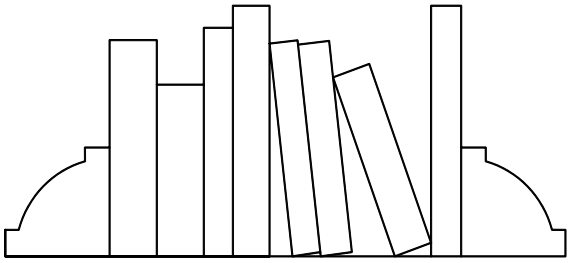
Environmental Science 101 *Fall 2012*

Air Resources

Lecture Outline:

11. OZONE DEPLETION
    A. Nature and Importance of the Ozone Shield
    B. Formation and Breakdown of the Shield
        1. Ozone Formation
        2. Chloroflourocarbons in the Atmosphere
        3. Ozone Hole
    C. Coming to Grips with the Problem
        1. CFC History
        2. International Agreements
        3. Action in the USA
        4. Consequences of International Cooperation
        5. Current Outlook



Learning Objectives:

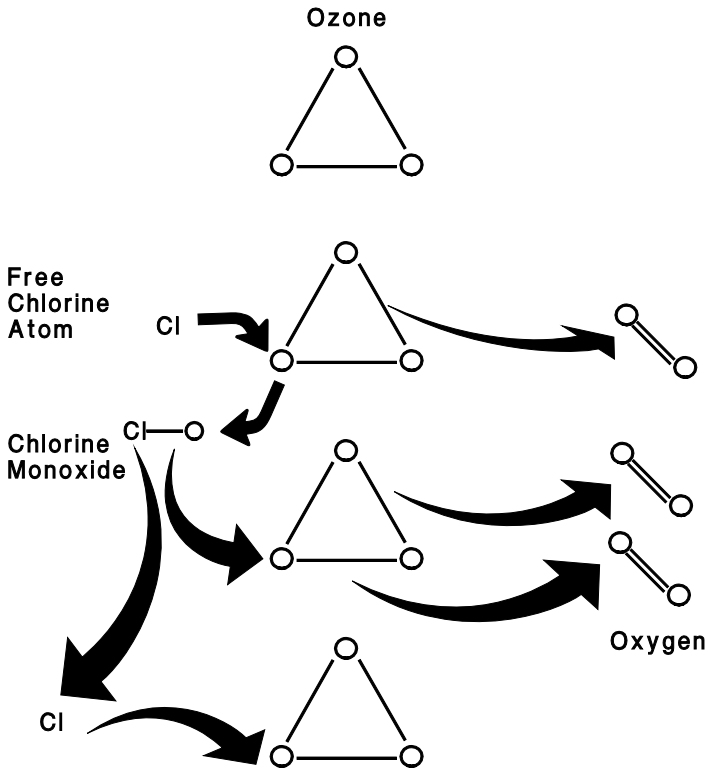
When you are finished with this unit you should be able to:

1. Define the purpose of the ozone shield.
2. Describe the impact of UV radiation of biological organisms.
3. Understand the reasons for the degradation of the shield.
4. Suggest steps that should be taken to stabilize atmospheric concentrations of the greenhouse gases.
5. Describe how protecting the ozone shield will impact the daily life of Americans.

Terms You Should Know:

- Ozone shield
- Ultraviolet radiation
- Ozone
- CFCs
- Clean Air Act Title 6
- HCFCs

Destruction of the ozone shield.



Reading Assignment:

Brennan and Withgott:
Chapter 17; pages 480-484.

11. DEPLETION OF THE OZONE SHIELD

A. NATURE AND IMPORTANCE OF THE OZONE SHIELD

- ***ULTRAVIOLET (UV) RADIATION***—wavelengths slightly shorter than visible light

UV radiation:

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- The ***OZONE SHIELD*** absorbs > 99% of UV radiation
- The 1% of UV radiation that gets through the Shield causes:
  - sunburns
  - > 200,000 cases of skin cancer per year
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B. FORMATION AND BREAKDOWN OF THE OZONE SHIELD

1. Ozone Formation
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   - High energy UV causes O_2 to split apart into free O atoms
2. Chloroflourocarbons in the Atmosphere

   Chloroflourocarbons (CFCs):

   – type of halogenated hydrocarbon

   – non-toxic, non-reactive molecule

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CFC uses:

- refrigerators, air conditioners, heat pumps as the heat transfer fluid
  - ✓ as machines break down CFCs escape into atmosphere
- production of plastic foams
  - ✓
- electronics industry for cleaning computer parts
  - ✓
- pressurizing agent for aerosol cans (not in USA)
  - ✓

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- In stratosphere CFCs are subjected to UV radiation and break apart
  - releases Cl
  - Cl is catalyst
  - 1 Cl atom is capable of breaking down 100,000 O_3 molecules

3. Ozone Hole

- Scientists noticed a O_3 hole (thinning) in 1985 over Antarctica
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  -
  - may impact phytoplankton, which in turn could have a severe impact on the food chain
  - may also occur in the Arctic — more problems for northern hemisphere populations
- Why a hole over the Polar Regions?

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- cold atmospheric temperatures
  ICE CRYSTALS
-
- when sun returns in spring . . .
  - ✓
  - ✓ Cl ions bond with O_3
  - ✓
  - ✓

- O_3 losses over non-polar regions
  -
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- In 1997:
  - the hole forming each year over Antarctica has ozone levels 70% less than normal
  - in the USA:
    - ✓ summer:
    - ✓ winter:
  -

- In 1996 scientists showed for the first time that UV levels over population areas in the USA had increased

C. COMING TO GRIPS WITH THE PROBLEM

1. CFC History

- CFCs were invented in the 1920s

- considered wonder chemicals because they were:

  non-toxic

  non-flammable

  non-corrosive

  stable

- Scientists first predicted problems with CFCs in 1973
  - Sherwood Roland at the University of California (Irvine)
- First major public response was in the late 1970s
  - banned CFCs in aerosol sprays

- First world-wide conference on potential CFC problem in 1977

2. International Agreements
   - 1987 UN Montreal Protocol
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     -
   - Protocol amended in June 1990 because O_3 losses were much greater than predicted
     - phase out CFCs by 2000 in developed countries; by 2010 in developing countries
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3. Action in the USA
   - USA has been the traditional leader in CFC production (Du Pont)
   -

The Clean Air Act (CAA) of 1990 Title VI dealt with ozone depletion:

- restricts production, use, emissions, and disposal of ozone depleting gasses
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- US companies must halt CFC production by December 31, 1995. This phase out schedule was met.

4. Consequences of International Cooperation
   - By 1995 production of CFCs had fallen by 76% compared to 1988 levels
   - If all countries comply with the Montreal Protocol the Ozone Shield will begin to gradually heal
   - The Montreal Protocol was successful because:
     -
     -
     -
     -
   - The Montreal Protocol is viewed as a model to solve other environmental problems
5. Current Outlook (2010)
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- USA populations are at their most vulnerable point now—until 2012 (thinnest ozone shield layer)
  - consequences range from 250,000 to 45,000,000 additional deaths due to skin cancer during this period

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6. What are the potential problems with the current efforts?

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- May be other ozone depleting chemicals are out there that we have not linked to problems yet

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