OZONE

I.) The Atmosphere

Troposphere--0 to 12-14 km Heat from the ground (>390nm)

Stratosphere--12-14 to 50 km...heat at 50 km by O_3 (200-300)

Mesosphere--50-80 km...seperates ionosphere from strat

Ionosphere--80 km to space...Heat by photoionization (<100nm)

Pressure decreases with altitude: ~50% for each 6000 m

II.)Electromagnetic spectrum:

Radio waves>3000 nm

above 760nm infrared

400nm-760nm visible ROYGBIV

320nm-400nm UV-A Used for photosynthesis

280-320 nm UV-B--50% blocked by O3

<280nm UV-C--100% blocked by O3

<10 nm X-rays

III.) Ozone (O_3)

ozone is only 1ppm or 1/2 cm thick layer at atmospheric pressure

It has a major effect on the structure of the atmosphere--determines wind patterns to some extent.

A.) Protects earth's surface from harmful UV rays<290nm (290 nm is ozone cutoff)

$O_2 + h\nu \text{--->} O + O$

$O + O_2 \text{---->} O_3$

UV-B and UV-C can break down DNA bonds and causes skin cancer, cataracts, destroys plants and phytoplankton

Documented case of fair-skinned cancer vs latitude.

B.) Maximum concentration at 25 km (middle of stratosphere)

C.) Chlorine radical and Nitrous oxide (N_2O) catalyze the destruction of O_3 as

$O_3 + Cl \text{--->} O_2 + ClO$

$\underline{ClO + O \text{----->} O_2 + Cl}$

$O_3 + O$ -----> $O_2 + O_2$

can use each Cl 10,000 to 100,000 times

Natural sources include volcanic HCl (most is washed out), biomass burning-CH3Cl)

IV.) Freons

A.) Freons are used for solvents for electronics, refridgerants, lubricants, aerosols, bubbles in insulation and packaging because of their volatilities and inertness.

B.) This makes them perfect to escape the reactive troposphere and get into the stratosphere where they can do damage.

C.) release Cl radical due to UV

10-20 year lag time to get into stratophere

65-135 year residence times

5 ppb has power to destroy 50 x's O_3 amount

even though Freon production halted today (Montreal Protocol, 1987), will destroy in future

V.) Meaurements

A.) Freon increases

Molecule	t (yr)	1980	2030
CO_2	2	339 ppm	450 ppm
N_2O	120	300 ppm	375 ppm
F-11(CCl_3F)	65	>18 ppb	1.1 ppb
F-12(CCl_2F_2)	110	.28 ppb	1.8 ppb
O_3	.1-.3	??	??

1.) Freon production very well known (Dupont)

B.) Ozone

1.) very hard to measure--satellites, 30 ground stations

1979-1994 a global 4% decrease in O3

7-13% decrease expected in 1990s

2.) seasonal and latitudinal variations based on sunlight and circulation

3.) yearly variations due to solar activity--sunspots, proton event of 1972

F.) Models predict major destruction of ozone, destructive UV increases

Are models correct??

--we know mechanism of destruction

--We know freon production

--so far models agree with measurements

VI.) Antarctic Ozone hole

325 dobson units in Oct, 1956

175 dobson units in Oct, 1985

10% loss in ozone ---> 500% increase in 287nm radiation

Polar Vortex-3Xs size of US

Polar stratosheric clouds catalyze reaction in AA spring

Arctic ozone hole hits norhtern europe-20-40 % depletion, circulation less stable so more mixing

VII.) Effects

A.) Skin Cancer

Hole widened into Australia and many cases of skin cancer

10% O3 loss-->300,000 more cases of skin cancer, 4500-9000 cases of malignant melonoma (UN estimates)

B.) Cataracts-clouding of the eye lens

10% O3 loss-->1.5 million cases

C.) Ecosystems

Antarctica is less damage

seawater limited to upper 1 m

VII.) What is being done?

A.) Replacements are Hydrohalocarbons

Replace $28B/yr industry

By getting rid of the Cl and adding an H, the Freons are more reactive and still have good properties. More reactive means less gets into the Stratosphere and so destroys <10% that of Chlorofluorocarbons.

B.) Montreal Protocol-1987

phase out CFC s by 35% in 2000

1992 Copenhagen--more phaseouts-->77% reduction in production 1988-1995

I.) Ozone--1/30 amount in Stratosphere

product of many chemical reactions involving sunlight, hydrocarbons, aerosols (2mm), PAH's, and NO_x. --->builds up during days, rains out if rain

hurts eyes

Aerosols cut down visibility