (O), photons of UV radiation, and **OZONE** (O_3).

The Chapman Mechanism



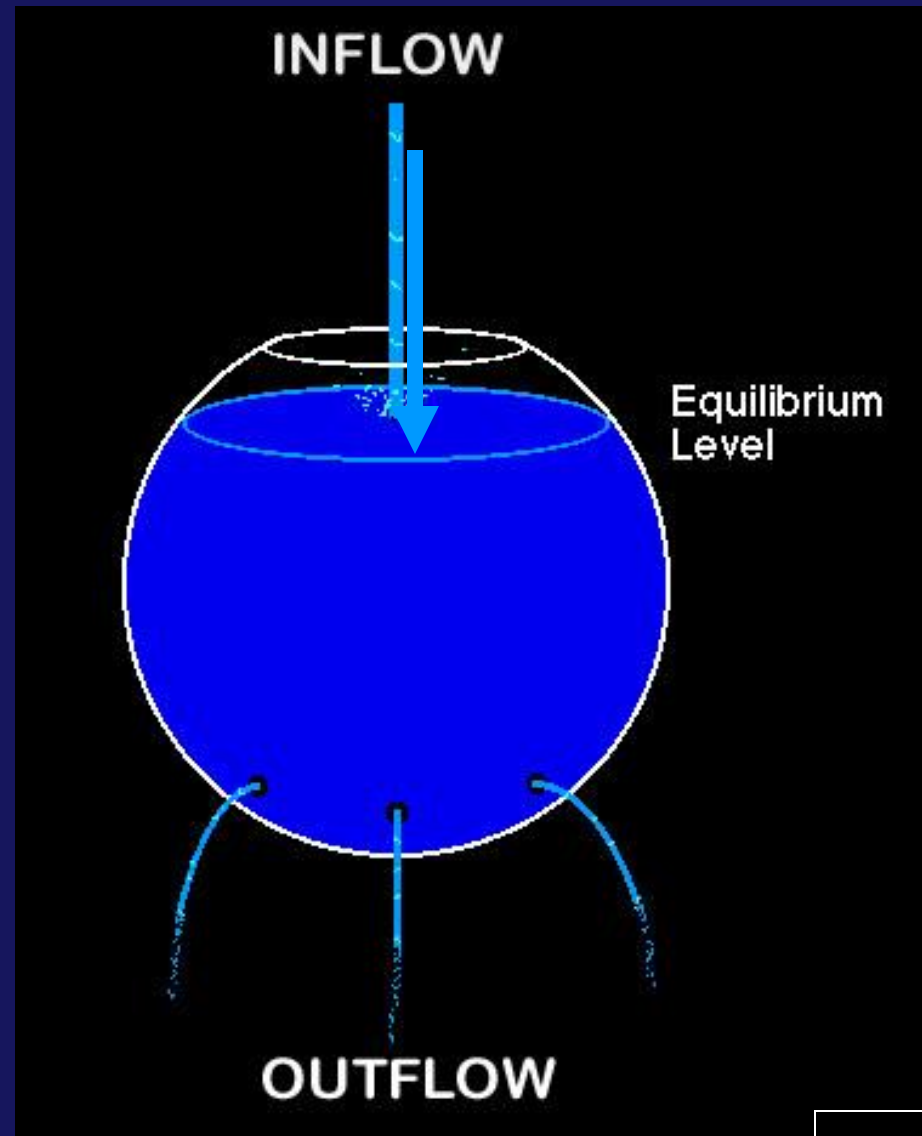
[Go to movie clip]

In theory:

- **a balance of ozone is established over time**
- > prevents much of the harmful UV radiation from reaching the earth's surface.**

**Leads to an “Equilibrium” or
“Steady State”**

STEADY STATE =
a condition in which
the **STATE** of a
system component
(e.g. reservoir)
is **CONSTANT**
over time.

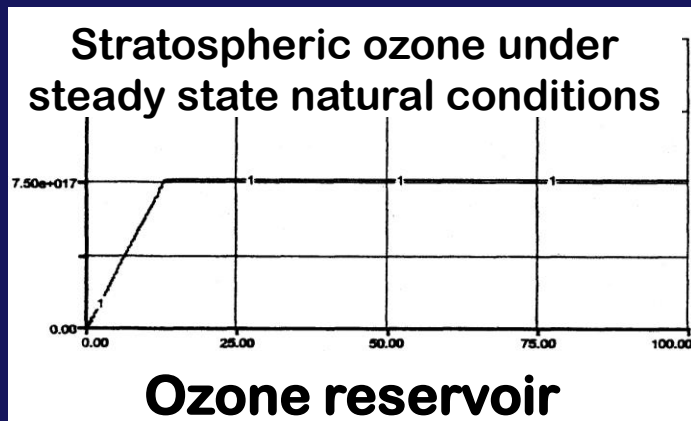
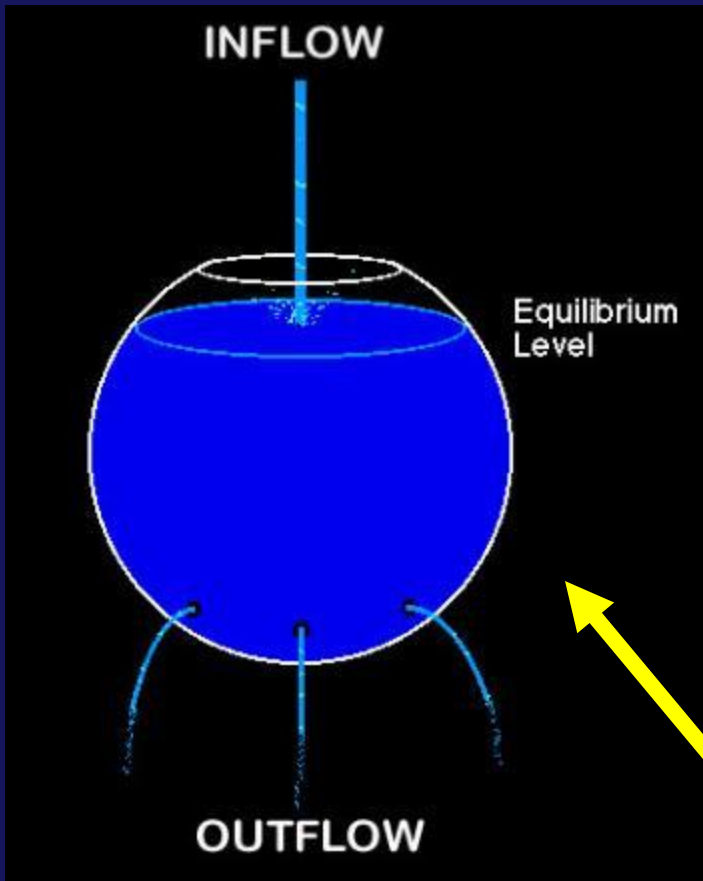


Steady state can be achieved in a reservoir:

a) if there are no inflows or outflows, *or*

b) if the rate of inflow = the rate of outflow.

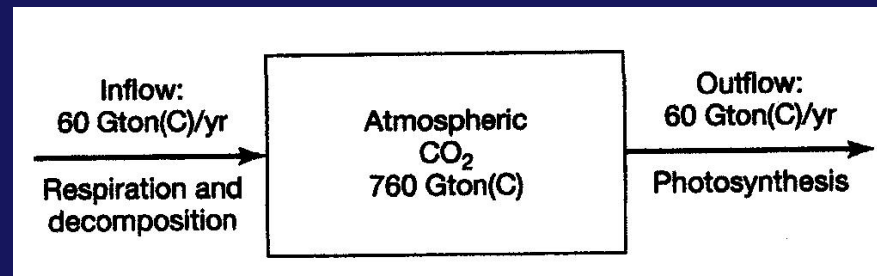
Any imbalance in these rates leads to a change in the level of the reservoir.



FLOW DIAGRAM OF A STEADY STATE

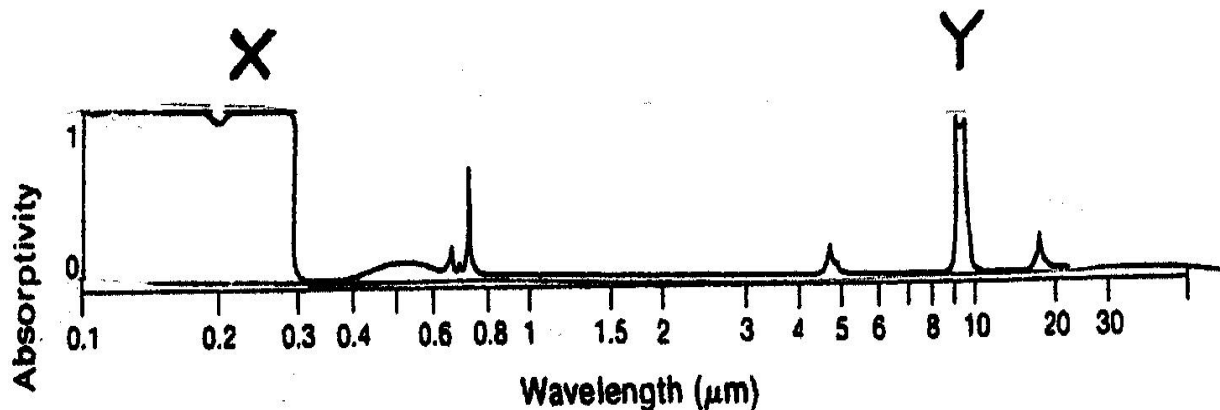
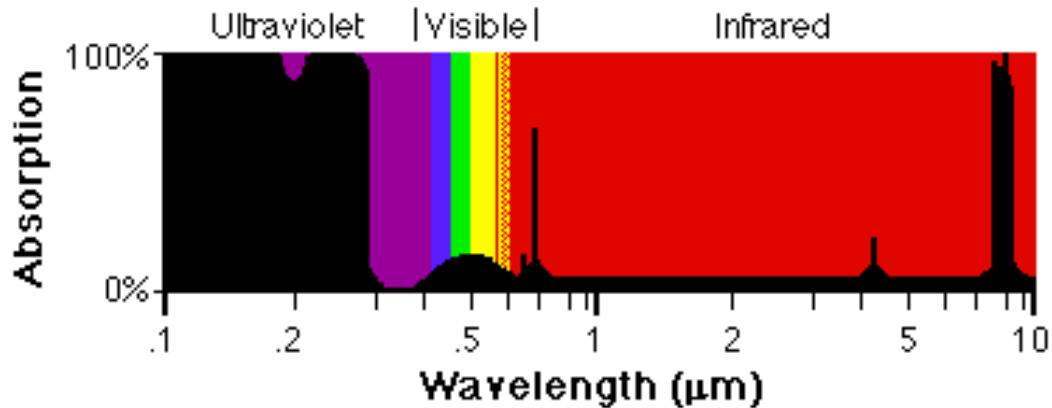


Where have we seen something like this before?



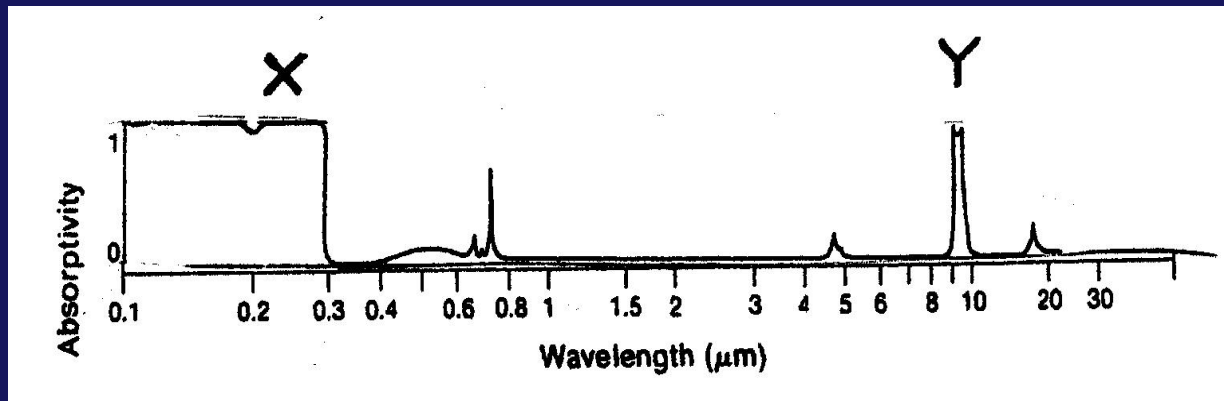
Review: Why stratospheric ozone is “Good”:

Black areas = radiation absorbed



Ozone has the property of being a very strong absorber of ultraviolet radiation → **nearly total absorption of wavelengths less than 0.3 μm**

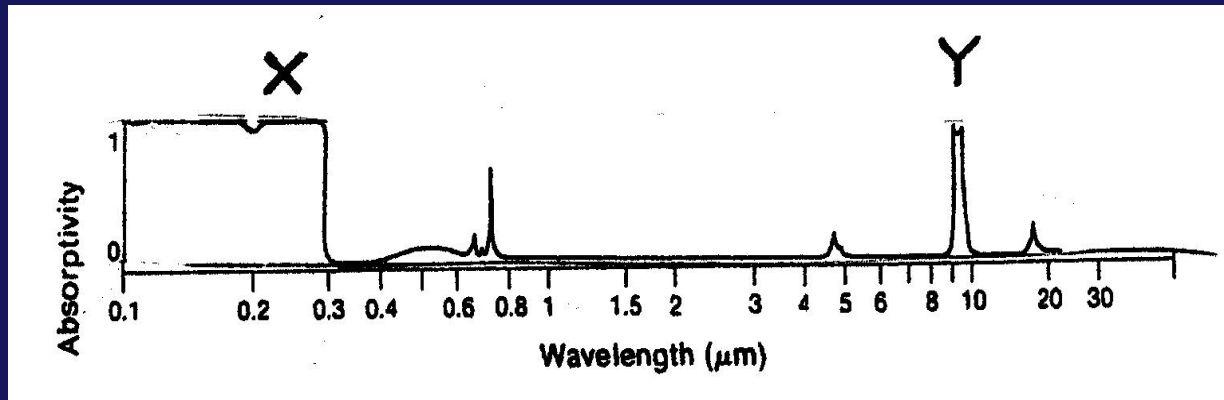
← remember this absorption curve?



Q4 – What is the **CORRECT** completion to this sentence:

The global change issue usually referred to as **Stratospheric Ozone Depletion** is related to the part of the absorption curve that is labeled _____.

(1) **X** or (2) **Y**

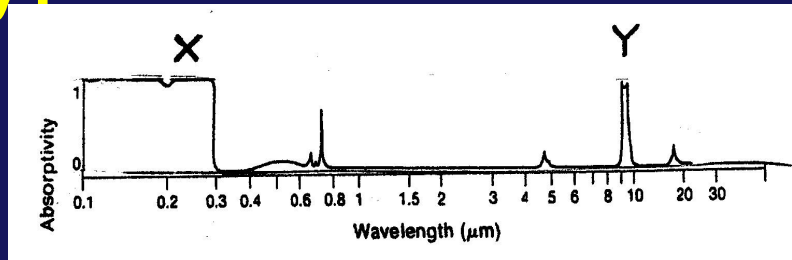


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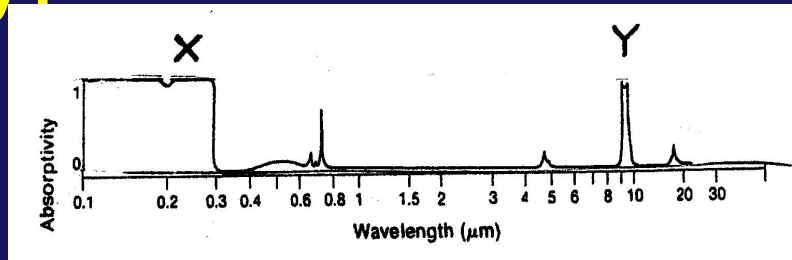
(1) **X** or (2) **Y**

Q5. Ok, **X** is right, but
Why?



1. . . . because X represents **UV** radiation being absorbed -- hence **if ozone is depleted, MORE ultraviolet** radiation will **reach the Earth's surface**.
2. . . . because X represents **terrestrial longwave** radiation being absorbed -- and hence serves as a catalyst in the Chapman mechanism.
3. . . . because X represents **easy transmission of wavelengths of terrestrial longwave radiation out to space which** then disappear through the “atmospheric window” also known as the ozone hole.

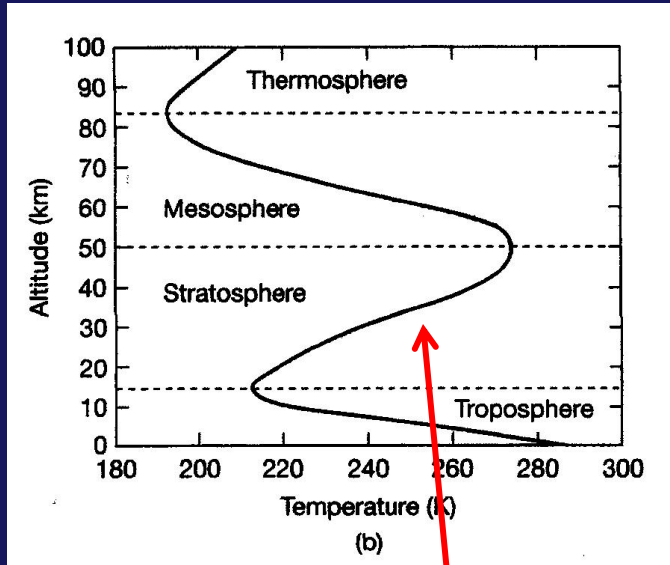
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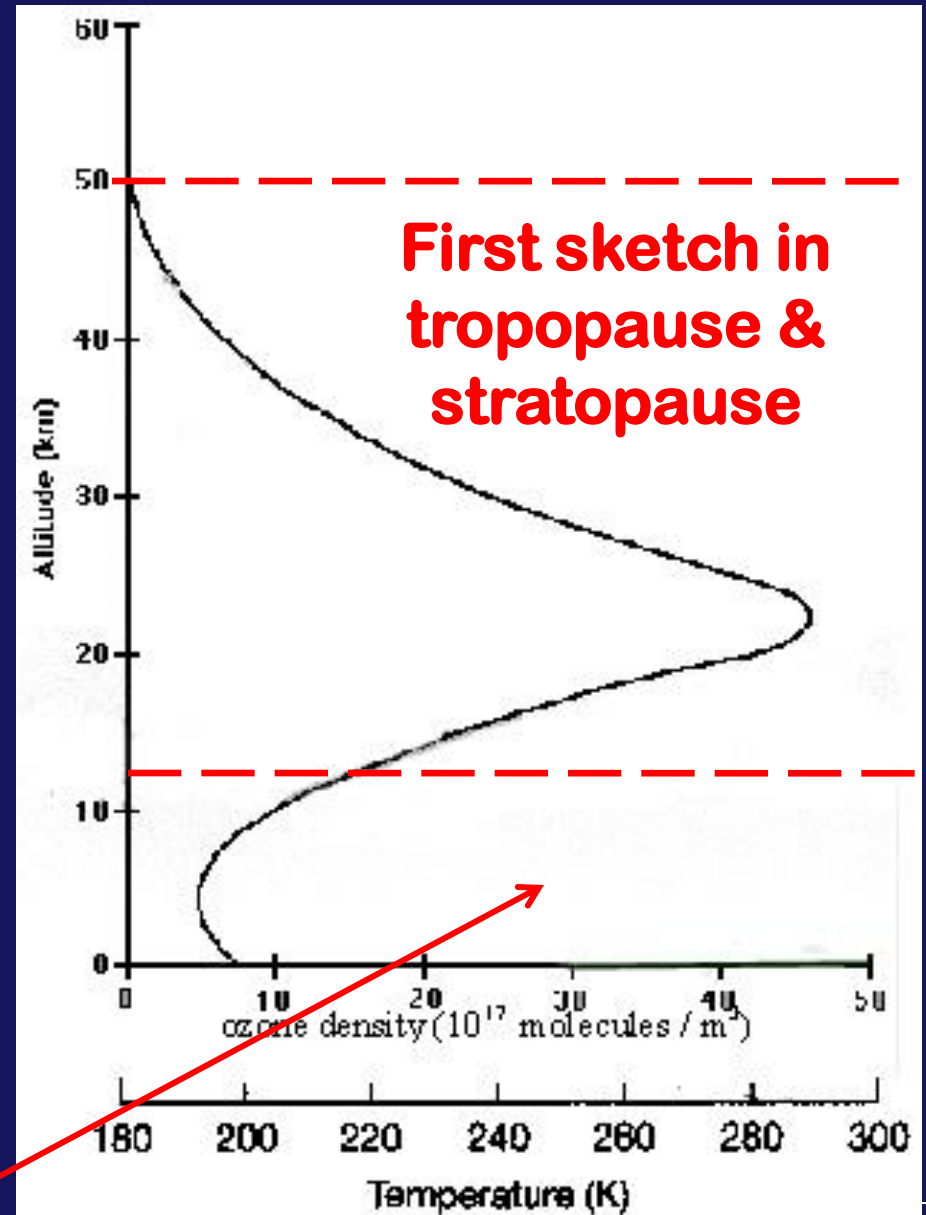
From p. 40 in
Class Notes:

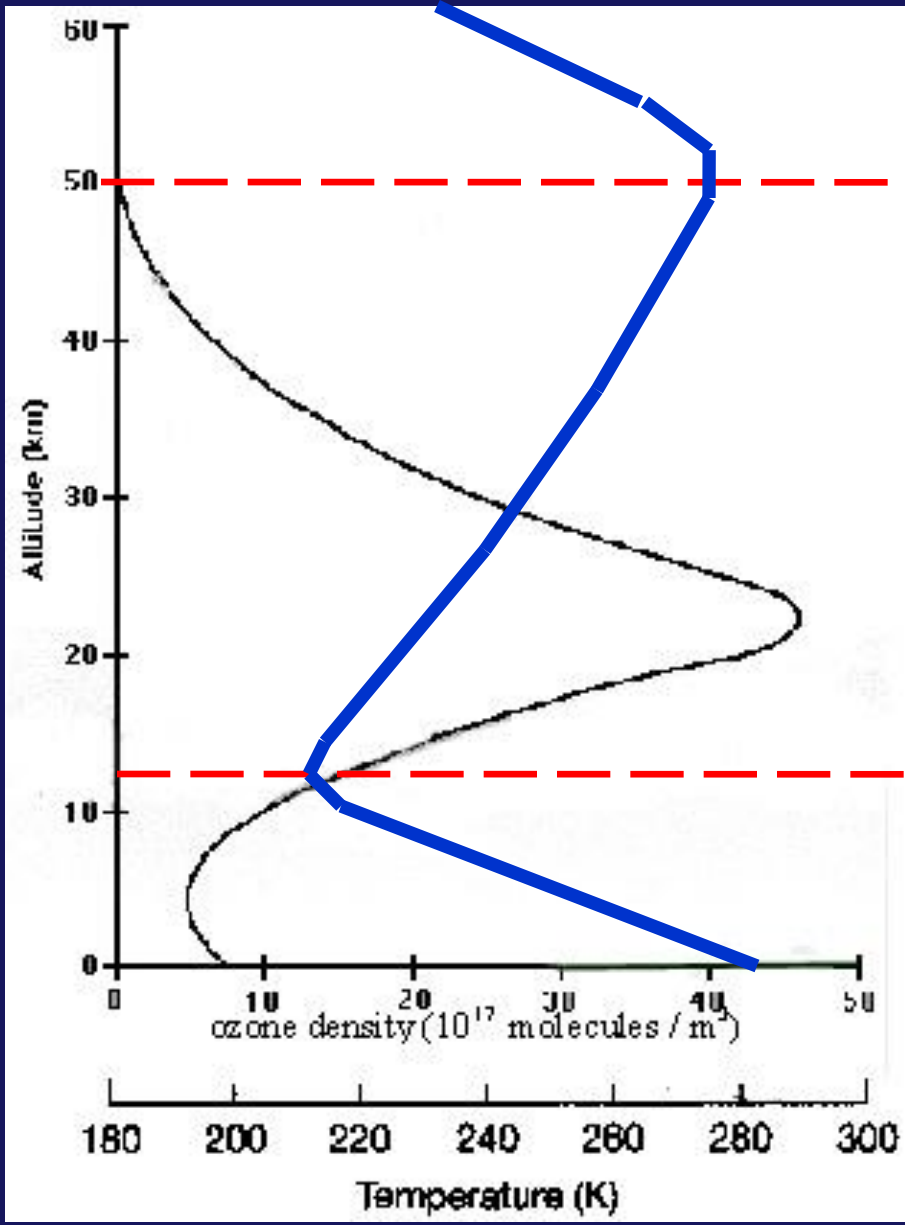
Temperature graph



Now roughly sketch
the temperature line
from this graph onto
the ozone graph

Ozone Density graph





TEMPERATURE

[increases / decreases]

with increasing altitude
in the stratosphere

WHY???

Q6. Why is there an increase in temperature with altitude in the STRATOSPHERE?



1. It is the **closest layer to the sun**, hence it is **closest to the solar “heat source.”**
2. It receives **large amounts of UV radiation** from the sun PLUS it has a **high concentration of ozone** to absorb this UV.
3. It is the layer which **contains most of the GH gases** that absorb IR radiation emitted by the Earth's surface.

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**This is about where we
ended . . . We'll finish up on
THURSDAY
before TEST #4!**