

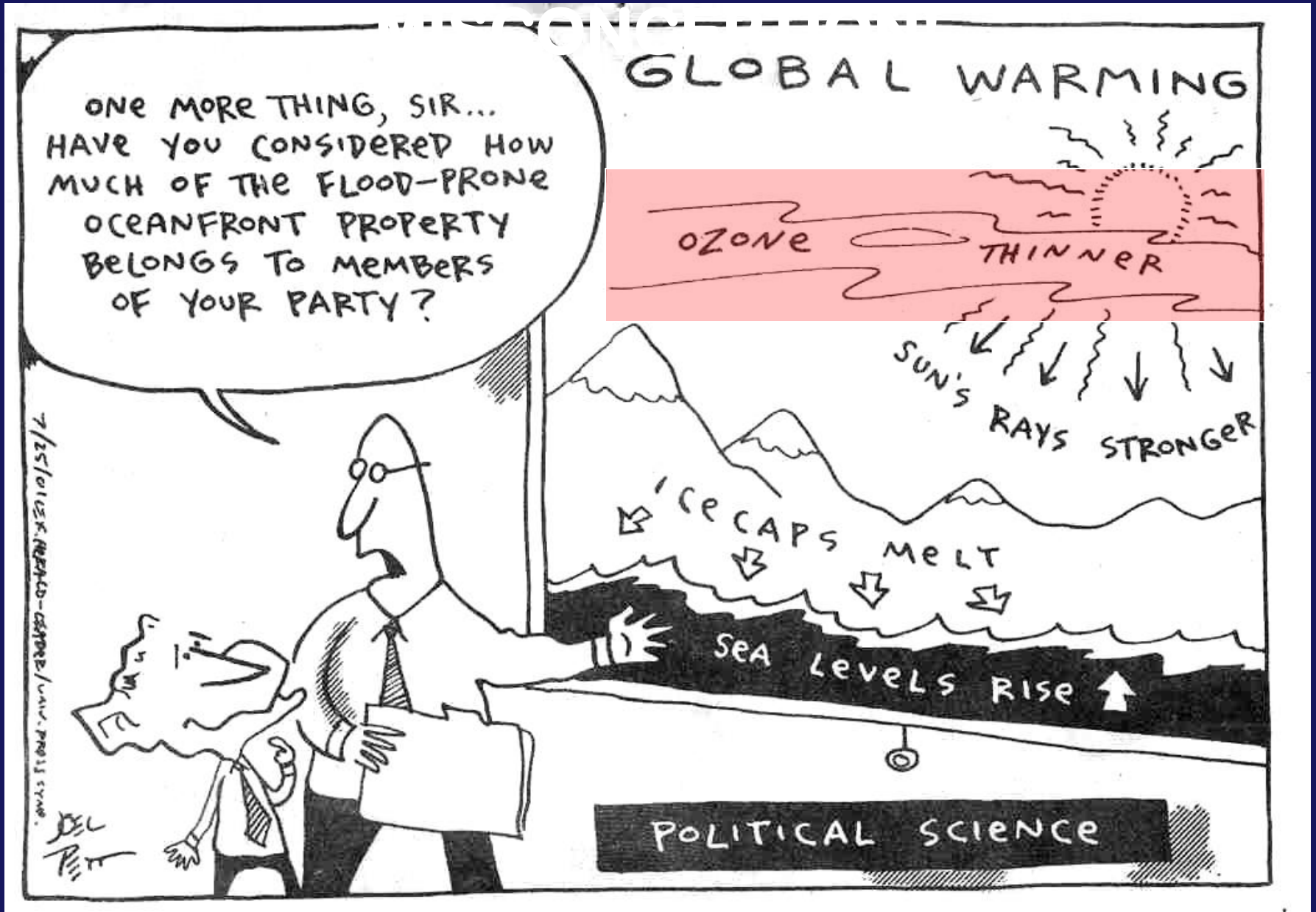
Topic # 14

OZONE DEPLETION IN THE STRATOSPHERE

A Story of Anthropogenic
Disruption of a Natural
Steady State

p 77 in Class Notes

AN OZONE-RELATED CARTOON:



Q1 – Is the depletion of STRATOSPHERIC OZONE (in the OZONE HOLE and elsewhere) an important cause of GLOBAL WARMING?

1 – YES

2 -- NO

“[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!

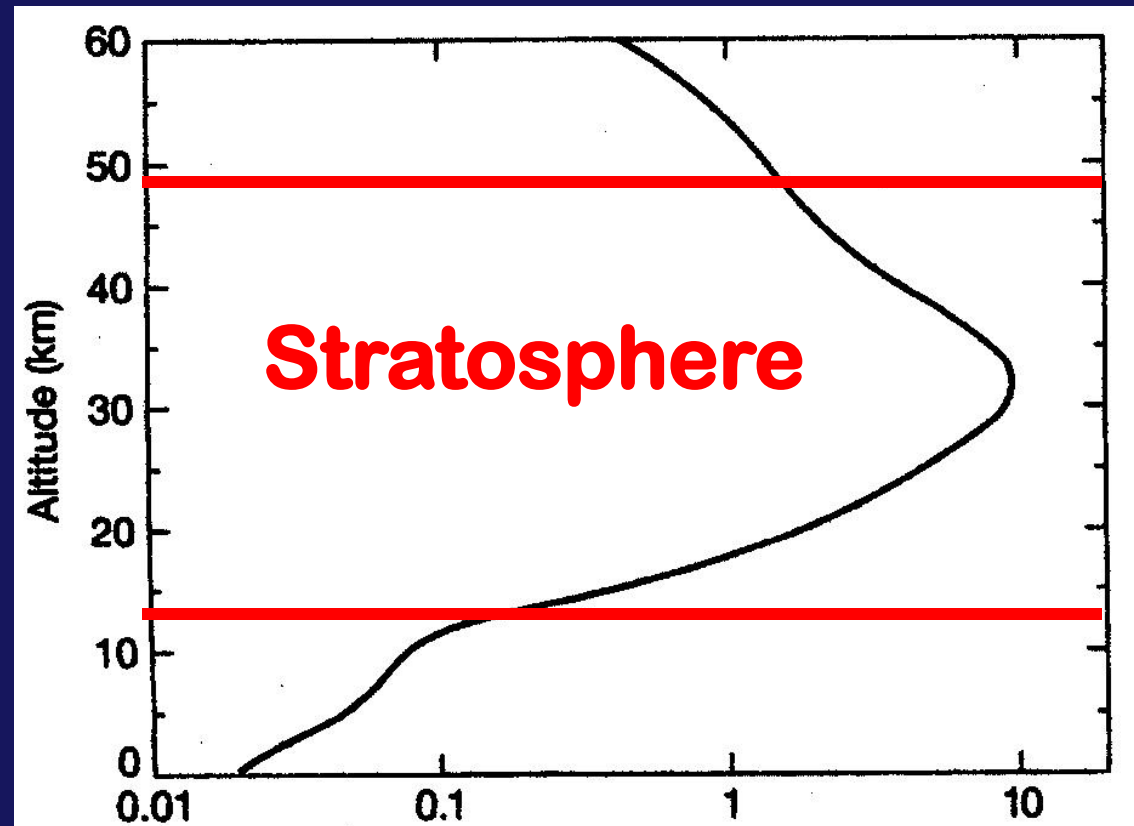
The THEORY that the ozone layer in the stratosphere might be damaged by human intervention PRECEDED the actual OBSERVATION of the ozone hole.

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

REVIEW: WHERE IS THE OZONE LAYER?

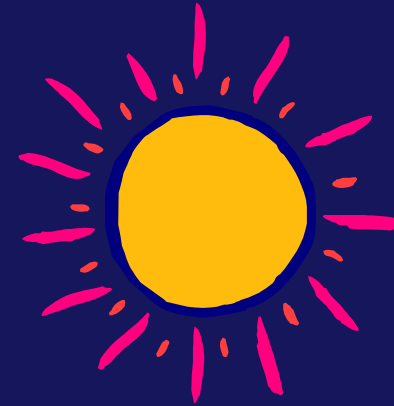
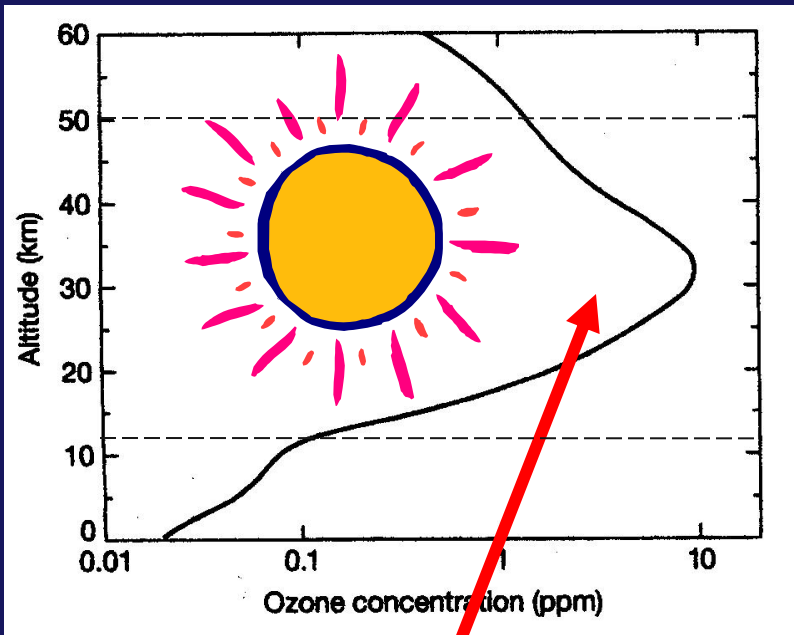
SGC
E-Text
Fig. 3-11



Ozone Concentration (ppm)



OZONE: Sources



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

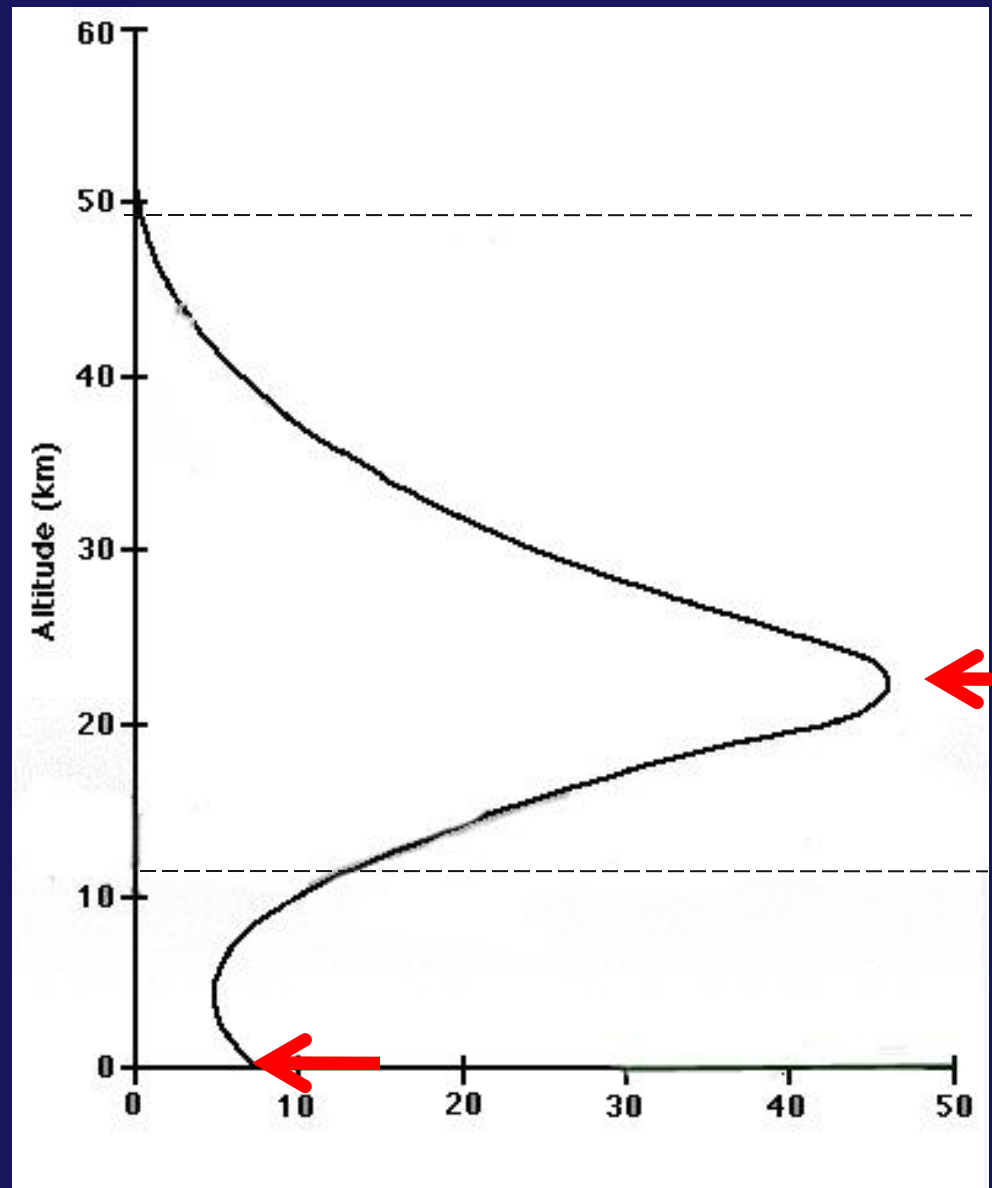


However, ozone has increased in troposphere due to photochemical smog reactions -- “bad ozone”

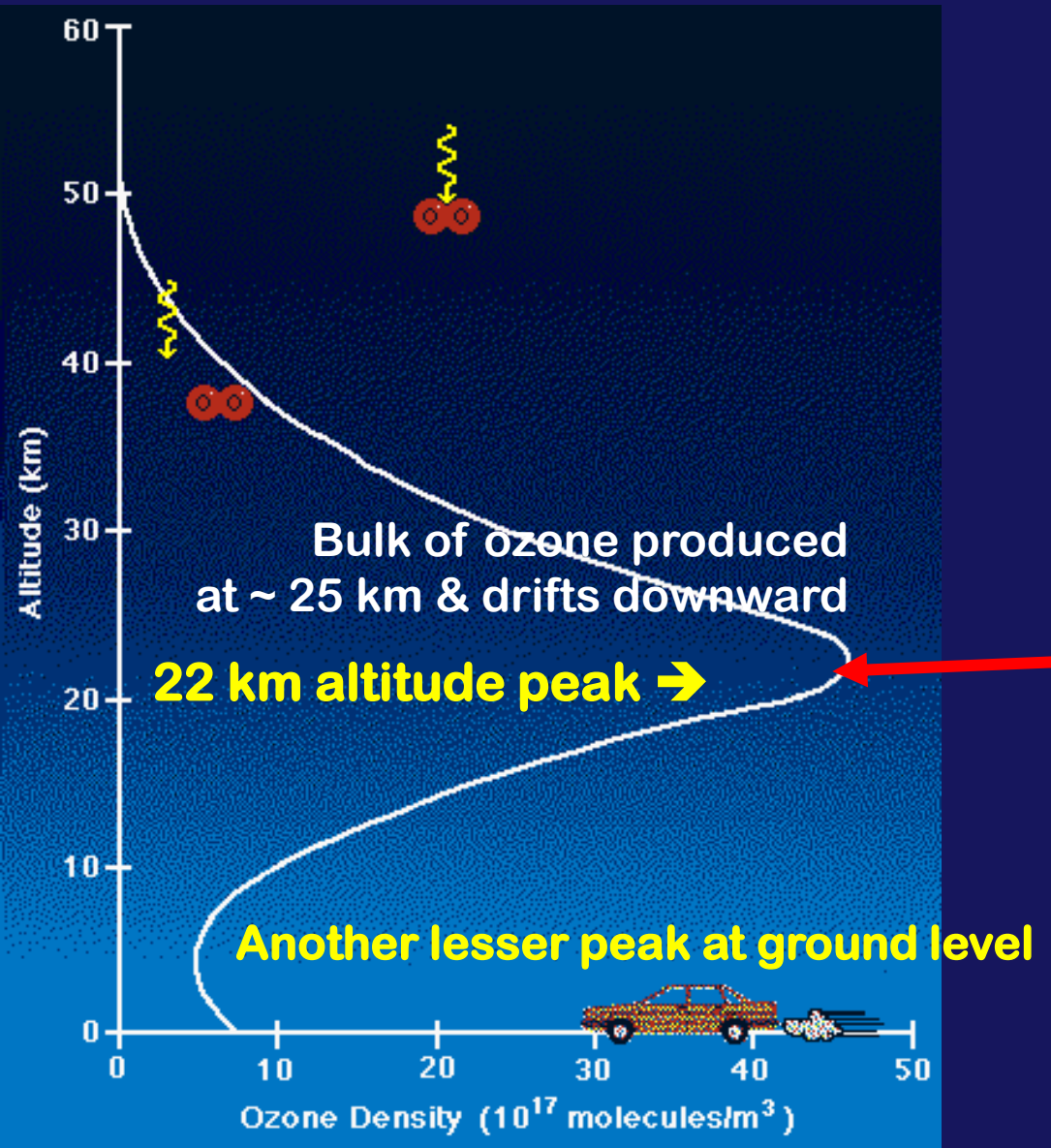
review

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**

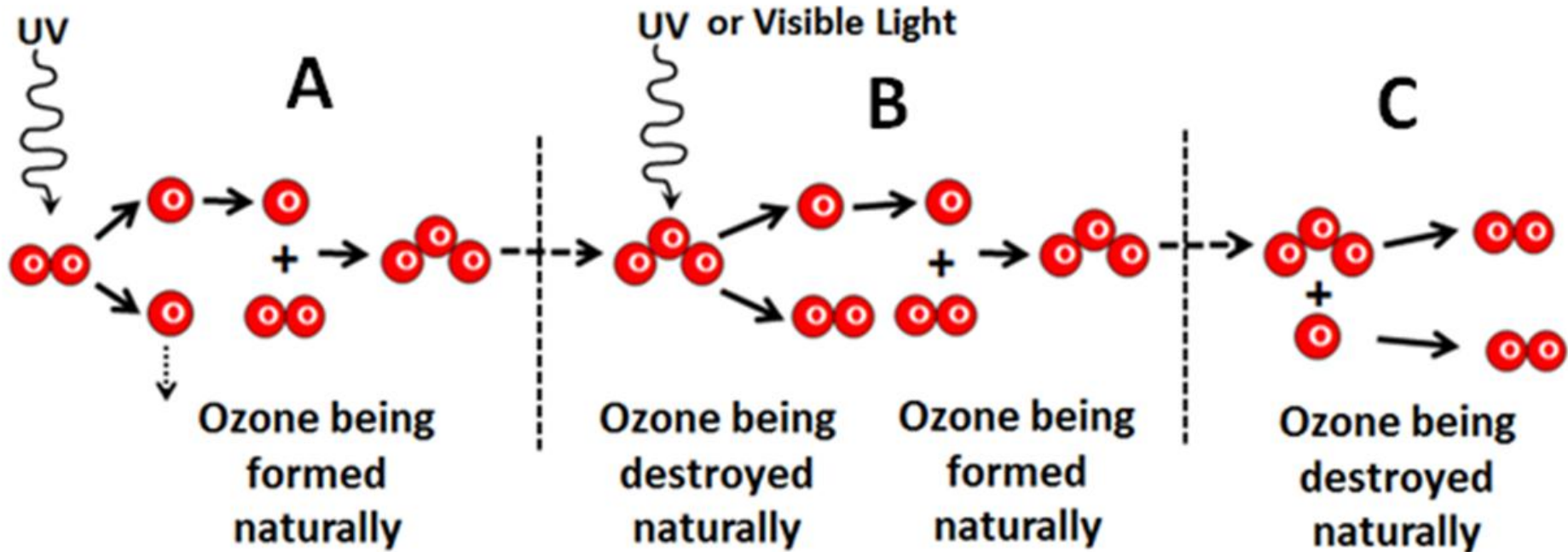
Due to: the natural
“Chapman Mechanism”
(a series of photochemical reactions)

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



(See explanation in box on top of p 77)

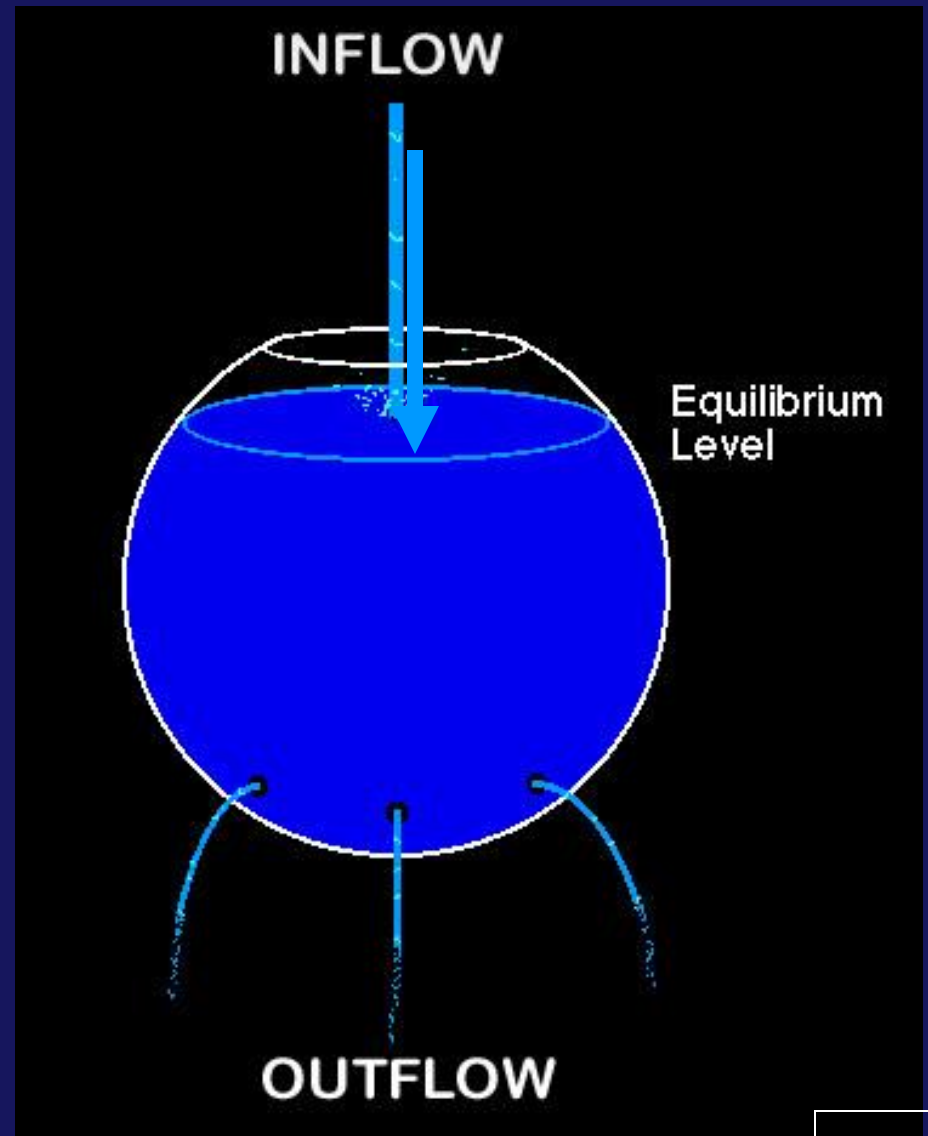
[Go to movie clip]

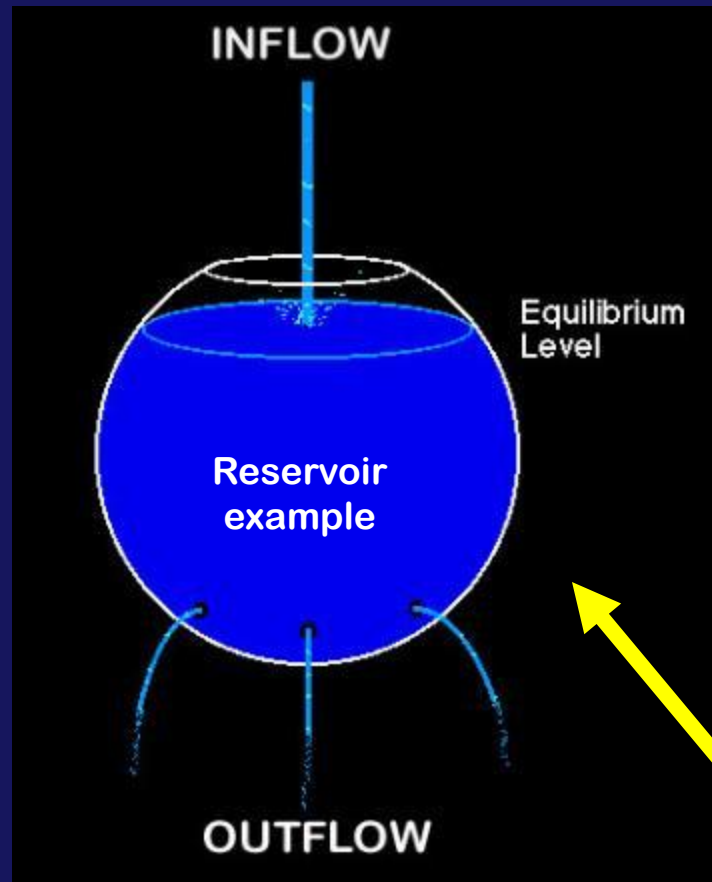
In theory:

- **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.

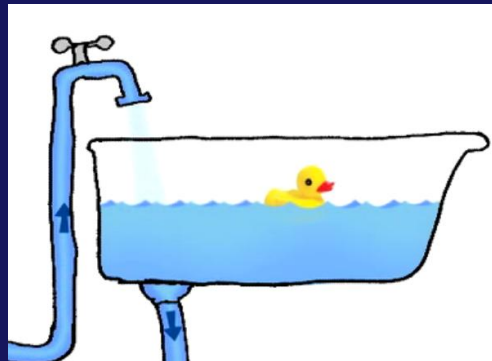


FLOW DIAGRAM OF A STEADY STATE



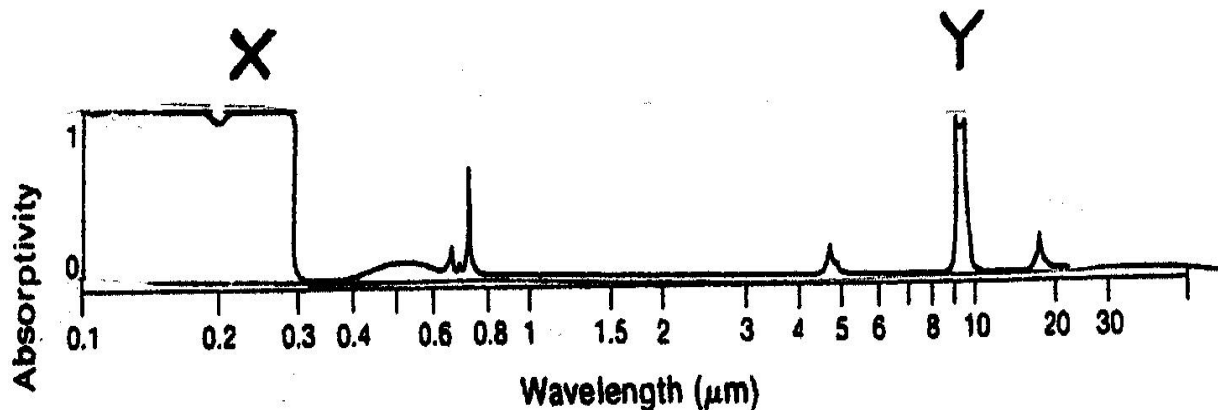
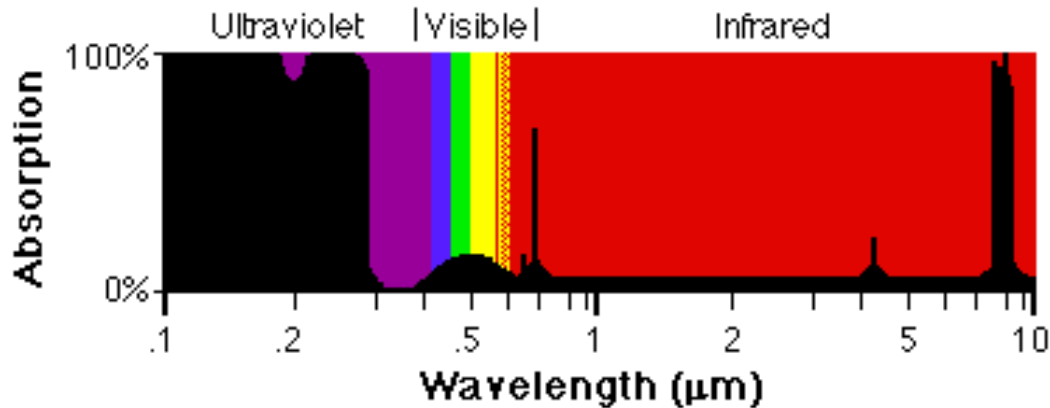
Where have we seen something like this before?

Lesson 1
Carbon Dioxide in
the Atmosphere



Review: Why stratospheric ozone is “Good”:

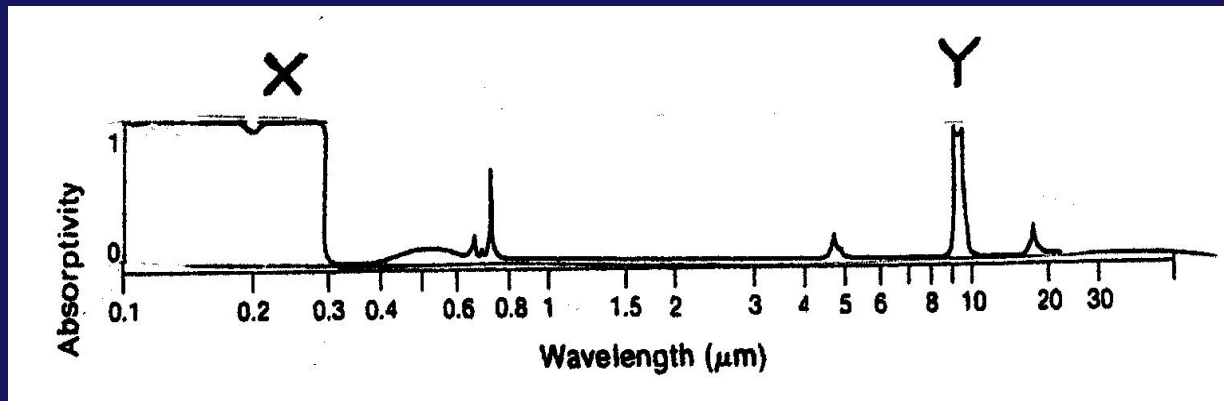
Black areas = radiation absorbed



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?

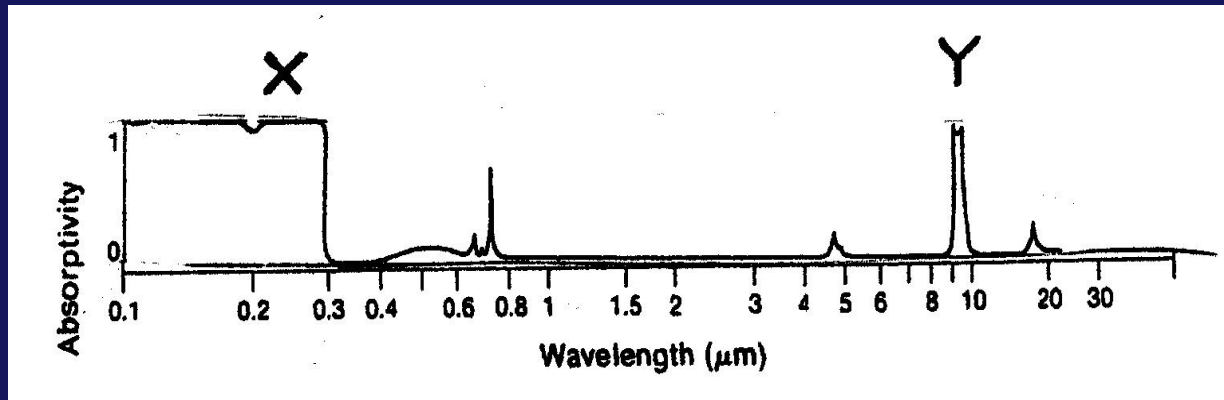
←**CLICKER Q** coming up!



Q2 – 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**

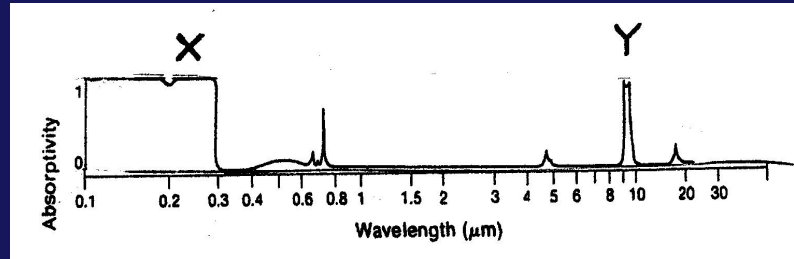


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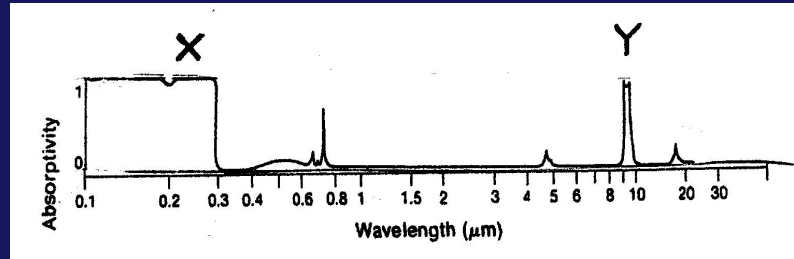
(1) **X** or (2) **Y**

Q3. Ok, X is right, but Why?



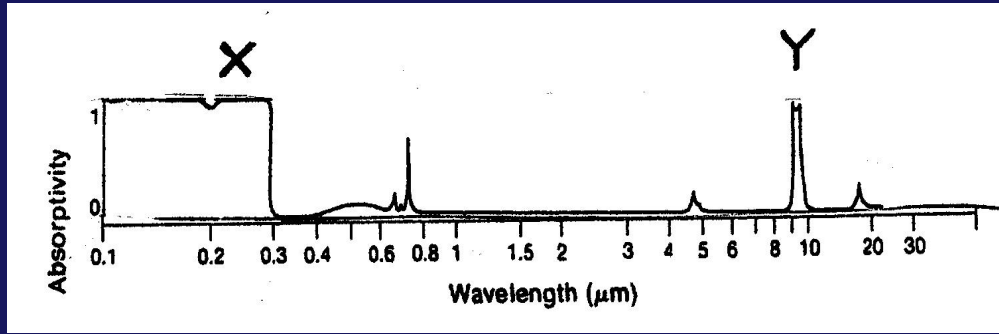
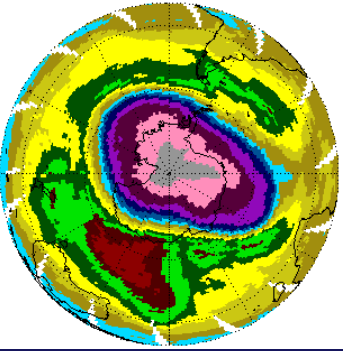
1. . . . because X represents **UV** radiation being absorbed -- hence **if ozone is depleted, MORE ultraviolet** radiation will **reach the Earth's surface**.
2. . . . because X represents **terrestrial longwave** radiation being absorbed -- and hence serves as a catalyst in the Chapman mechanism.
3. . . . 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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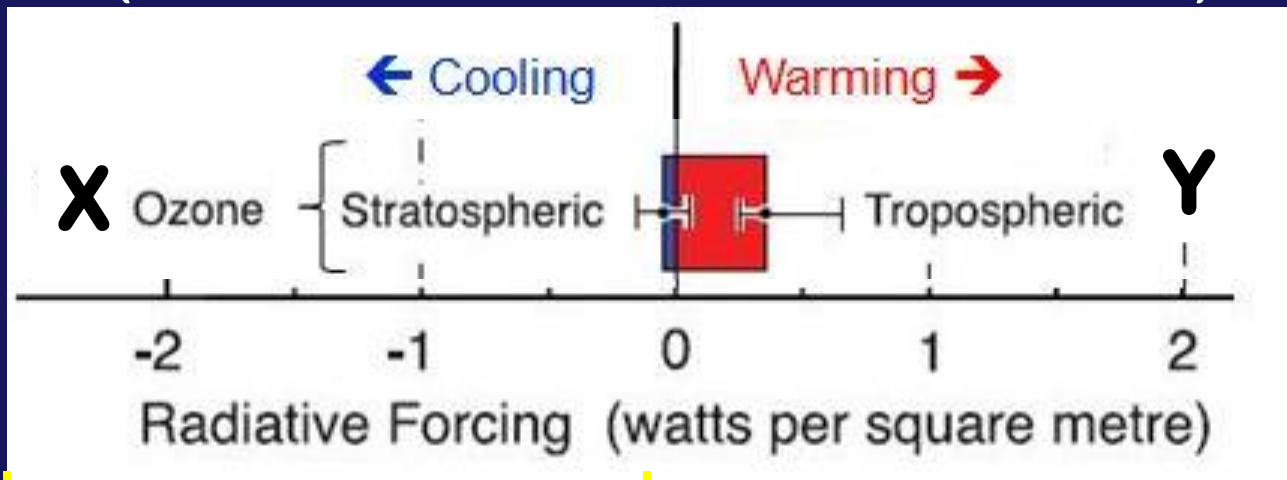


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OZONE'S DUAL PERSONALITY!



RADIATIVE FORCING:
(how much a factor warms or cools)



Important as an absorber of harmful UV in the **STRATOSPHERE**

Important as an absorber of IR as a GH Gas in the **TROPOSPHERE**

**To be continued on
Wednesday . . .**