Last part of:

Topic # 8
ATMOSPHERIC STRUCTURE & CHEMICAL COMPOSITION

NITROUS OXIDE (N_2O): Sources

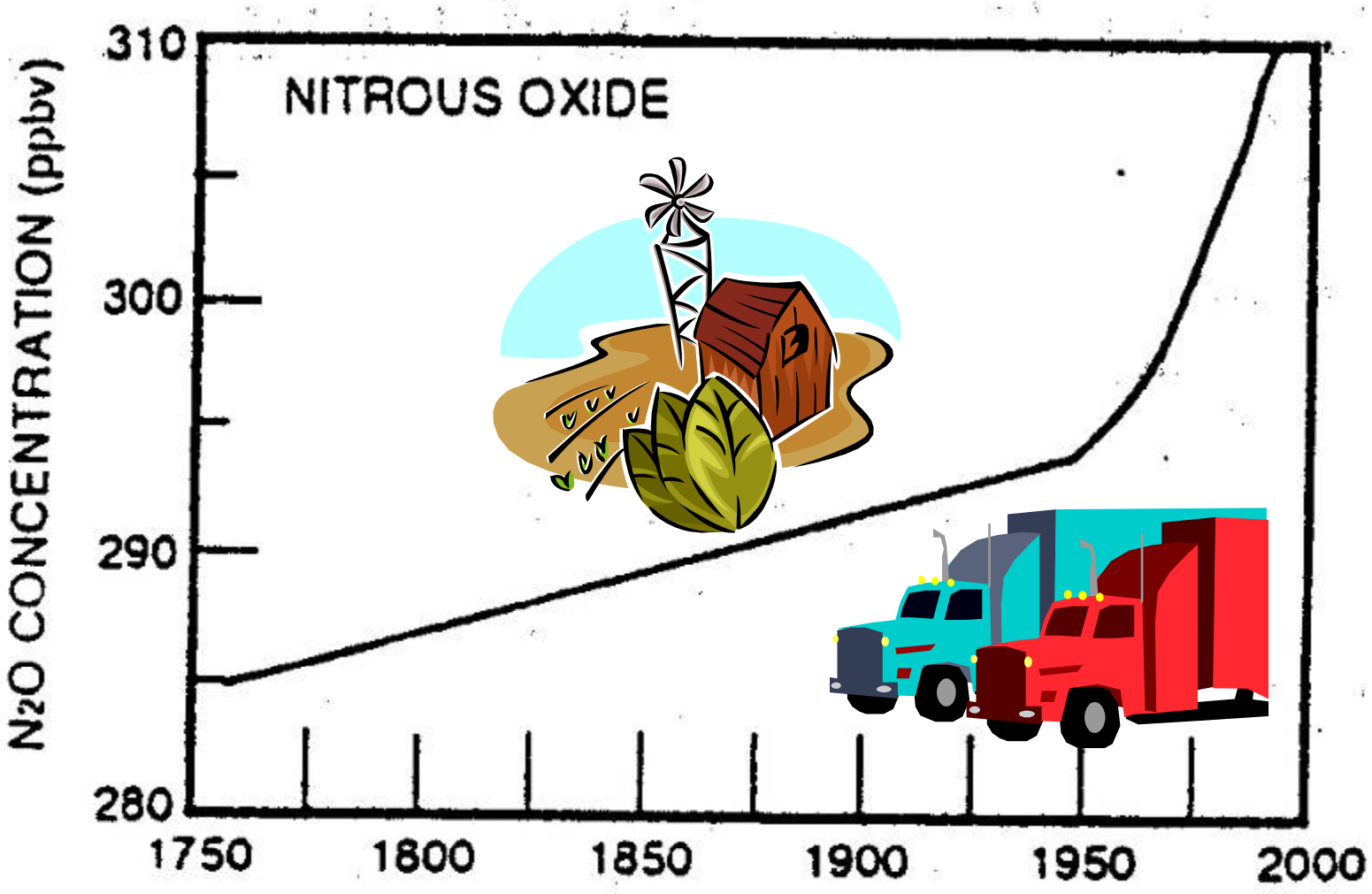
* Produced naturally in soils

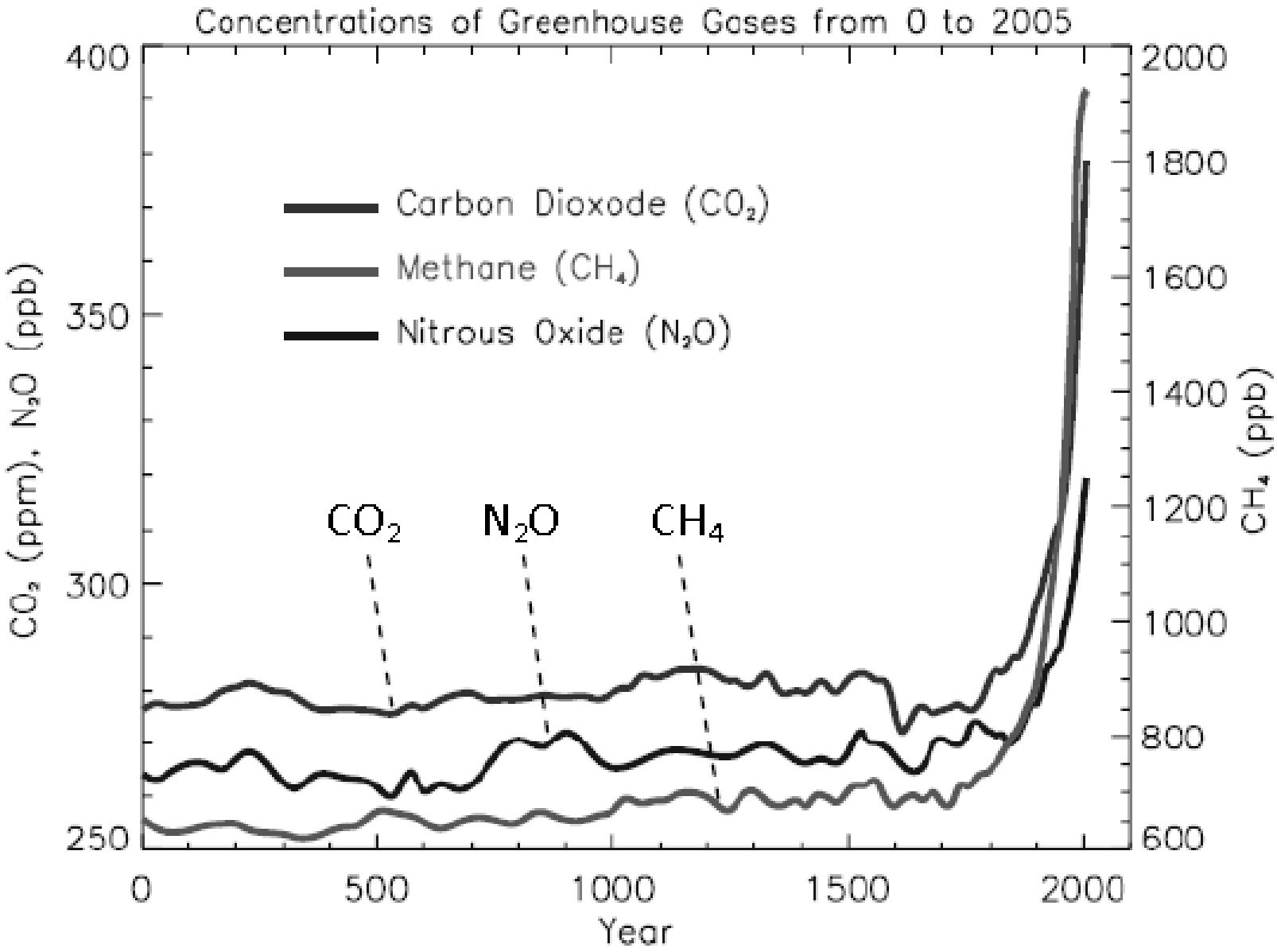
* Has increased due to fossil fuel combustion (esp. diesel), forest burning, use of nitrogen fertilizers

* Has long atmospheric residence time (~ 150 years)

This info is in Table on p 39

NITROUS OXIDE: Trends




Concentrations of Greenhouse Gases from 0 to 2005
Carbon Dioxode (CO_2)
Methane (CH_4)
Nitrous Oxide (N_2O)
CO_2
N_2O
CH_4
CO_2 (ppm), N_2O (ppb)
CH_4 (ppb)
Year
400
350
300
250
2000
1800
1600
1400
1200
1000
800
600
0
500
1000
1500
2000

CFCs (Freon-11 & Freon-12)

* Human-made CFCs (didn't exist in atmosphere prior to 1950s)

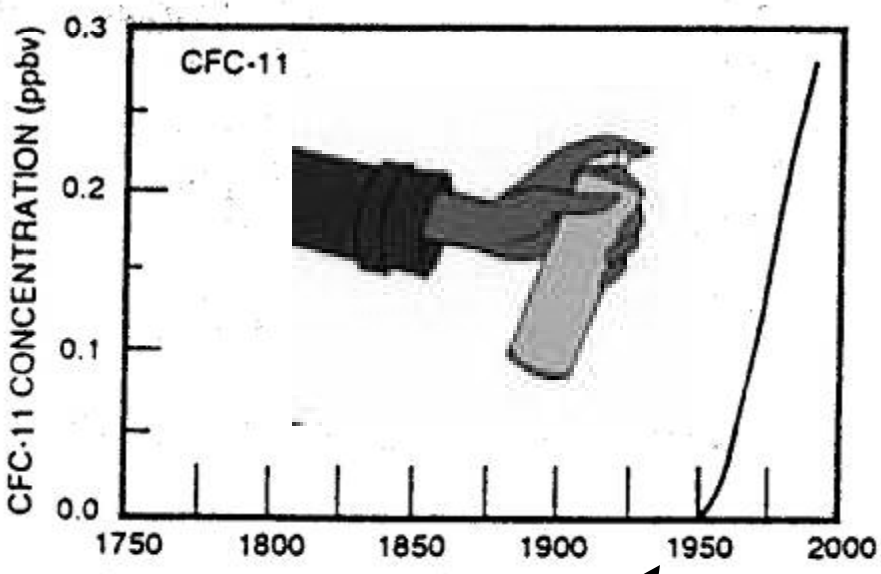
* Have increased at rates faster than any other greenhouse gas; used in refrigerants, fire retardants, some aerosol propellants & foam blowing agents

* Absorb at different wavelengths than H_2O and CO_2 (in 8 –12 μm "WINDOW" part of spectrum), hence a single molecule can have great effect

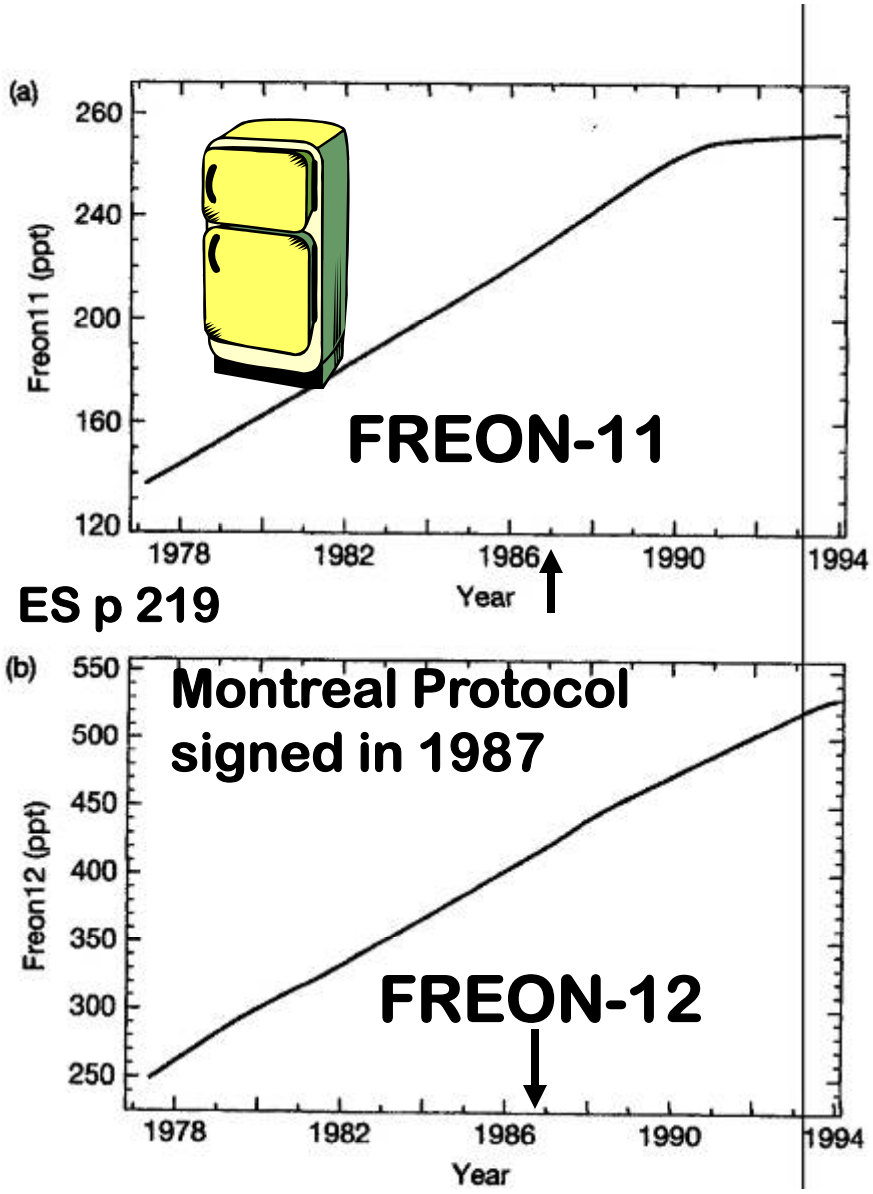
MONTREAL (and subsequent) PROTOCOLS have reduced CFCs!

This info is in Table on p 39

CFCs: Trends



Human-made -- didn't exist before 1950!



Q6 – Why do you think the concentration of CFC's didn't begin dropping immediately after the Montreal Protocol in 1987?

1. **Because it was an international "agreement only" and the nations of the world never followed through.**

2. **Because it called for only a 50% reduction of CFC's over 10 years and had to be followed by more stringent protocols later.**

3. **Because CFC's are very stable molecules and don't break down easily once they are in the atmosphere.**

OZONE: Sources

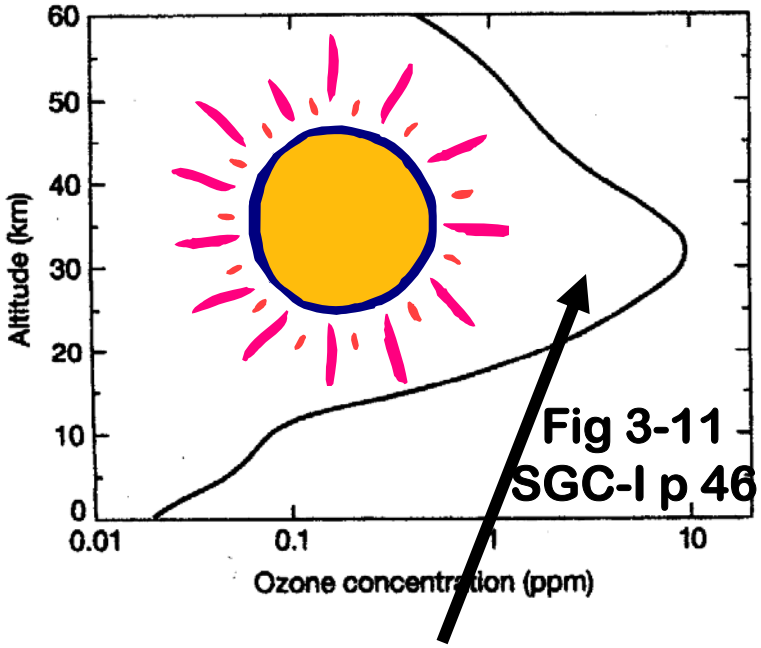
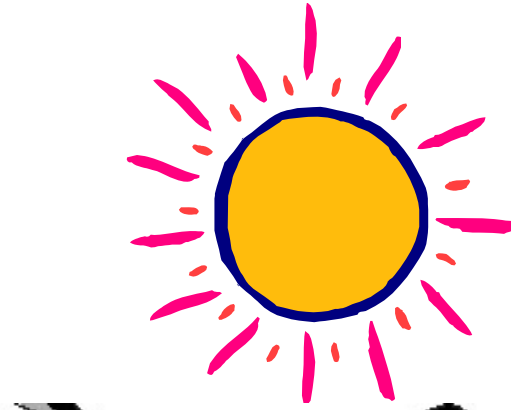


Fig 3-11
SGC-I p 46

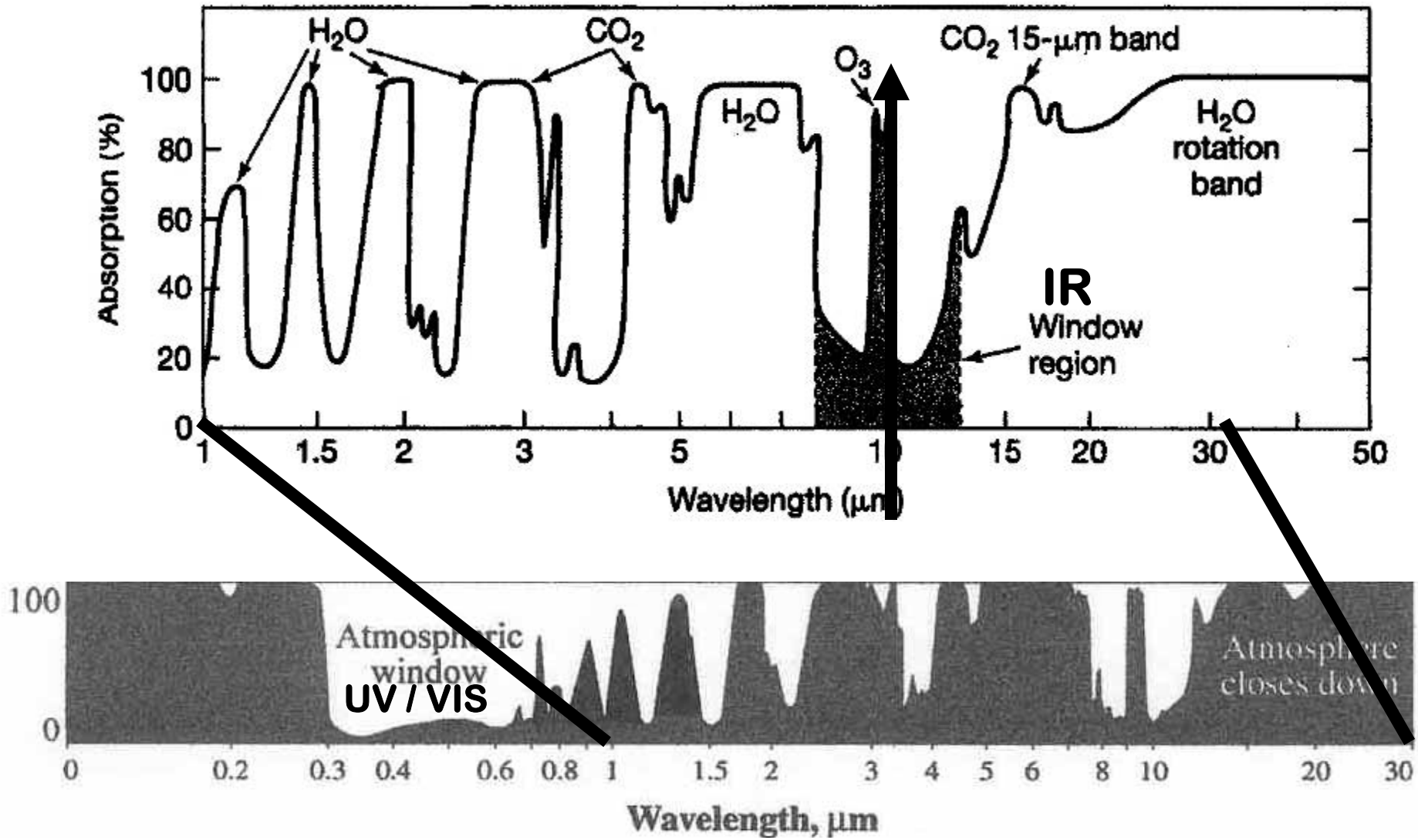


Produced naturally in photochemical reactions in STRATOSPHERIC ozone layer --"good ozone"

Has *increased* in TROPOSPHERE due to photochemical smog reactions -- "bad ozone"

This info is in Table on p 39

O_3 absorbs IR radiation of 9.6 µm, close to wavelength of maximum terrestrial radiation (10 µm)



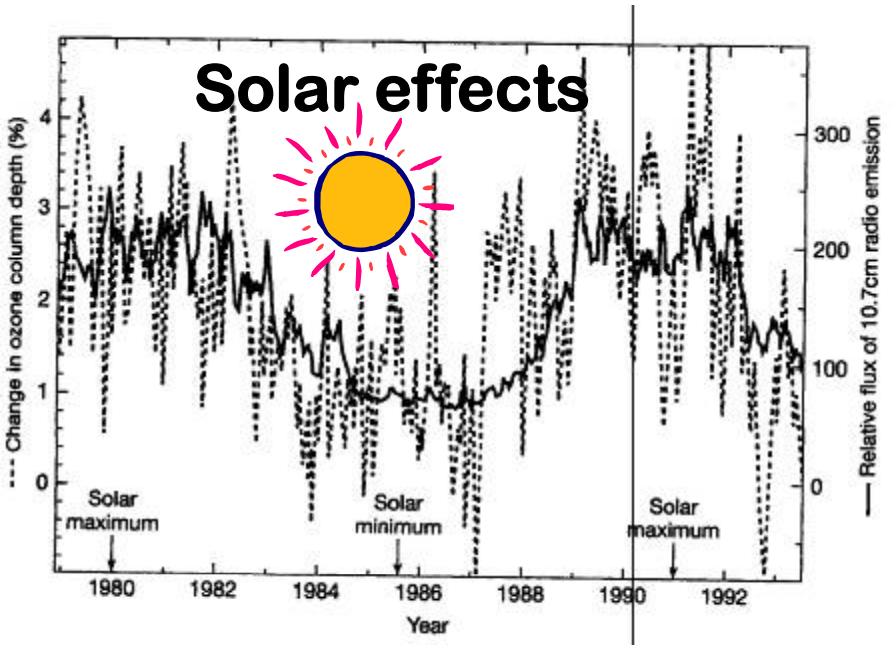
Bottom of p 34 (also see pp 48 in SGC-I)

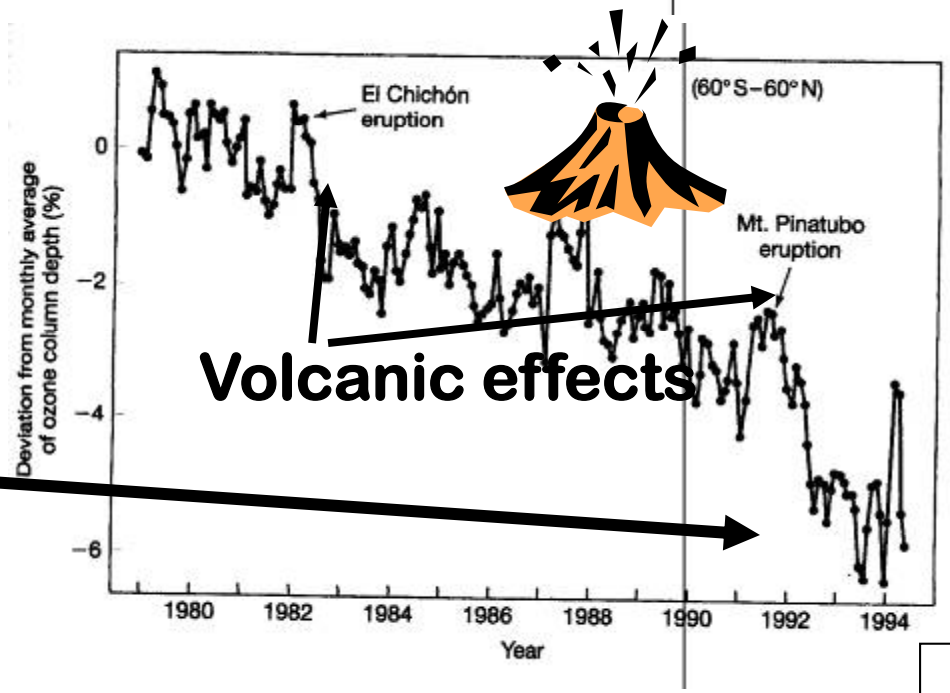
OZONE: Trends

Stratospheric ozone varies by latitude and season -- is affected by solar radiation, volcanic eruptions & chemical reactions due to CFCs.

Overall, O3 is <u>decreasing</u> in the STRATOSPHERE

More on OZONE later on in the semester





Two Important Global Change Terms Related to Atmospheric Composition

(They are being introduced now, but we'll discuss them in more detail later)

Radiative Forcing (RF) – Change in incoming minus outgoing radiation at the tropopause due to some factor.

For example, a change in the concentration of carbon dioxide or the output of the Sun.

In the IPCC report, radiative forcing is further defined as the change relative to the year 1750 as a global average.

Global warming potential (GWP) - An index that measures how much a given mass of greenhouse gas is estimated to contribute to global warming.

SUMMARY OF KEY CONCEPTS

1. Four gases N_2, O_2, Ar, & CO_2 comprise about 99% of the volume of the atmosphere. These are the major gases.

However, even the "minor" gases by % volume can be extremely important to us, especially H_2O, CH_4 , and O_3 which -- together with CO_2 -- are the main GREENHOUSE EFFECT gases.

ALSO:

Even smaller amounts of other trace gases such as CFC's and halons can play an important role by disrupting stratospheric ozone.

2. Most of the MASS of the atmosphere is in the bottom few kilometers.

Traces of the Earth's atmospheric gases can be detected up to 60,000 km above the earth's surface, but:

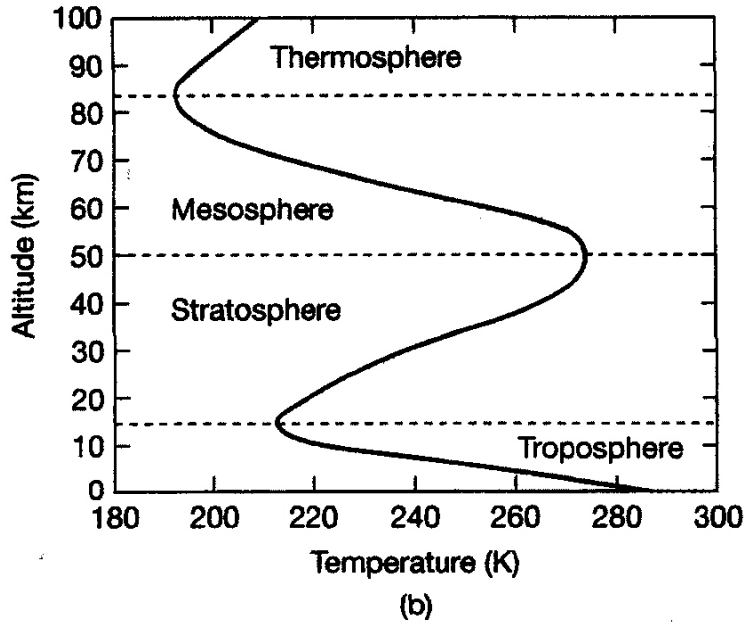
*** 99% of the mass of the atmosphere lies below 50 km (near top of stratosphere) and**

*** 50% of the mass lies below about 6 km (middle troposphere).**

3. Different gases are abundant at certain levels in the atmosphere.

Because gases absorb and emit only certain wavelengths of radiation, different wavelengths are absorbed at different altitudes, depending on which gas is abundant at that level . . . .

. . . Wherever radiation is absorbed by these gases, the atmosphere heats up, leading to VARIATIONS IN THE VERTICAL TEMPERATURE PROFILE of the atmosphere. . . .



(b)

. . . N_2, N, O and O_2 are very effective in absorbing very short wave radiation that is HARMFUL (e.g. x-rays and the shorter ultraviolet wavelengths).

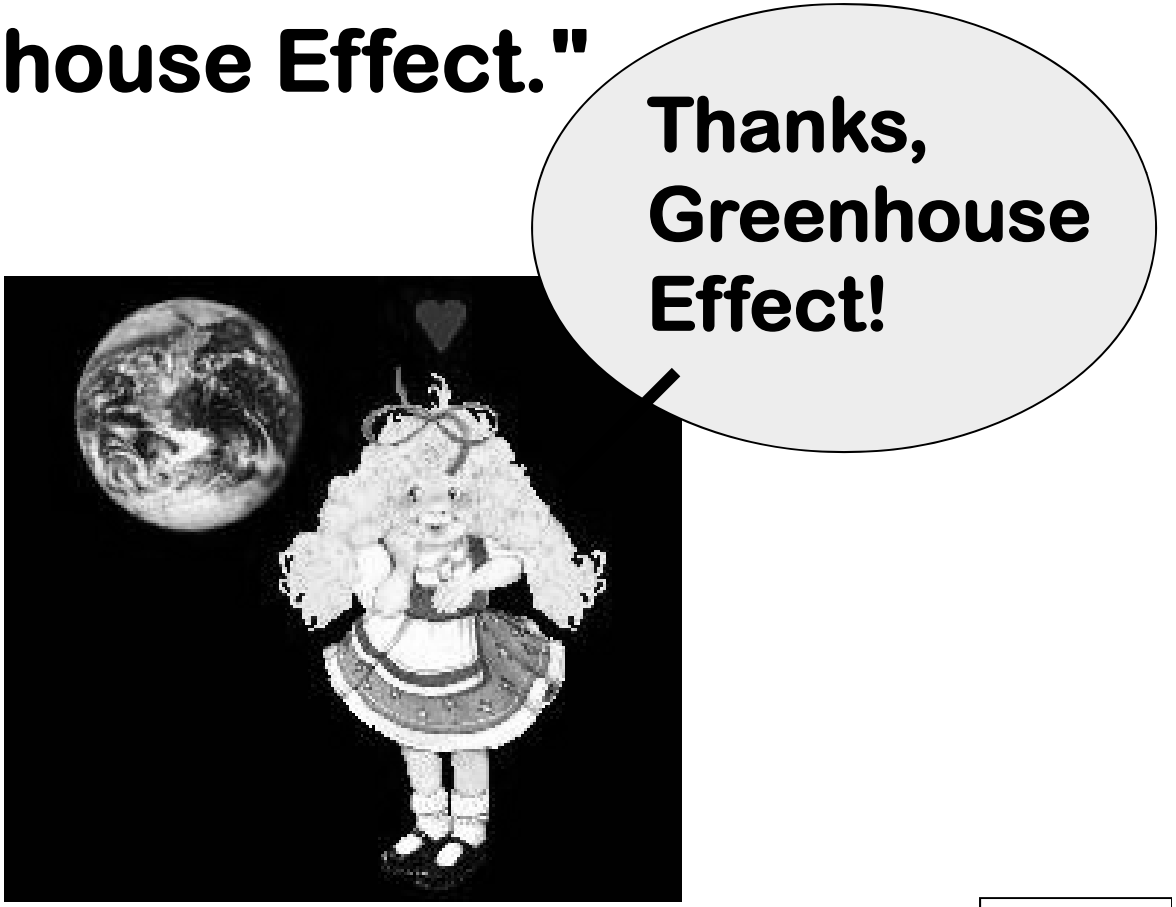
Since these gases are abundant at high altitudes, much of this harmful radiation never reaches the earth's surface. . . .

. . . Similarly, O_3 in the concentrated ozone layer (at about 25 - 35 km in the mid-stratosphere) absorbs additional amounts of the HARMFUL ultraviolet shortwave radiation. . . .

. . . H_2O and CO_2 are most abundant close to the earth's surface in the lower troposphere.

Being greenhouse gases, they are transparent to incoming solar shortwave radiation, but they absorb terrestrial longwave radiation emitted from the earth's surface. . . . .

They then re-radiate much of this energy back to the surface, keeping the earth comfortably warmer than it would be without a "Greenhouse Effect."



4. The differential absorption of wavelengths of radiation by atmospheric gases at various elevations leads to the "vertical structure" of the atmosphere:

Troposphere, Stratosphere, Mesosphere, Thermosphere.

The boundaries separating these layers of the atmosphere are defined by temperature changes and are referred to as “pauses” i.e., tropopause, stratopause, and mesospause.