Effect of Air Pollution

- Green House Effect
- Global Warming
- Acid Rain
- Ozone Layer Depletion
- Photochemical Smog

Green House Effect

- The Greenhouse shield that keeps our planet warm enough to sustain life …….
- But now is becoming a heat trap threatening to disrupt the global environment.
- Thin layer of certain gases - 25km up- acts like glass letting heat through but stoppping enough radiation back in to warm our world.

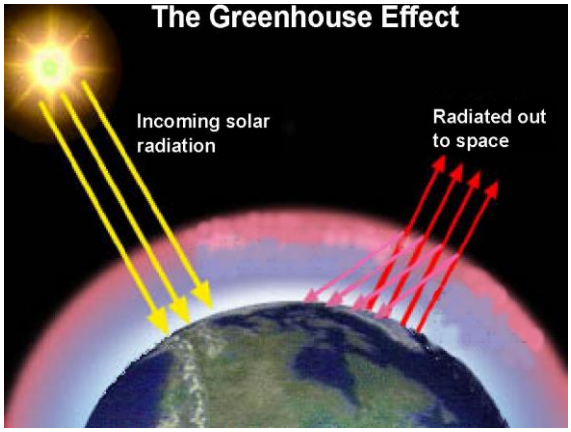
- The heat trap provided by atmospheric CO_2 probably help to create the conditions necessary for the evolution of life and greening of the earth
- Compare to moderately warm planets, Mars, with too little CO_2 in its atmosphere is frozen cold and Venus with to much dry…

- But now the expansion of human activity in industry and agriculture is changing the fundamental environmental system making the "GREENHOUSE" layer denser, keeping in more heat.
- CO_2 is the chief single culprit – other 39 known gases
- The atmospheric content of CO_2 has increased by 25% in last 100 Years
- Raise the planet temperature between 1.5 – 4.5 ^oC
- Sea level around 12cm.

Green House Effect

- "The process of warming of earth surface due to blanketing of CO_2 in the atmosphere is called as "GREEN HOUSE EFFECT"
- The phenomena due to which the earth retains heat is called as GREENHOUSE EFFECT.
- The main green house gases
  - CO_2
  - Methane
  - Chloro floro carbon
  - NO_2

- CO_2 is confined exclusively to the troposphere, its higher concentration may act as serious pollutant.
- Under normal condition the temp. at the surface of the earth is maintained by the energy balance of the sunrays that strike the planet and heat that is radiated back into space.



- Solar energy in the form of light radiation has wavelengths in the range of 0.2 to 4 μm.
- It will loss some energy after striking the earth and will be converted to heat energy of longer wavelengths.
- The wavelength of this terrestrial reradiation, from earth to atmosphere is more..(4-100 μm).
- $E = h\nu = hc/\lambda$
- As Energy $\downarrow$ Wavelength $\uparrow$

- CO_2 has radiation absorbance band in the range of 12-18 μm wavelength.
- Thus CO_2 is present in the atmosphere, it allows the incoming solar radiation to pass through but does not allow the reradiation from the earth to space to pass through.
- This is the origin of the term GREEN HOUSE EFFECT.

- Due to the presence of the CO_2 layer in the atmosphere it causes much heating effect on the earth atmosphere
- Due to greenhouse effect the earth atmosphere rises every year the world wide concentration of CO_2 is increasing at a rate of 0.75 ppm & temp is rising at the rate of 0.05 ^{0}C every year

- Nearly 100 years ago CO_2 275ppm
- Today 350ppm
- By 2035 & 2040 450ppm

Imagine the earth's temperature then??????

Greenhouse gases

- Greenhouse gases covered by the Kyoto Protocol are:

CO_2	Carbon dioxide
CH_4	Methane
N_2O	Nitrous Oxide
SF_6	Sulphur hexafluoride
PFCs	Perfluorocarbones
HFCs	Hydrofluorocarbons

The greenhouse gases

Name	Pre-industrial concentration (ppmv *)	Concentration in 1998 (ppmv)	Atmospheric lifetime (years)	Main human activity source	GWP **
Water vapour	1 to 3	1 to 3	a few days	-	-
Carbon dioxide (CO_2)	280	365	variable	fossil fuels, cement production, land use change	1
Methane (CH_4)	0,7	1,75	12	fossil fuels, rice paddies waste dumps, livestock	23
Nitrous oxide (N_2O)	0,27	0,31	114	fertilizers, combustion industrial processes	296
HFC 23 (CHF_3)	0	0,000014	260	electronics, refrigerants	12 000
HFC 134 a (CF_3CH_2F)	0	0,0000075	13,8	refrigerants	1 300
HFC 152 a (CH_3CHF_2)	0	0,0000005	1,4	industrial processes	120
Perfluoromethane (CF_4)	0,00004	0,00008	> 50 000	aluminium production	5 700
Perfluoroethane (C_2F_6)	0	0,000003	10 000	aluminium production	11 900
Sulphur hexafluoride (SF_6)	0	0,0000042	3 200	dielectric fluid	22 200

* ppmv = parts per million by volume, ** GWP = Global warming potential (for 100 year time horizon).

UNEP GRID Arendal

United Nations Environment Programme / GRID-Arendal

Greenhouse Gas Emissions

- Combustion of fossil fuels?
  - coal-burning power plants,
  - automobile exhausts,
  - factory smokestacks,
  - other waste vents of the human environment
  - contribute 22 billion tons of carbon dioxide and other greenhouse gases each year
- Animal agriculture, manure, natural gas, rice paddies, landfills, coal, and other anthropogenic sources contribute about 450 million tons of methane each year
- Atmospheric concentrations of CO_2 and CH_4 have increased by 31% and 149% respectively above pre-industrial levels since 1750

Effect of Greenhouse gases

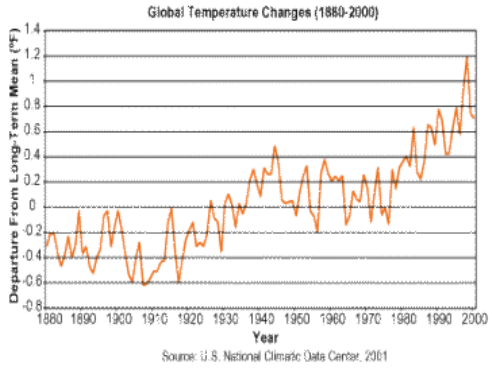
Effect of Greenhouse gases

- According to WHO, mosquitoes may have longer lives and breeds in larger nos. hence spreads MALARIA.
- Warmer & Humid condition enhance growth of bacteria & moulds.
- CO_2 is also expected to influence intensely the process of depletion of OZONE layer

- The temperature of the atmosphere is increasing day by day
- the glaciers, polar ice caps melts, resulting in flooding of many low laying areas
- The climate changes from one region to another region with global CO_2 increases day by day
- increasing the sea level
- At a higher the CO_2 undergoes photochemical reacting producing CO, Which is more poisonous

Global Warming

- An increase in the average temperature of the Earth's atmosphere and oceans
- Global temperature on both land and sea increased by 0.6 ± 0.2 °C over the past century
- Volume of atmospheric carbon dioxide increased from 280 parts per million in 1800 to 367 in 2000, a 31% increase over 200 years



Our Changing Climate

- Global mean surface temperatures have increased 0.5-1.0°F since the late 19th century
- The snow cover in the Northern Hemisphere and floating ice in the Arctic Ocean have decreased
- Sea level has risen 4-8 inches over the past century
- Global surface temp. could rise 1- 4.5°F (0.6-2.5°C) in the next fifty years, and 2.2-10°F (1.4-5.8°C) in the next century

What causes it?

- Human Impacts- Atmospheric greenhouse gases trap some of the outgoing energy, retaining heat
- **Natural Impacts-** Change in sun's energy output Volcanoes Water Vapor Clouds

Greenhouse Gases -

- CO_2 Methane Nitrous oxide Fluorinated compounds
- Since industrial revolution, atmospheric concentrations of carbon dioxide increased 30%, methane more than doubled, nitrous oxide risen by 15%.
- These increases have enhanced the heat-trapping capability of the earth's atmosphere

- Combustion of fossil fuels, coal-burning power plants, automobile exhausts, factory smokestacks, other waste vents of the human environment contribute 22 billion tons of carbon dioxide and other greenhouse gases each year
- Animal agriculture, manure, natural gas, rice paddies, landfills, coal, and other anthropogenic sources contribute about 450 million tons of methane each year
- Atmospheric concentrations of CO_2 and CH_4 have increased by 31% and 149% respectively above pre-industrial levels since 1750

Greenhouse Gas Emissions

- **Power Plants**
  40% of carbon dioxide emissions stem from the burning of fossil fuels for the purpose of electricity generation
- **Cars**
  20% of carbon dioxide emissions comes from the burning of gasoline in internal-combustion engines of cars and light trucks with poor gas mileage contribute the most to global warming
- **Trucks**
  Another 13% of carbon dioxide emissions come from trucks used mostly for commercial purposes
- **Airplanes**
  Aviation causes 3.5 percent of global warming, and the figure could rise to 15 percent by 2050
- **Carbon Dioxide from Building structure** account for about 12% of carbon dioxide emissions

Methane

- Methane is more than 20 times as effective as CO_2 at trapping heat in the atmosphere 2004 Levels of atmospheric methane have risen 145% in the last 100 years
- Derived from sources such as rice paddies, bovine flatulence, bacteria in bogs and fossil fuel production.
- In flooded fields, anaerobic conditions develop and the organic matter in the soil decomposes

Nitrous oxide

- Naturally produced by oceans and rainforests , man-made sources-nylon and nitric acid production, the use of fertilizers in agriculture, cars with catalytic converters and the burning of organic matter
- **Deforestation**

  Responsible for 25% of all carbon emissions entering the atmosphere by the burning and cutting of about 34 million acres of trees each year .

Effects of Global Warming

Negative Effects

- Rising Sea Level
- Change of precipitation and local climate conditions;
- acid rain
- Alteration of forests and crop yields
- Expansions of deserts into existing rangelands
- More intense rainstorms
- Destabilization of Ocean currents

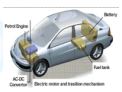
Positive Effects

- Can stimulate plant growth in places where CO_2 and temperature are the limiting factors (preventing photorespiration which can destroy existing sugars).
- Melting Arctic ice may open the Northwest Passage in summer, which would cut 5,000 nautical miles from shipping routes between Europe and Asia

What Can be Done: Alternatives

- **Solar Energies**
- **Wind Power**
- **Biomass**
- **Geothermal**
- **Hybrid**
- **Fuel Cell**
- **Battery-Electric**



Hybrid


Fuel Cell


Battery-Electric

Kyoto Protocol

- 1997, Kyoto, Japan developed countries agreed to specific targets for cutting their emissions of greenhouse gases
- Industrialized countries committed to an overall reduction of emissions of greenhouse gases to 5.2% below 1990 levels for the period 2008 - 2012

Ozone Layer Depletion

Introduction

- The layer of life-protecting ozone found at the top of the stratosphere.
- A brief history of the discovery of the ozone 'hole' is included.
- The general concepts found in this section include the following:
- Concentrations of stratospheric ozone represent a balance, established over eons, between creative and destructive forces and this balance, or dynamic equilibrium, has been changed by human activity.

- Ozone is formed in the earth's stratosphere and is critical to life on earth as we know it.
- There is compelling scientific evidence that ozone is destroyed in the stratosphere and that some human-released chemicals are speeding up the breakdown of ozone in the atmosphere.
- CFCs, a human-developed compound, are particularly destructive to the breakdown of ozone in the atmosphere.
- Ultraviolet radiation is present in natural outdoor light and can be blocked or filtered by various substances.

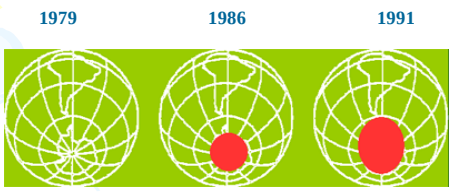
Historical Perspective

- The ozone 'hole', it is really not a hole but rather a thinning of the ozone layer in the stratosphere.
- We will use the term 'hole' in reference to the seasonal thinning of the ozone layer.

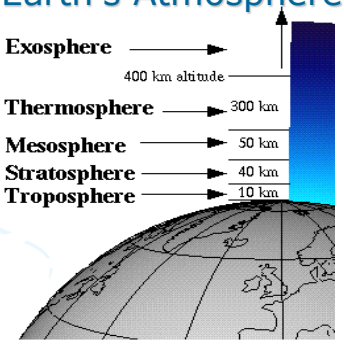
- The appearance of a hole in the earth's ozone layer over Antarctica, first detected in 1976.
- 1974: Rowland & Molina theorize CFCs destroy stratospheric ozone molecules
- 1975: University of Michigan / Harvard papers predict that CFCs deplete Earth's ozone layer
- 1985: Ozone holes found over Antarctic

- 1988: Ozone layer thinning over North Pole
- 1993: Thinning over mid-latitudes of the Northern Hemisphere
- 1997: Low values of total ozone occur in Arctic as well as Antarctic

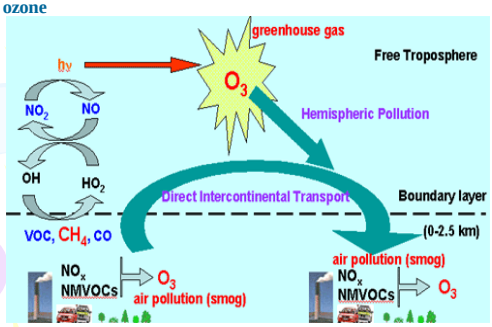
Antarctic Ozone Hole Progression



Earth's Atmosphere



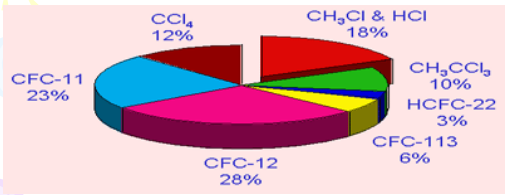
CH_4 itself is an important greenhouse gas, and links climate with air pollution via its influence on tropospheric ozone



Ozone Layer Depleting Chemicals

- chlorofluorocarbons (CFCs)
  - Freon-11, Trichlorofluromethane (CCl_3F)
  - Freon-12, Dichlorofluromethane (CCl_2F)
  - Freon-22, $CHClF_2CClF_2$
  - Freon-114, $CClF_2CClF_2$
  - Freon-115, $CClF_2CF_3$
- carbon tetrachloride (CCl_4)
- methyl chloroform (CH_3CCl_3)
- hydrochloric acid (HCl)
- methyl chloride (CH_3Cl)
- methyl bromide(CH_3Br)

- Freon 11: A/C, Refregeration, Cleaning Foams, aerosols etc…
- Freon 22: aerosol-propellants
- Freon 13: Refrigeration
- Freon 114:aerosol, refregeration, cleaning foams etc.
- CF_2BrCl: used in Fire extingushers



Ozone Layer Depleting Chemicals: CFCs

- CFCs are inert, non reactive, nontoxic, nonflammable.
- Human-made CFCs used in:
  - refrigeration
  - air conditioning
  - foam blowing
  - cleaning electronic components
  - solvents

The ozone layer

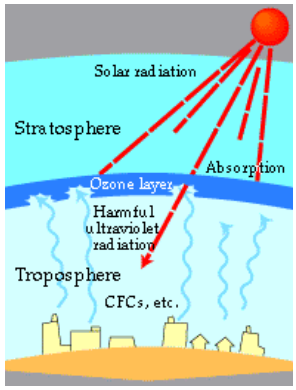
•Ozone is a triatomic form of oxygen (O_3) found in Earth's upper and lower atmosphere.

•The ozone layer, situated in the stratosphere about 15 to 30 km above the earth's surface.

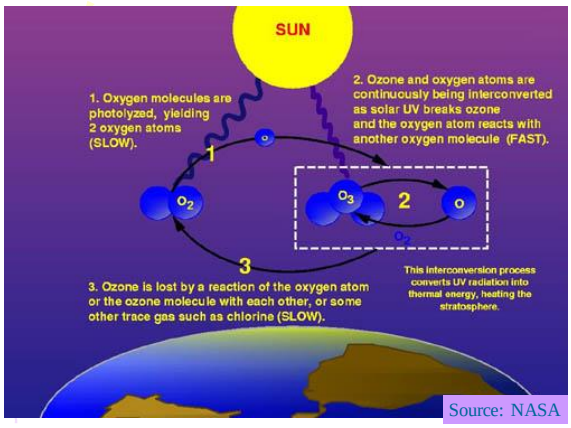
•Ozone protects living organisms by absorbing harmful ultraviolet radiation (UVB) from the sun.

•The ozone layer is being destroyed by CFCs and other substances.

• Ozone depletion progressing globally except in the tropical zone.

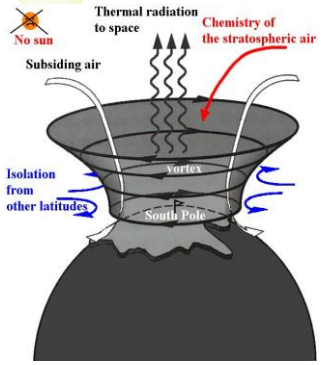


www.epcc.pref.osaka.jp/apec/eng/earth/ozone_layer_depletion/susumu.html



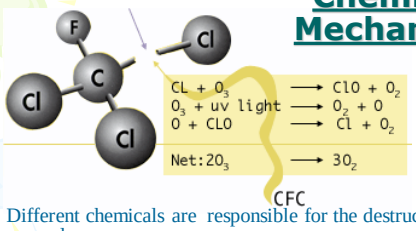
Source: NASA

Hole Formation Based on Two different mechanisms:



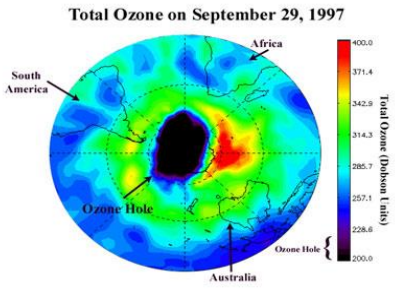
- Meteorological mechanism
  - Movement of air from one place to another in the upper stratosphere
  - Cold temperature in the upper atmosphere causes nitric acid to freeze into crystals forming wispy pink clouds
  - Forms a vortex of tightly twisted winds thus forming a hole in the upper atmosphere

Chemical Mechanism



- Different chemicals are responsible for the destruction of the ozone layer
- Topping the list :
  - chlorofluorocarbons (CFC's)
  - man-made, non-toxic and inert in the troposphere
  - In the stratosphere are photolysed, releasing reactive chlorine atoms that catalytically destroy ozone

- $CFCl_3$ —hv/ sunlight ⟶ $CFCl_2$ + Cl
- $CFCl_2$ —hv/ sunlight ⟶ CFCl + Cl
- CF_2Cl_2 —hv/ sunlight ⟶ CF_2Cl + Cl
- $CClF_2$ —hv/ sunlight ⟶ CClFC + Cl

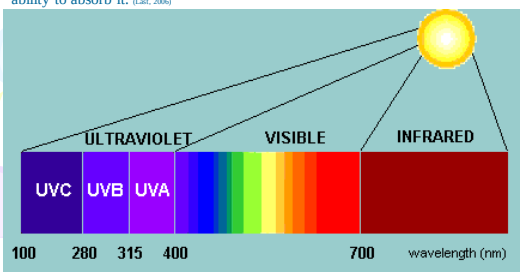


A combination of low temperatures and elevated chlorine and bromine concentrations are responsible for the destruction of ozone in the upper stratosphere thus forming a "hole". (Kerr, 1987)

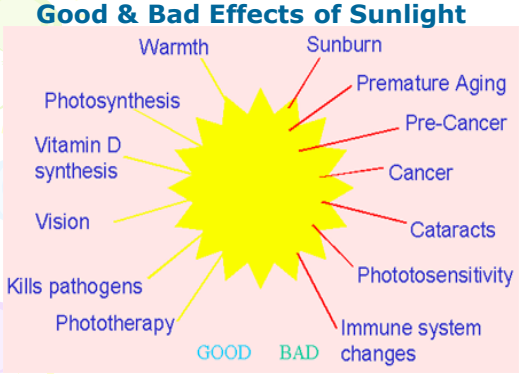
www.met.sjsu.edu/~cordero/ education/education.htl

Stratospheric Ozone and Ultraviolet Radiation (UVR)

- **Ultra-violet radiation (UVR)** high energy electromagnetic wave emitted from the sun. It is made up of wavelengths ranging from 100nm to 400nm.
- **UV radiation includes UV-A**, the least dangerous form of UV radiation, with a wavelength range between 315nm to 400nm, **UV-B** with a wavelength range between 280nm to 315nm, and **UV-C** which is the most dangerous between 100nm to 280nm. UV-C is unable to reach Earth's surface due to stratospheric ozone's ability to absorb it. (Last, 2006)



Good & Bad Effects of Sunlight



Too much ultra-violet light can result in:

- Skin cancer
- Eye damage such as cataracts
- Immune system damage
- Reduction in phytoplankton
- Damage to the DNA in various life-forms
  - this has been as observed in Antarctic ice-fish that lack pigments to shield them from the ultra-violet light (they've never needed them before)
- Possibly other things too that we don't know about at the moment

- The impact of a depleted ozone layer on human depends mainly on theire reaction to UV-B rays.
- Every 1% loss in Ozone leads to 2% increase in disease
- Increase the incidence of cataracts & photocaratitis.
- Make the blood vessels carry more blood making the skin hot, swollen or red and cause sun burn
- It causes leukemia
- Crop yields, especially tea, cabbage and soybean reduced.

Effects of UV radiation on biological organisms

- **DNA damage** ..... Maximum effect on small and single cell organisms
- **Impaired growth and photosynthesis** ...poor crop yields
- **Phytoplankton**: .....Reduced uptake of CO_2
  .....mortality
  .....Impaired reproductive capacity
- **Nitrogen-fixing soil bacteria**..... Reduced, damaged
- **Human health effects**:

Suppressed immune system.....Enhanced susceptibility to infection
.....Increase risk of Cancer
Dermatology (skin).....Sunburn
.....Loss of skin elasticity (Premature aging)
..... Photosensitivity
Neoplasia (cancer).....Melanocytic (malignant melanoma)
.....Squamous cell skin – cancer
.....Basal skin – cancer
Still questionable if causes lip cancer or cancer of the salivary glands
Oculur (Eye).....Cataract
.....Pterygium

(last. 1993)

Effects on Human Health

- Over exposure may:
  - Increase risk of non-melanoma and malignant melanoma skin cancer
  - Higher risks of malignant melanoma from severe sunburns – especially in childhood
  - Risk of malignant melanoma has increased 10%
  - Risk of nonmalignant melanoma has increased 26%

www.ldeo.columbia.edu/.../ lectures/ozone_health/

Over Exposure

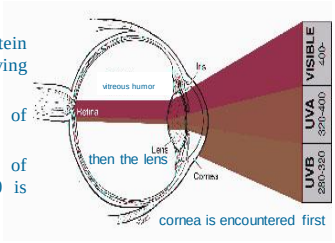
- Suppress immune system
- Accelerate aging of skin due high exposure
- Cause an outbreak of rash in fair skinned people due to photo allergy – can be severe

Skin Protection

- Protect the skin against the solar radiation using skin creams with Sun Protective Factor
  - The greater the numerical value of the SPF the greater the protection
- Use lip balm with SPF
- Cover up

Over Exposure to UV-B….

- Increases the risk of cataracts
  - Induces type of protein that provokes cleaving (splitting) in the lens
  - Leading cause of blindness
  - The prevalence of cataract after age 30 is doubling each decade
- Causes apterygial
  - A wedge-shaped growth over the central cornea



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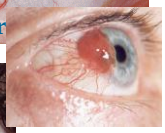
Manifestations of…

Cataracts

Cancer



brought on by over exposure to UV-B

Pterygium

Protection

- Sunglasses with 100% UV block
- Wrap around sunglasses
- Eye protection for children
- Hats

What Is Being Done to Counter the Effects of Ozone Depletion?

- **Montreal Protocol**– panel of experts was formed to investigate substances responsible for hole formation
  - Established policies that prevent future use of certain types of chemicals
  - Stipulated that the production and consumption of compounds contributing towards depletion of ozone in the stratosphere were to be phased out by the year 2000 (2005 for methylchloroform)

Control of Ozone Depletion

- More than 80% of Ozone layer depletion may be attributed to the large scale release of CFCs in to atmosphere. Hence CFCs must be controlled.
- US has recently developed Bioact FC-7, a successful alternative for Freon-12.
- US scientist have developed bacteria that can eat the main chemicals threatening to Ozone layer
- The satellite Research Institute of Frankfort, Germany has developed a method to use hydrogen as propellant in aerosol sprays which is best alternative to CFC / Butane.

- The Montreal Protocol on Substances That Deplete the Ozone Layer is an international treaty designed to protect the ozone layer by phasing out the production of a number of substances believed to be responsible for ozone depletion. The treaty entered into force on January 1, 1989.
- Due to its widespread adoption and implementation it has been hailed as an example of exceptional international cooperation
- "Perhaps the single most successful international agreement to date...".

The Environmental Protection Agency (EPA)

- Responsible for enforcing the Montreal Protocol within the U.S.
  - The EPA has several programs in place;
    - Regulating and enforcing on-road car and truck air-conditioning systems
    - Regulating most air-conditioning and refrigeration appliances
    - Technician certification
    - Service equipment

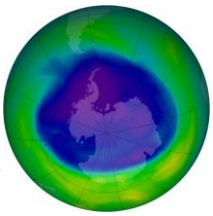
Signs of Recovery???

There have been some signs of recovery

- 1997 satellite showed a decline of several known ozone-depleting gases
- Satellite images show some slowing down of ozone loss

However….

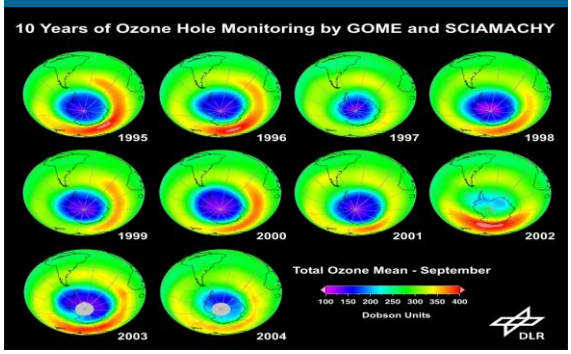
Recovery is slow



Antarctica - Dec. 2005

www.coolantarctica.com/...ozone_hole.htm

Images of Antarctica Taken Indicate A Slow Recovery



- Montreal Protocol has led to reductions in the emissions of CFCs, atmospheric concentrations of the most significant compounds have been declining. These substances are being gradually removed from the atmosphere.
- By 2015, the Antarctic ozone hole would have reduced by only 1 million km² out of 25

- Complete recovery of the Antarctic ozone layer will not occur until the year 2050 or later.
- A detectable recovery will not occur until around 2024, with ozone levels recovering to 1980 levels by around 2068.

Efforts Need to Be Continued

- Create reliable models
  - To gain a better understanding of the effects ozone depletion has on organisms living within different ecosystems
- Enforcement of Montreal Protocol
  - To reduce concentrations of chemicals responsible for ozone depletion
- Monitoring chemicals being emitted
- Gain a better overall understanding on just how ozone depletion is affecting our planet

An invisible threat

Contents

- Definition
- Causes
- Formation
- Affected Areas
- Effects
- Preventive Measures

What is acid deposition?

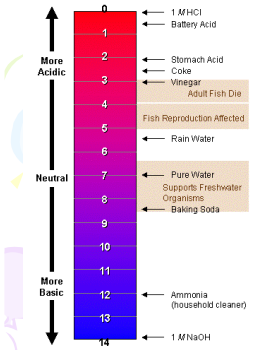
Often called acid rain

SO_2 and NOx in the atmosphere interacts to produce acidic chemicals that can travel long distances before falling to earth.

Coal power plants are huge source.

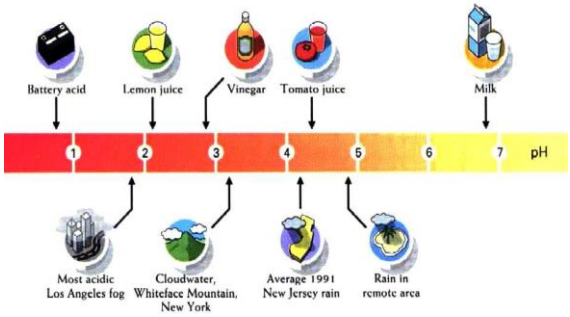
Secondary Pollutant

Acidic Review



"Normal" precipitation is slightly acidic.

Acidity Review



The pH values in atmospheric water of various types, compared with the pH values for several common liquids.

What ever happened to acid rain?

- In the 1980's, acid rain received a lot of media attention.
- Although we don't hear about acid rain as much these days, it is still a problem that deserves our attention.
- Fortunately, acid rain is a problem that we can all help to solve.

Definition of Acid Rain

- Precipitation that has a pH of less than that of natural rainwater (which is about 5.6 due to dissolved carbon dioxide).
- It is formed when sulphur dioxides and nitrogen oxides, as gases or fine particles in the atmosphere, combine with water vapour and precipitate as sulphuric acid or nitric acid in rain, snow, or fog.

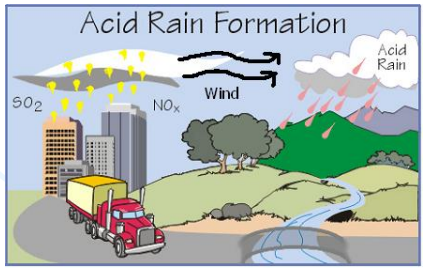
Causes of Acid Rain

- Natural Sources
  - Emissions from volcanoes and from biological processes that occur on the land, in wetlands, and in the oceans contribute acid-producing gases to the atmosphere
  - Effects of acidic deposits have been detected in glacial ice thousands of years old in remote parts of the globe

Causes of Acid Rain

- The principal cause of acid rain is from human sources
  - Industrial factories, power-generating plants and vehicles
  - Sulphur dioxide and oxides of nitrogen are released during the fuel burning process (i.e. combustion)

Formation of Acid Rain

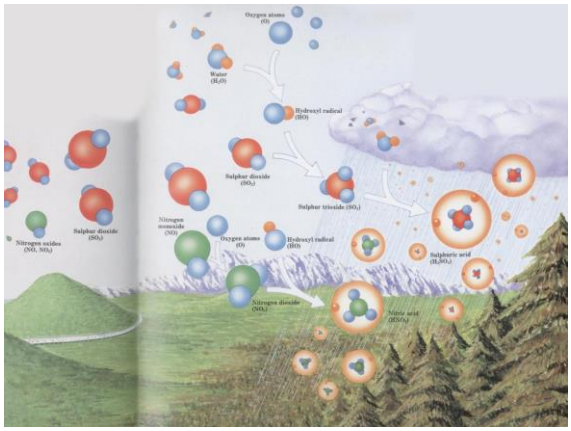


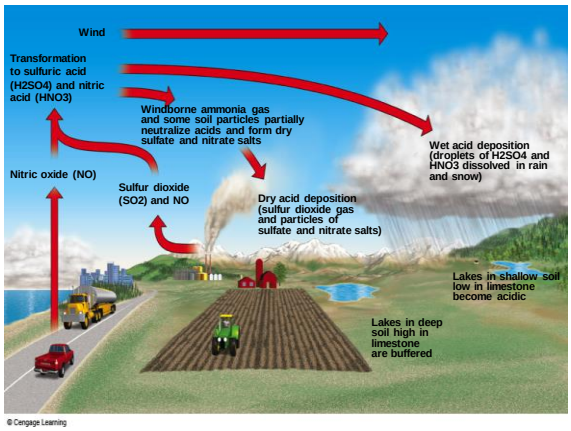
Formation of Acid Rain

- When water vapour condeses, or as the rain falls, they dissolve gases in the water to form sulphuric acid (H_2SO_4) and nitric acid (HNO_3).
- While the air in cleaned of the pollutants in this way, it also causes precipitation to become acidic, forming acid rain

Reactions

- $2SO_2 + O_2 + 2H_2O \rightarrow 2H_2SO_4$
- $4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3$
- $HCl + H_2O \rightarrow HCl\ (aq)$





Where do Sulfur Dioxide & Nitrogen Oxide Particles Come From?

- Sulfur dioxide and nitrogen dioxide particles are emitted from utility plants, especially coal-fed electric plants
- Automobiles also emit acid rain causing pollution

- Now a days, acid rain with pH<4.5 are common in many developed countries.

Effects of Acid Rain

- Harmful to aquatic life
  - Increased acidity in water bodies
  - Stops eggs of certain organisms (e.g. fish) to stop hatching
    - Changes population ratios
    - Affects the ecosystem

Effects of Acid Rain

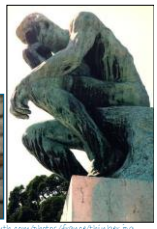
- Harmful to vegetation
  - Increased acidity in soil
  - Leaches nutrients from soil, slowing plant growth
  - Leaches toxins from soil, poisoning plants
  - Creates brown spots in leaves of trees, impeding photosynthesis
  - Allows organisms to infect through broken leaves

Effects of Acid Rain

MSN Encarta

Effects of Acid Rain

- Accelerates weathering in metal and stone structures
  - Eg. Parthenon in Athens, Greece; Taj Mahal in Agra, India



MSN Encarta http://www.louvrepaductn.com/photos/france/thinker.jpg

Effects of Acid Rain

- Affects human health
  - Respiratory problems, asthma, dry coughs, headaches and throat irritations
  - Leaching of toxins from the soil by acid rain can be absorbed by plants and animals. When consumed, these toxins affect humans severely.
  - Brain damage, kidney problems, and Alzheimer's disease has been linked to people eating "toxic" animals/plants.

Preventive Measures

- Reduce amount of sulphur dioxide and oxides of nitrogen released into the atmosphere
  - Use less energy (hence less fuel burnt)
  - Use cleaner fuels
  - Remove oxides of sulphur and oxides of nitrogen before releasing
    - Flue gas desulphurization
    - Catalytic Converters

Preventive Measures

- Use cleaner fuels
  - Coal that contains less sulphur
  - "Washing" the coal to reduce sulphur content
  - Natural Gas

What else needs to be done about Acid Rain ?

- In 1990, an amendment to the Clean Air Act called for reductions in sulfur emissions
- This proved to be less effective than hoped, as acid rain still persists today
- This is largely due to 2 reasons: 1) reductions in sulfur emissions were not great enough and

2) there were no reductions in nitrogen emissions which are also implicated in forming acid rain

- The New England Governors and eastern Canadian Premieres were working together on a solution
- An International Acid Rain Steering Committee was formed and is currently discussing joint action to further reduce sulfur emissions by 50% and reduce nitrogen emissions by 30% by the year 2010

Can We Do Anything About Acid Rain?

- YES! We can all take small actions to help solve the problem
- We can help by:
  -using our cars less
  -conserving electricity
  -choosing electricity providers that emit lower amounts of air pollution emissions

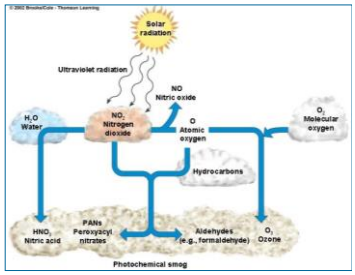
- Use other sources of electricity (i.e. nuclear power, hydro-electricity, wind energy, geothermal energy, and solar energy)
  – Issue of cost

http://upload.wikimedia.org/wikipedia/commons/4/4e/Nuclear_Power_Plant_Cattenom.jpg

Photochemical Smog

Photochemical Smog

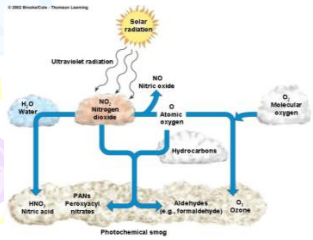
- **Brown-air smog**
- **Photochemical reaction**
- **Photochemical oxidants**



What is photochemical smog?

Secondary Pollutant

VOCs + NOx + heat + Sunlight = Ground Level



Complex series of chemical reactions

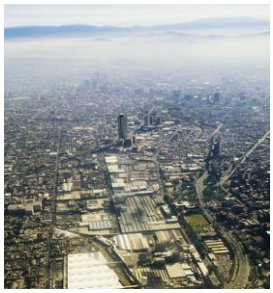
SMOG (smoke + fog)

What is photochemical smog?

All modern cities have smog, but it is more common in hot, sunny, warm climates with a lot of motor vehicle traffic.

What time of year do you think it is most common?

- Los Angeles
- Denver
- Mexico City
- Houston
- Beijing China



What is photochemical smog?

Industrial Smog: a mixture of SO_2, droplets of sulfuric acid and suspended PM from burning coal and oil.

More of a problem today in developing counties.

Coal burning HUGE issue.

Health Impacts of Smog

Smog Impacts:

- Breathing Problems
- Coughing, Eye Irritation
- Aggravates asthma, heart problems
- Speeds up aging of lung tissue
- Damage plants
- Reduce Visibility

Factors Influencing Smog Formation

Smog Levels Are Influenced By:

- Local climate
- Topography
- Population Density
- No. of industry
- Transportation

Factors Influencing Smog Formation

Factors Can ***Increase*** Smog:

1) Tall urban buildings slow air exchange
2) Hills or Mountains do the same
3) High temperatures
4) Atmospheric Circulation towards poles

Factors Influencing Smog Formation

Natural Factors Can ***Reduce*** Smog:

1) Rain or snow can "wash wash" air
2) Winds can push pollutants elsewhere" air
3) Salty Sea Spray can also "