Gas Air Pollution (Characteristics and effects)

Effects of Air Pollution

- Low level exposure
  - Irritates eyes
  - Causes inflammation of respiratory tract
- Can develop into chronic respiratory diseases

Air Quality	Air Quality Index	Protect Your Health
Good	0-50	No health impacts are expected when air quality is in this range.
Moderate	51-100	Unusually sensitive people should consider limiting prolonged outdoor exertion.
Unhealthy for Sensitive Groups	101-150	Active children and adults, and people with respiratory disease, such as asthma, should limit prolonged outdoor exertion.
Unhealthy	151-200	Active children and adults, and people with respiratory disease, such as asthma, should limit prolonged outdoor exertion, everyone else, especially children should limit prolonged outdoor excertion.
Very Unhealthy (Alert)	201-300	Active children and adults, and people with respiratory disease, such as asthma, should limit prolonged outdoor exertion everyone else, especially children, should limit outdoor exertion.

Children and Air Pollution

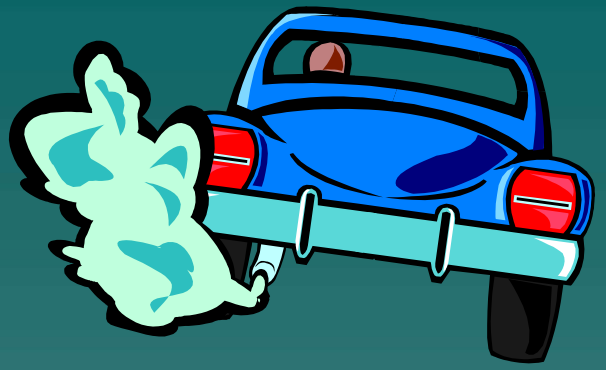
- Greater health threat to children than adults
  - Air pollution can restrict lung development
  - Children breath more often than adults
- Children who live in high ozone areas are more likely to develop asthma

Other Ways to Improve Air Quality

- Reduce sulfur content in gasoline
  - Sulfur clogs catalytic converters
- Require emission standards for all vehicles
  - Including SUVs, trucks and minivans
- Require emission testing for all vehicles

Effects of Ozone Depletion

- Higher levels of UV-radiation hitting the earth
  - Eye cataracts
  - Skin cancer (right)
  - Weakened immunity
- May disrupt ecosystems
- May damage crops and forests



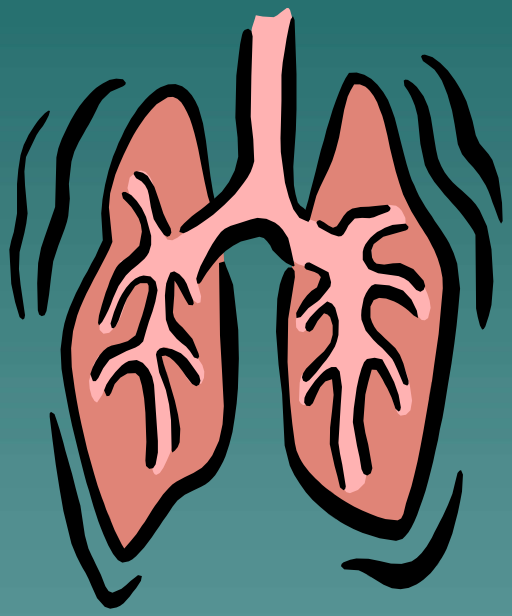
Carbon Monoxide

- deprives body of O2 causing
- headaches,
- fatigue, and
- impaired vision

Sulfur Dioxide

- narrows the airway, causing wheezing and shortness of breath, especially in those with asthma
- Causes acid precipitation

Nitrogen Dioxide



- reddish, brown gas
- affects lungs and causes wheezing; increases chance of respiratory infection

Problems

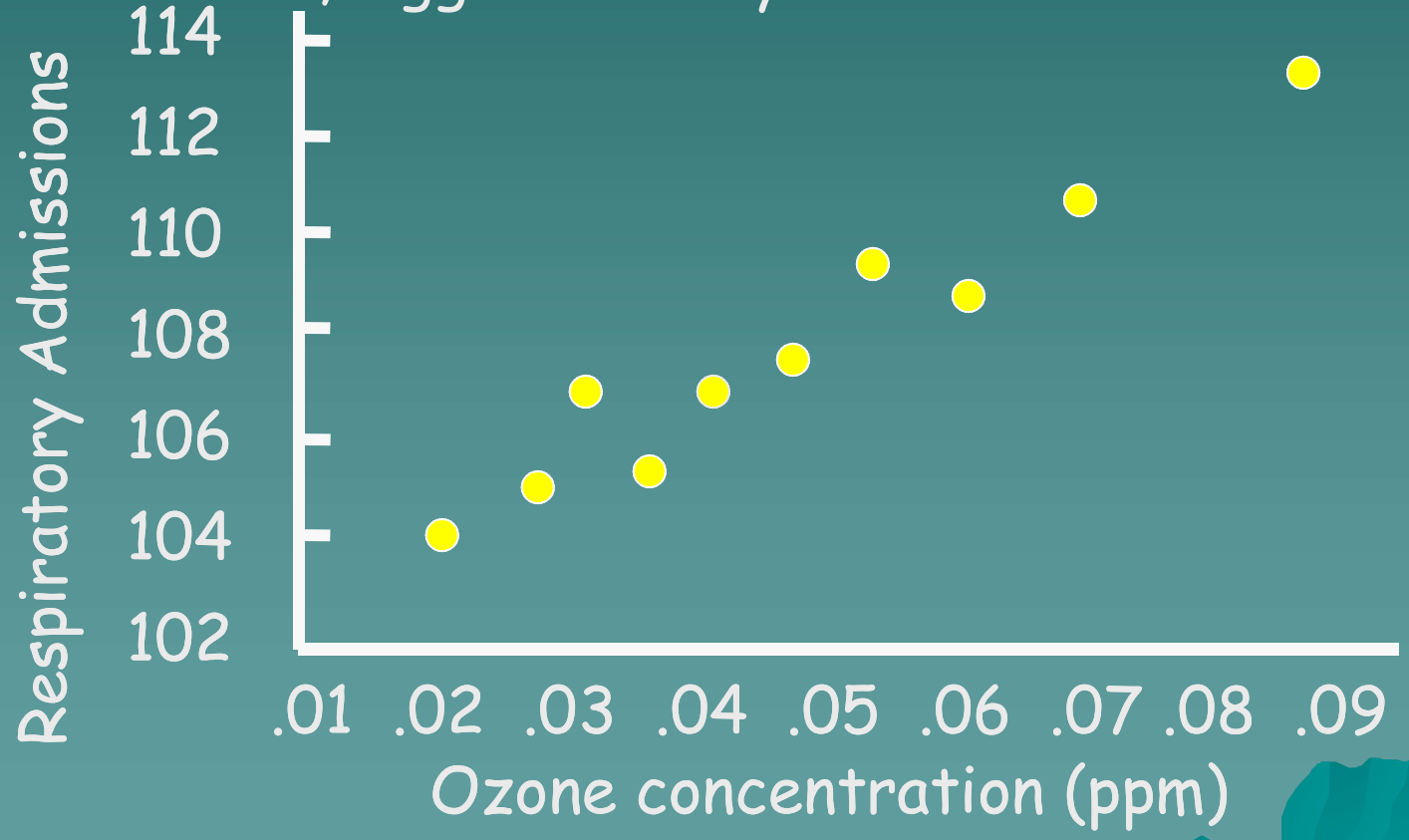
- Greenhouse gases
- Cause difficulty breathing

Ground Level Ozone

- at upper level, ozone shields Earth from sun's harmful UV rays
- at ground level, ozone is harmful pollutants
- formed from car, power and chemical plant exhaust
- irritate respiratory system and asthma; reduces lung function

Public Health Risks Are Significant

- Respiratory hospital admissions by daily maximum ozone level, lagged one day



(Burnett et al, 1994)

Hydrocarbons

- Diverse group of organic compounds that contain only hydrogen and carbon (ex: CH_4- methane)
- Some are related to photochemical smog and greenhouse gases


These 5 together form.....
SMOG

- Combination of gases with water vapor and dust
  - Combination of words smoke and fog
    - Forms when heat and sunlight react gases (photochemical smog)
      - Occurs often with heavy traffic, high temperatures, and calm winds

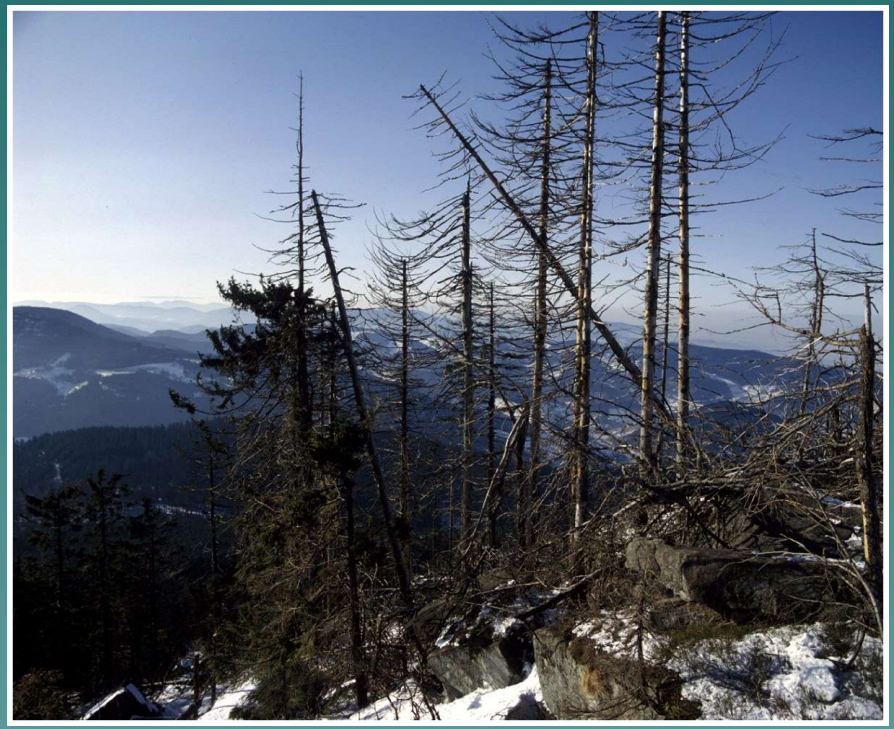
- Limits visibility
- Decreases UV radiation
- Yellow/black color over cities
- Causes respiratory problems and bronchial related deaths
- 1st smog related deaths were in London in 1873; death toll 500 people.

Recovery of Ozone Layer

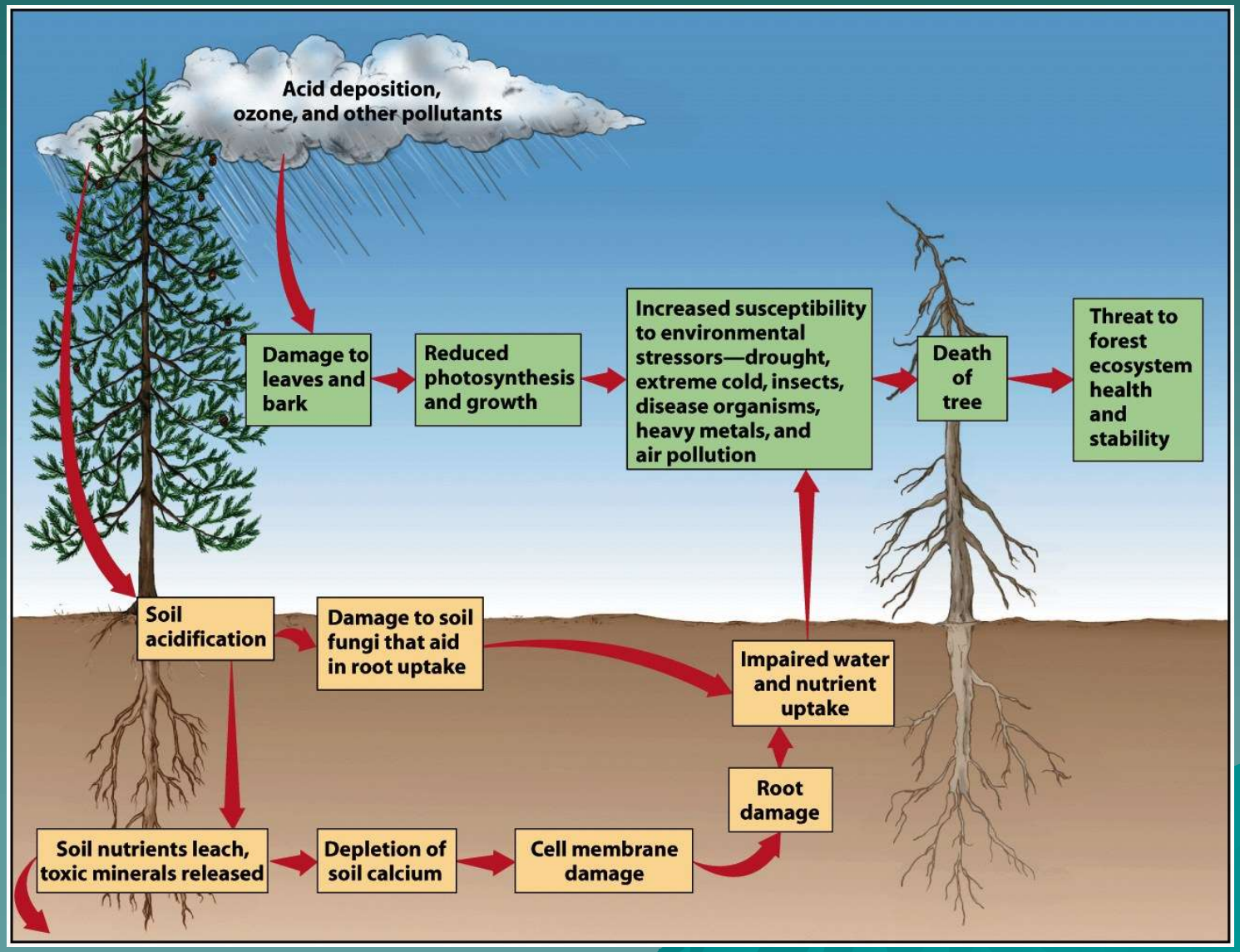
- Montreal Protocol (1987)
  - Reduction of CFCs
  - Started using HCFCs (greenhouse gas)
- Phase out of all ozone destroying chemicals is underway globally
- Satellite pictures in 2000 indicated that ozone layer was recovering
- Full recovery will not occur until 2050

Effects of Acid Deposition

- Declining Aquatic Animal Populations
- Thin-shelled eggs prevent bird reproduction
  - Because calcium is unavailable in acidic soil
- Forest decline
  - Ex: Black forest in Germany (50% is destroyed)



Acid Deposition and Forest Decline



PAH and Allergies

PAH exposure increases the physiological responses to allergens

Allergy symptoms scores worse 3-fold

Diaz-Sanchez J. All. Clin. Immun. Dec 2000 106

Traffic Emissions and Death

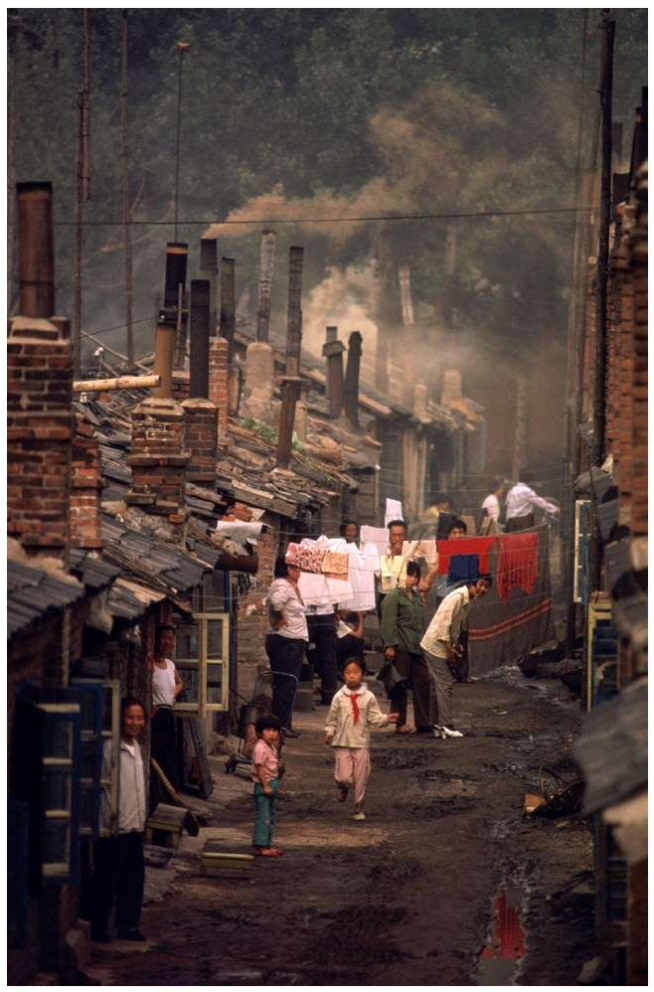
Near-road group had:

- **Almost double the death rate from heart and lung disease**
- **1.4 times higher overall death rate**

Hoek, G., et al. "Association between Mortality and Indicators of Traffic-related Air Pollution in the Netherlands: A Cohort Study"

Lancet 360 (2002) 1203

Air Pollution Around the World



- Air quality is deteriorating rapidly in developing countries
- Shenyang, China
  - Residents only see sunlight a few weeks each year
- Developing countries have older cars
  - Still use leaded gasoline
- 5 worst cities in world
  - Beijing, China; Mexico City, Mexico; Shanghai, China; Tehran, Iran; and Calcutta, India

Effects On Surroundings

Carbon Monoxide

- **Effects on plants:-**
- CO reduces nitrogen fixing capacity of bacteria. Which affects the plant growth.
- High concentration of causes leaf drops, reduces the size of leaf and ageing
- **Effects on materials:-**
- Carbon monoxide appears to have no detrimental effect on materials.

Oxides Of Sulfur

- **Effects on Plants:-**
- The low concentration for long period may cause discoloration of leaves
- SO_2 affects the growth of plants
- At high concentration the leaf tissues gets damaged.
- H_2SO_4 is extremely toxic to plants and soil fertility.

Effect on Material

Effects on Plants

- **Effects on Materials:-**
- The sulphuric acid will attack building materials containing carbonates. This will form $CaSO_4$ the $CaSO_4$ gets easily washed away leaving discolored surface
- Paper absorb SO_2 causing the paper to become brittle
- Leather looses the strength and flexibility.

Oxides of Nitrogen

- **Effects on Vegetation:-**
- NO_2 and primary pollutants can damage plant tissues
- High concentration of NO Causes Damage to leaves.
- Secondary Pollutants such as smog, O_3 may damage the vegetation
- **Effects on Materials:-**
- Nitric acid causes corrosion to metal surface
- NO_2 fades the color of clothes
- NO_2 causes cracking of rubber

Corrosion

damaged plant tissues

Hydrocarbons

- **Effects on Vegetation:-**
- HC affects plant growth
- Discoloration of leaves
- **Effects on Materials:-**
- It causes discoloration of materials
- Material becomes less elastic and more brittle.

Discoloration of leaves

Critical role of OH

Hydroxyl radical (OH) steers lifetime of CH_4, HFCs, O_3

OH determined by:

- Nitrogen oxides (NO_x)
- Carbon monoxide (CO)
- Volatile organic compounds (VOCs)
- Methane (CH_4)
- etc., including stratospheric H_2O

NO_x and climate change

Increase in NO_x leads to

- decreased lifetime of CH_4 and HFCs (via OH):
  ↓ radiative forcing
- increase in O_3:
  ↑ radiative forcing
- increased N deposition → fertilization → CO_2 uptake:
  ↓ radiative forcing

Inclusion of air pollutants may alter net radiative forcing

Including air pollution in calculations might alter net radiative forcing and thus modify policy recommendations, e.g.:

- Diesel:
  Black carbon could compensate fuel saving effect in terms of GHGs (M. Jacobsen, 2001)

- Bio-fuels for cooking:
  Fossil LPG might cause less radiative forcing than bio-fuels
  (due to incomplete combustion products, e.g., VOC, CO, BC, OC, etc.) (K. Smith, 2001)

Multiple benefits of methane control

1. **Ozone:**

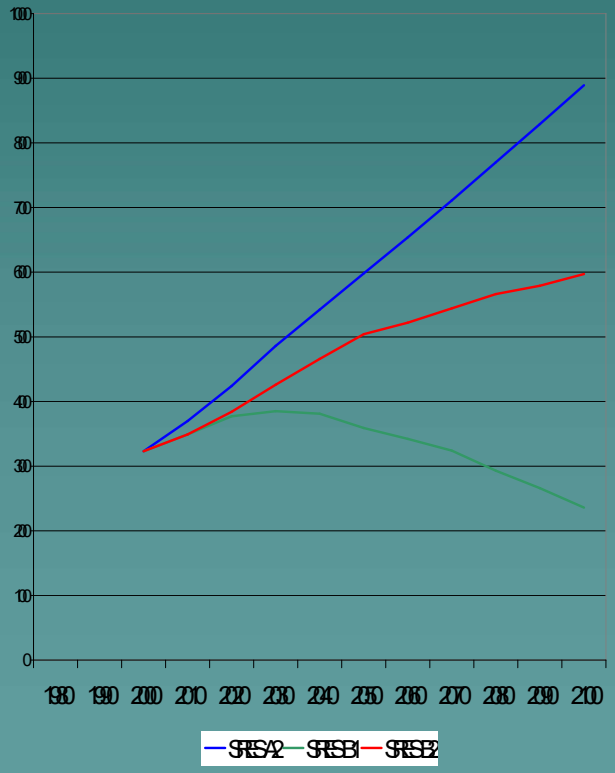
- CH_4 is another precursor of ground-level O_3, contributes to hemispheric O_3 background: Could (hemispheric) control of methane substitute for further NO_x+VOC reductions?

2. **Radiative forcing:**

- CH_4 emission cuts reduce radiative forcing directly + indirectly via shorter lifetime of CH_4
- CH_4 is Kyoto GHG
- Less radiative forcing via less tropospheric ozone

Methane reductions are possible

- SRES projects CH_4 to increase



- Technical control potential about 50% (in EU)

- Control measures:
  - Biogas
  - Controlled landfills
  - Reduced losses in gas distribution
  - Recovery in oil and gas production

  Cheap, often with negative costs and multiple benefits