Climate Change and Ozone Depletion

Troposphere
- 78% N₂, 21% O₂, 0.09% Ar, 0.035% CO₂
- Global warming occurs here

Stratosphere
- "global sunscreen" (ozone layer)
- Keeps 95% of the sun’s harmful UV radiation from reaching the earth’s surface.
- Helps protect humans from sunburn, skin & eye cancer, cataracts, etc.
Question

- Explain the relationship between global warming and the greenhouse effect.

Global Warming

- Warming of earth’s troposphere by the greenhouse effect.
Greenhouse Effect

- The warming of the troposphere caused by greenhouse gases that absorb heat.

Quote...

- “More people enjoy health and prosperity now than ever, and a warmer environment...should sustain life better than the current one does.”
  - February 2001, Oil and Gas Journal

Question

- What are the greenhouse gases?
- What are the primary sources for each of these gases?
Greenhouse Gases

- Water vapor
- Carbon dioxide
- Methane
- Nitrous oxide
- Synthetic HFC’s, PFC’s, and SF$_6$

1. Water Vapor

- Naturally occurring due to hydrologic cycle.
- Necessary to sustain life as is (keeps earth warm - average global surface temperature $\approx 59$ F).
- Man not proven to affect the amount of water vapor in troposphere - yet.

2. Carbon Dioxide

- Occurs naturally (carbon cycle) and by human activities (use of fossil fuels).
- Emissions is 30-35% higher today than before the industrial revolution (280 ppm to 375 ppm).
- Residence time in troposphere $\sim 50 - 200$ years.
Share of Global Total CO₂ Emissions

- United States – 23.4%
- China – 13.6%
- Russia – 6.2%
- Japan – 4.8%
- India – 4.2%
- Germany – 3.4%
- Canada – 2.4%
- UK – 2.3%

Question

What is the latest technology in removing CO₂ from the troposphere?

Sequestering CO₂

- Injecting gaseous or liquefied CO₂ deep in the Earth. Possible locations include:
  - Empty oil and gas reservoirs
  - Deep saline aquifer
  - Deep sea
3. Methane
- Sources include: livestock, landfills, natural gas production, manure, and rice fields.
- Residence time in troposphere ~ 12 yrs
- Concentration has doubled since Industrial Revolution.
- Current annual increase is 0.6%

4. Nitrous Oxide (N₂O)
- Sources include: burning fossil fuels, inorganic fertilizers, & biomass burning, decomposition of wastes and sewage.
- Residence time in troposphere ~114 years.
- Increased about 17% since 1750.

Synthetic HFC’s, PFC’s, and SF₆
- HFC = Hydrofluorocarbons: primarily used as replacements for ozone depleting substances. Have small impact, still unknown.
PFC = perfluorocarbons
SF₆ = sulfurhexafluoride.
These two are predominately emitted from various industrial processes (aluminum smelting, semiconductor mfg, electric power transmission and distribution, etc.)
Impact is also small, but significant growth, long atmospheric lifetime, and are strong absorbers, could influence in the future.

What is being done to reduce global warming?

Kyoto Protocol
Dec. 1997
171 nations
Developed treaty requiring 38 developed nations to cut GHG 5.2% below 1990 levels by 2012.
GHG includes: CO₂, CH₄, N₂O, HFCs, PFC, SF₆
Developing countries not required to participate.
Allowed emission trading.
Kyoto Protocol

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- 161 nations
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Kyoto Protocol

- Computer models predict with this reduction would only reduce the projected 2060 temp. rise of 1-3°F by 0.1°F.

Kyoto Protocol

- Thought treaty was unfair as India and China did not have to meet these requirements.
- Intensive lobbying by coal, oil, steel, & auto companies claimed that it would impact the US economy.
Kyoto Protocol

- 111 nations have ratified by late 2003. Waiting for Russia so treaty can take effect.
- Other countries are not waiting – going ahead as planned for their country.
- Russia finally signs and treaty officially in place as of Feb. 2005

Impacts of Global Warming

- Weather
- Diminishing crop yields
- Loss of biodiversity
- Rising Sea Levels
- Human Illness
**Ozone Depletion**

**Question**
- What is the difference between the greenhouse effect and ozone depletion?

**What is O₃ Depletion?**
- Thinning concentrations in stratosphere above Antarctica and Arctic
What causes ozone depletion?

CFC’s
- Chemically stable, non-reactive
- Odorless
- Non-flammable
- Non-toxic
- Non-corrosive
- Cheap to make

CFC products include:
- Coolants in Air Conditioners & refrigerants (Freon)
- Propellants in aerosol spray cans
- Cleaners for electric parts
- Sterilizing hospital instruments
- Bubbles in plastic foam
Key problem

• This cycle depletes O₃ in stratosphere faster than formed
• Each CFC molecule can last in stratosphere for 75 – 111 years

Montreal Protocol

• 1987 – Canada
• 36 nations met. Treaty to reduce CFC’s by 35% between 1989-2000.
• Due to 1989 news, nations met again in 1990 & 1992 to phase out key ozone depleting chemicals immediately.

Thinning of O₃ over South Pole

• Layer thins during the Antarctic spring and early summer (Sept – Dec), when sunlight penetrates stored up chlorine molecules, releasing them to attack O₃.