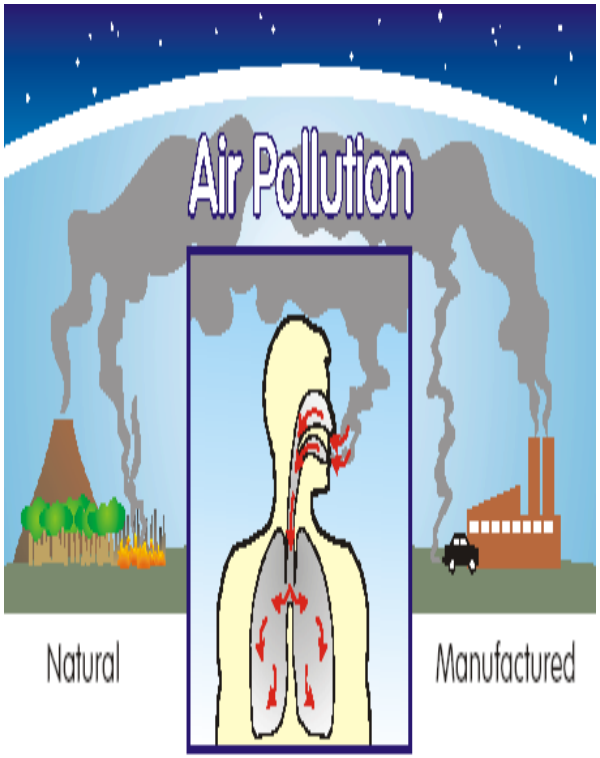
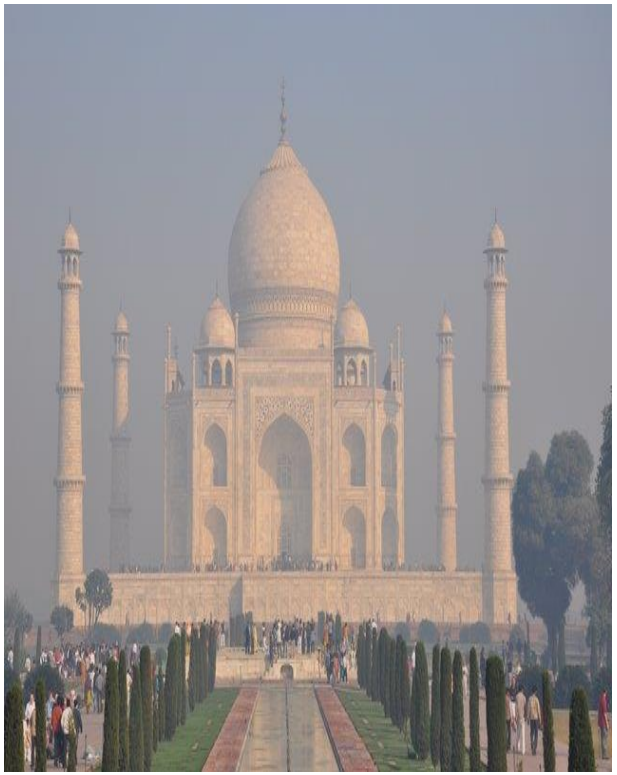
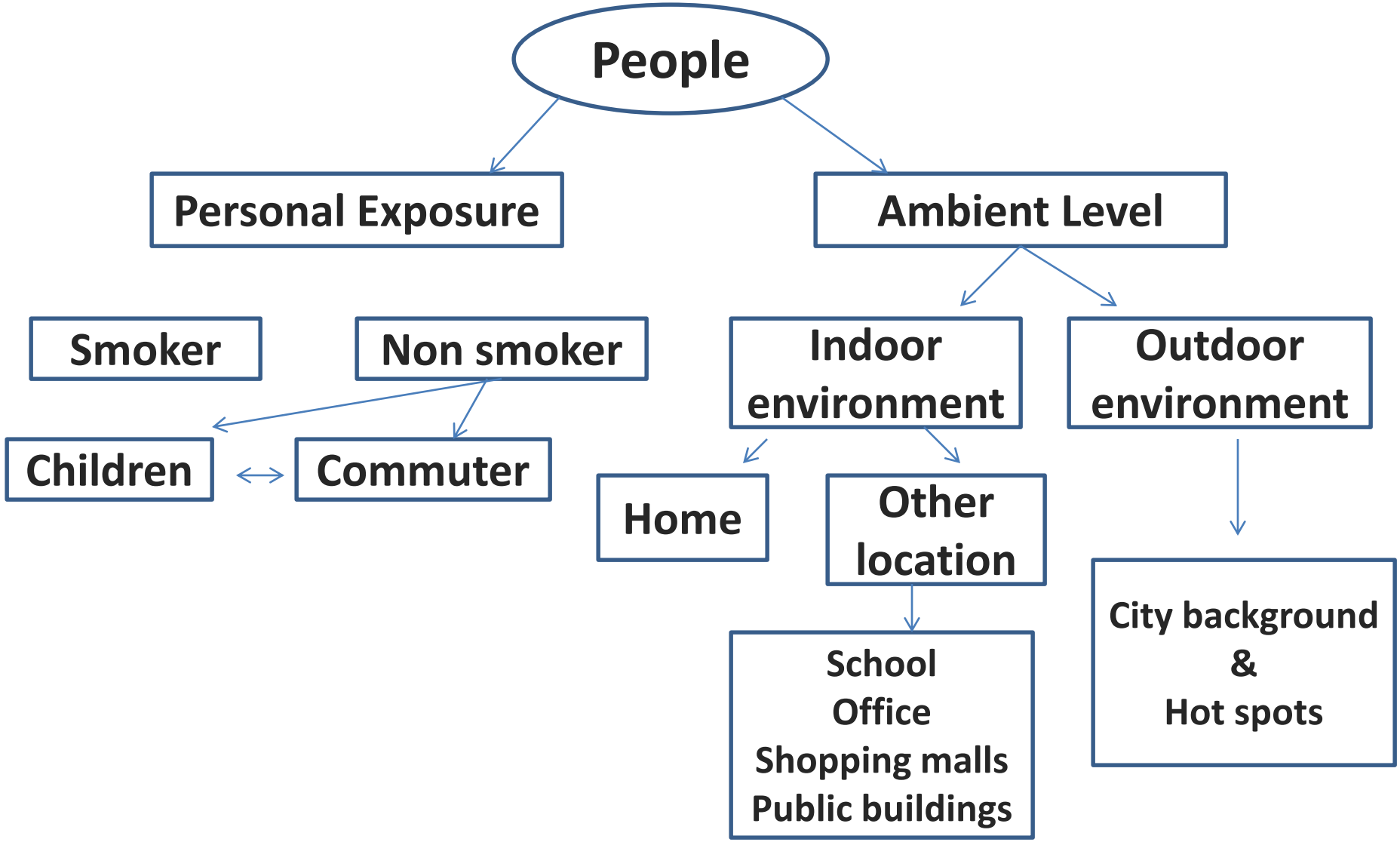
Air Pollution and its Effects





Effects of Air Pollution on Human

Effects of air pollution on human



Air pollution and health

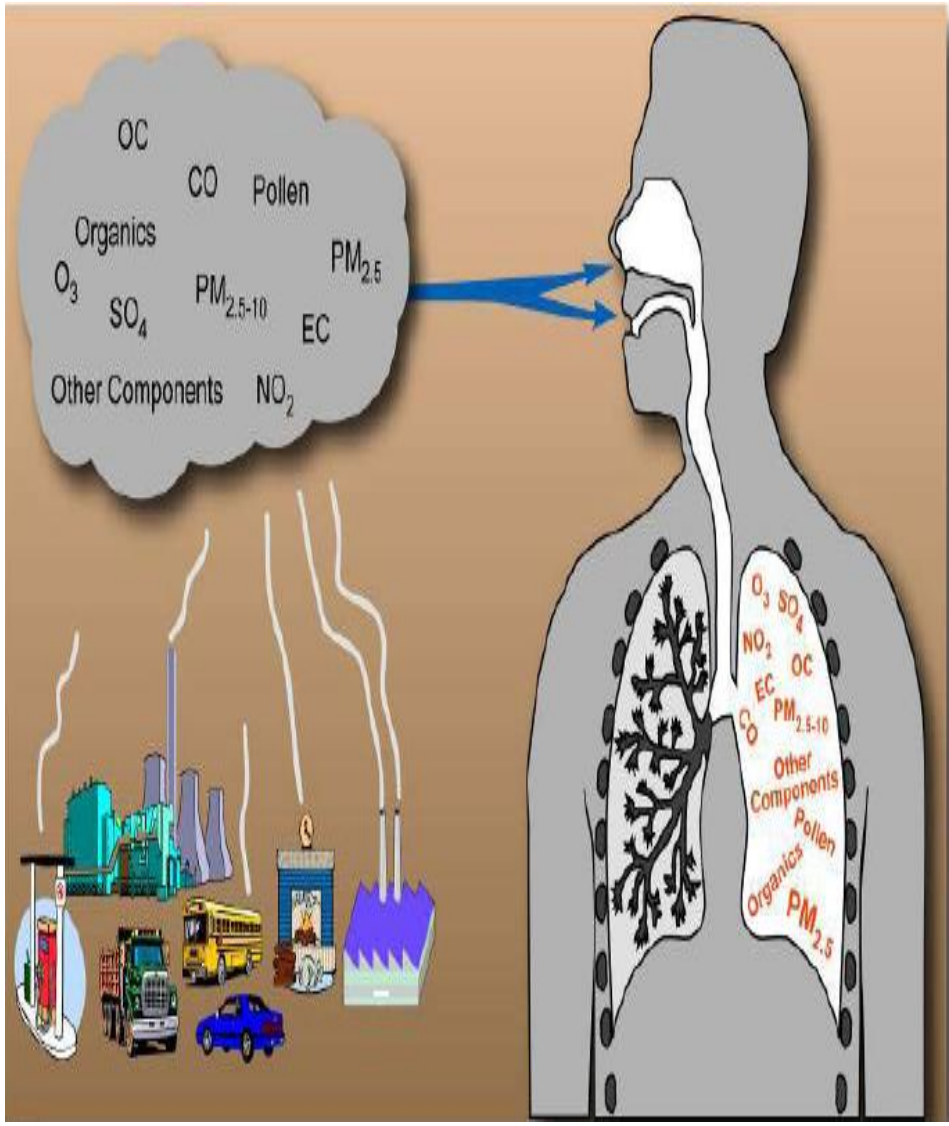
•***Pollutants act on surfaces of respiratory*** system(Causes chronic respiratory and cardiovascular disease)

•***Gaseous effects more acute than chronic*** (as opposed to the particulate pollutants)

•Long term exposure of Irritant pollutants can damage eyes, nose, throat and wet surfaces of body

•SO_2, O_3 and NO_2 are pulmonary irritants, may cause congestion, oedema and haemorrhage

•NO, H_2S and CO are asphyxiant gases (gases that can replace oxygen in body)



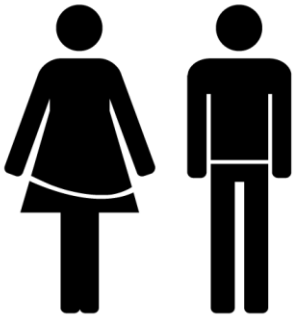
Average resting respiratory rates by age

- Birth to 6 weeks: 30–60 breaths per minute
- 6 months: 25–40 breaths per minute
- 3 years: 20–30 breaths per minute
- 6 years: 18–25 breaths per minute
- 10 years: 15–20 breaths per minute
- adults: 12–24 breaths per minute

The amount of CO_2 normally exhaled by an adult with an activity level is about 200 ml/min (0.0073 cfm) (Woods, 1980).

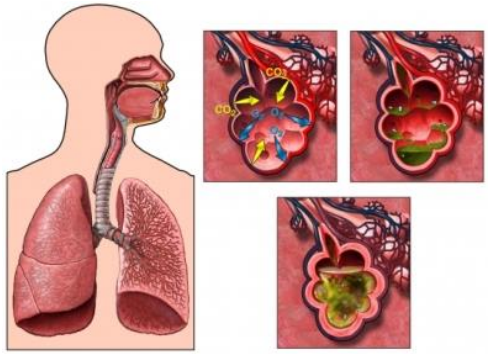
Biological factors modulating deposition

- Gender



- Age

- Respiratory Tract Disease



Sources, health and welfare effects for criteria

Pollutant	Description	Sources	Health Effects	Effects to community
Carbon Monoxide (CO)	Colorless, odorless gas	**Motor vehicle exhaust**, indoor sources include kerosene or **wood burning** stoves.	Headaches, reduced mental alertness, heart attack, cardiovascular diseases, impaired fetal development, death.	Contribute to OH radical formation thus O3 formation.
Sulfur Dioxide (SO_2)	Colorless gas that dissolves in water vapor to **form acid**, and interact with other gases and particles in the air.	**Coal-fired power plants**, petroleum refineries, manufacture of sulfuric acid and **smelting of ores** containing sulfur.	**Eye irritation, wheezing, chest tightness**, shortness of breath, lung damage.	Contribute to the **formation of acid rain, visibility impairment, damage of plants**, aesthetic damage.
Nitrogen Dioxide (N_O2)	Reddish brown, **highly reactive gas**.	**Motor vehicles, electric utilities,** and other industrial, commercial, and residential sources that **burn fuels**.	Susceptibility to respiratory infections, **irritation** of the lung and respiratory symptoms (e.g., **cough, chest pain, difficulty breathing**).	Contribute to the **formation of smog, acid rain, water quality deterioration, global warming, and visibility impairment**.
Ozone (O_3)	Gaseous pollutant when it is **formed in the troposphere**.	Formed from other air pollutants in the presence of sunlight.	Eye and throat irritation, coughing, respiratory tract problems, asthma, lung damage.	Plant and ecosystem damage.
Lead (Pb)	Metallic element	Metal refineries, lead smelters, battery manufacturers, iron and steel producers.	Anemia, high blood pressure, brain and kidney damage, neurological disorders, cancer, lowered IQ.	Affects animals and plants, affects aquatic ecosystems.
Particulate Matter (PM)	Very small particles of soot, dust, or other matter, including tiny droplets of liquids.	Diesel engines, power plants, industries, windblown dust, wood stoves, open burning.	Eye irritation, asthma, bronchitis, lung damage, cancer, heavy metal poisoning, cardiovascular effects.	Visibility impairment, atmospheric deposition, aesthetic damage.

http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-Delhi/Environmental%20Air%20Pollution/index.htm

Hemoglobin competitive binding affinity of different gaseous pollutants

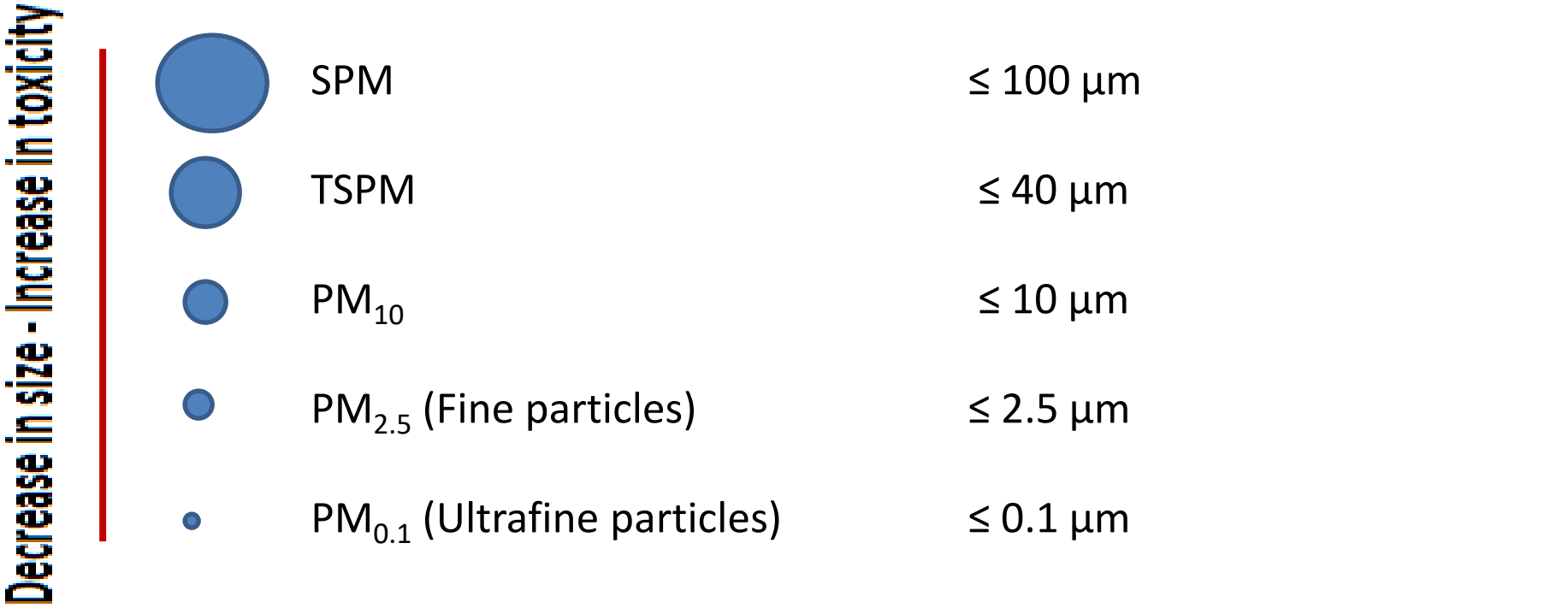
POLLUTANT	Hemoglobin binding capacity (compared to oxygen)
Carbon monoxide (CO)	210 – 250 times (Franklin H. 2009)
Nitric oxide (NO)	8000 times (Franklin H. 2009)
Other pollutants such as **Cyanide** (CN^-), **Sulfur monoxide** (SO) and **Sulfide** (S^{2-}), including **hydrogen sulfide** (H_2S)	

Carboxihemoclobin levels resulting from steady state exposure to increasing concentration of CO in ambient air

CO in atmosphere (ppm)	COHb in blood (%)	Signs and symptoms
10	2	Asymptomatic
70	10	No appreciable effect, except shortness of breath on vigorous exertion; possible tightness across the forehead; dilation of cutaneous blood vessels.
120	20	Shortness of breath on moderate exertion; occasional headache with throbbing in temples
220	30	Decide headache; irritable; easily fatigued; judgment disturbed; possible dizziness; dimness of vision.
350 - 520	40 – 50	Headache, confusion; collapse; fainting on exertion
800 - 1220	60 – 70	Unconsciousness; intermittent convulsion; respiratory failure, death if exposure is long continued
1950	80	Rapidly fatal

Source: Winter and Miller (1976), Ellenhorn and Barceloux (1998)

Background information



Source: USEPA, 1996.

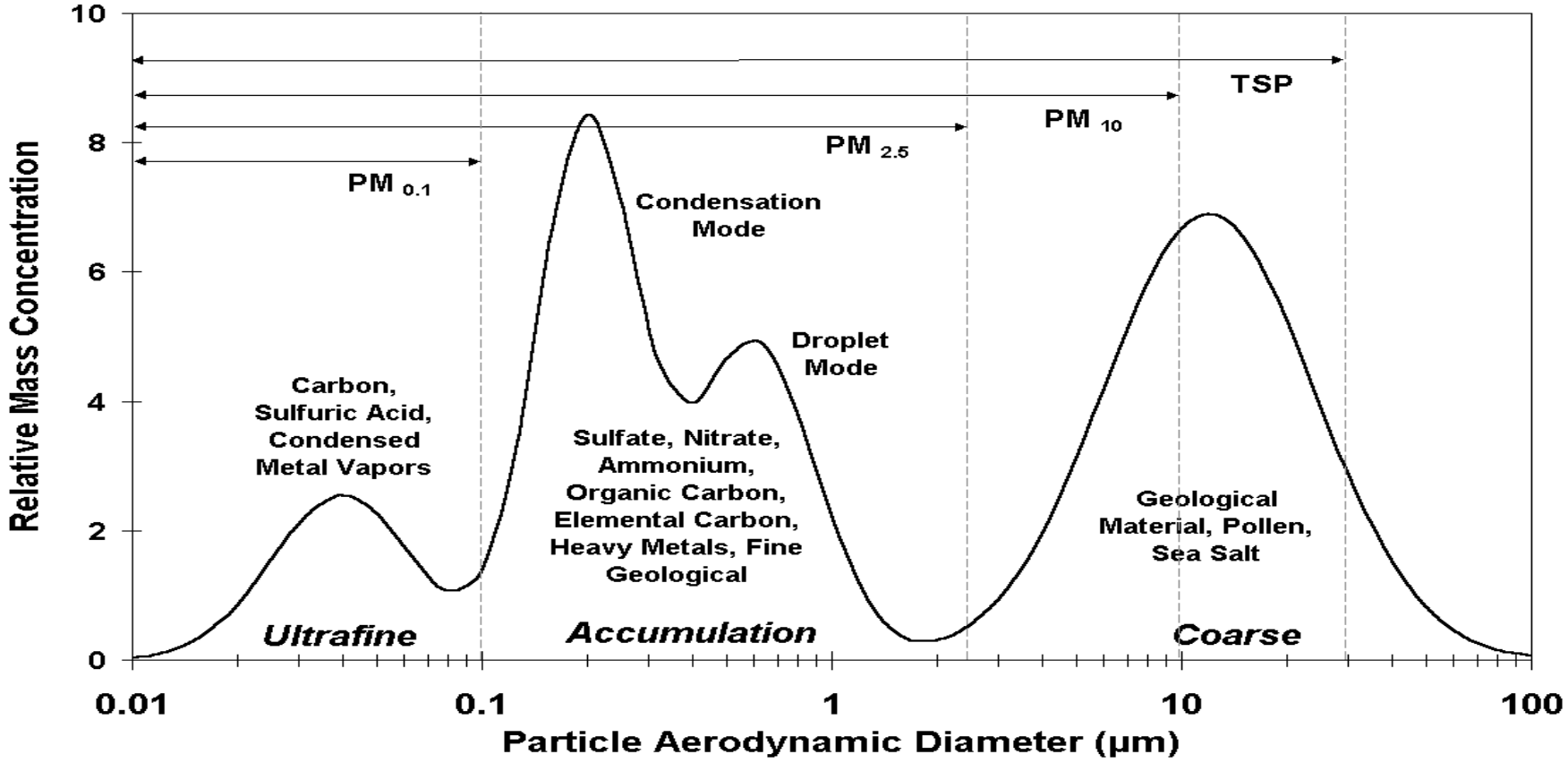
Synergism

- Small particles, exhibiting a large surface area per mass, have been found to induce a more pronounced proinflammatory response than larger particles of the same material.

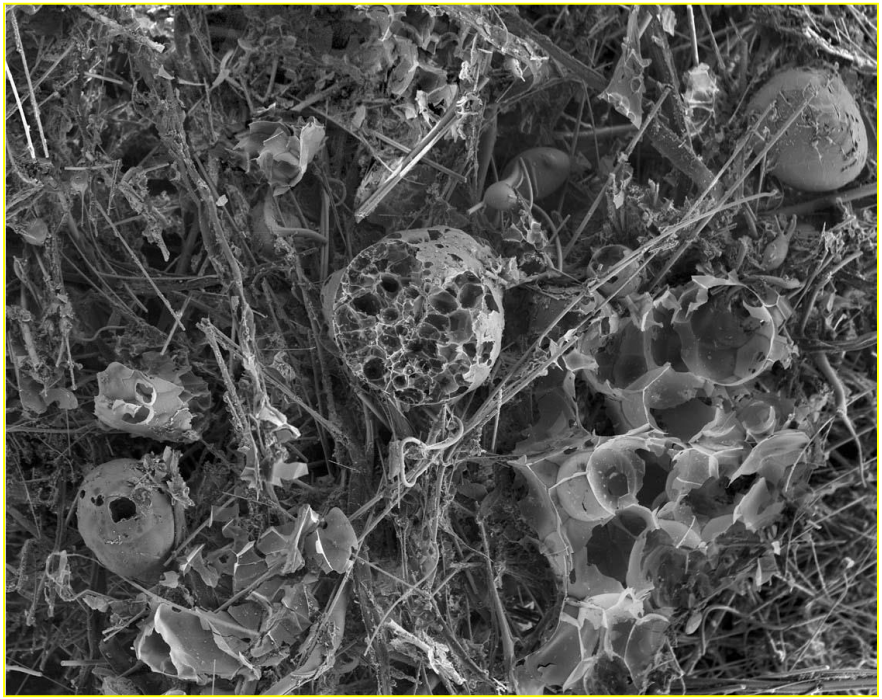
- Ultra fine particles are providing large surface area for toxic elements, gases and heavy metal to condense, even when these ultra fine particles itself having low solubility and low toxicity.

$$\left[\begin{array}{c}Synergistic\ effect\ of\\ particulate\ and\\ gaseous\ pollutants\end{array}\right] \geq \left[\begin{array}{c}effect\ of\\ particulate\ alone\end{array}\right] + \left[\begin{array}{c}effect\ of\\ toxic\ gas\ alone\end{array}\right]$$

Particulate matter



Shape, size and texture of particle



Source :-Photo by Dee Berger, LDEO, Columbia University

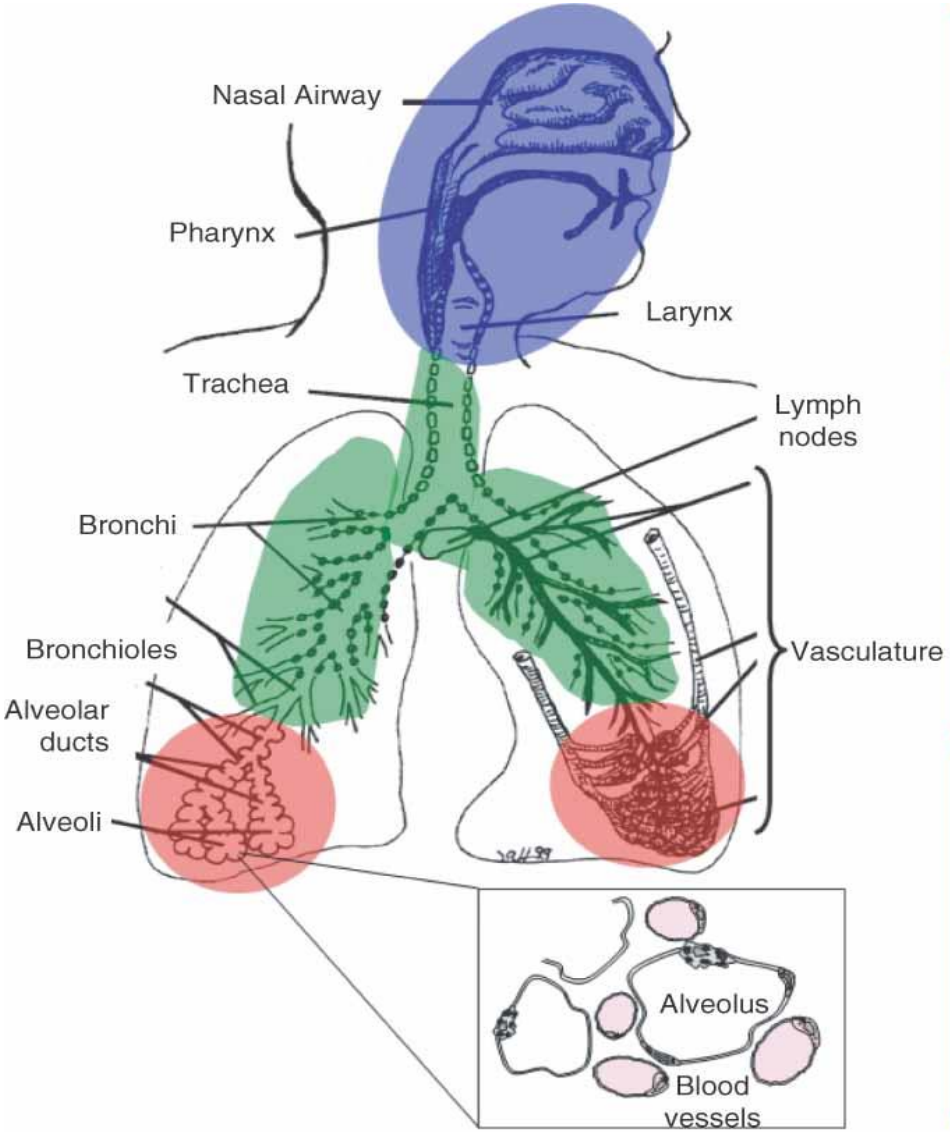
Particle characteristics relevant for health effects

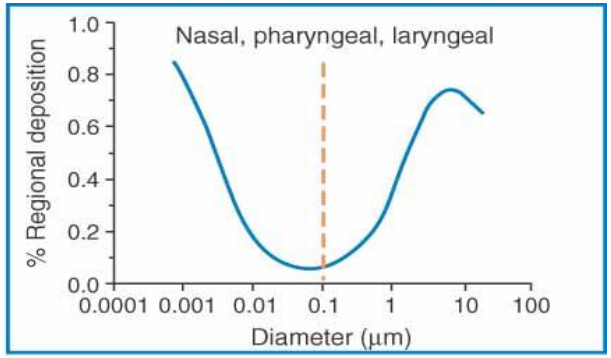
- The adverse health **effects of inhaled particles are highly dependent on the deposition and retention** of particles in the lung

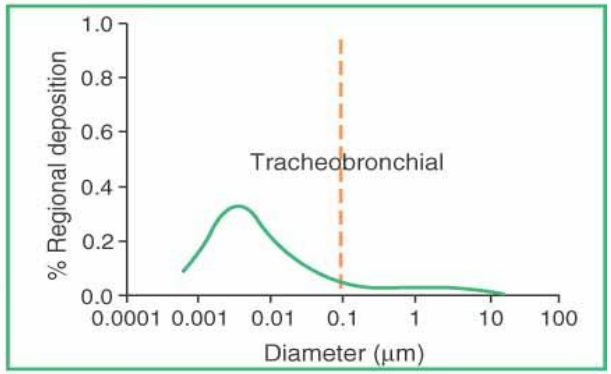
- The deposition probability and deposition site of particles is governed by their aerodynamic properties, such as size, density and shape, but also by other physicochemical properties such as hygroscopicity and texture, which also influence the toxic and inflammatory potential of particulate matter

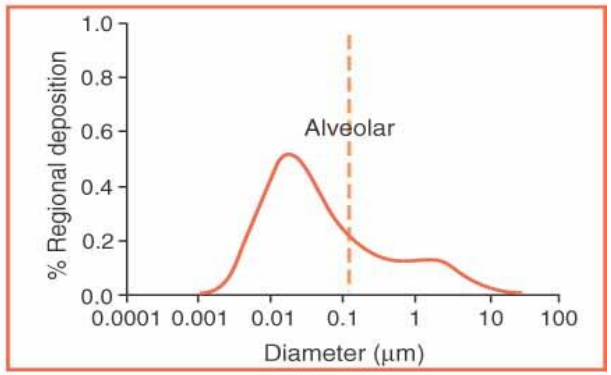
- With respect to chemical composition, the content of metals such as vanadium, zinc, iron, copper and nickel, as well as the content of organic compounds such as polycyclic aromatic hydrocarbons (PAHs), seem to influence the particle-elicited health effects (Schwarze et al. 2006)

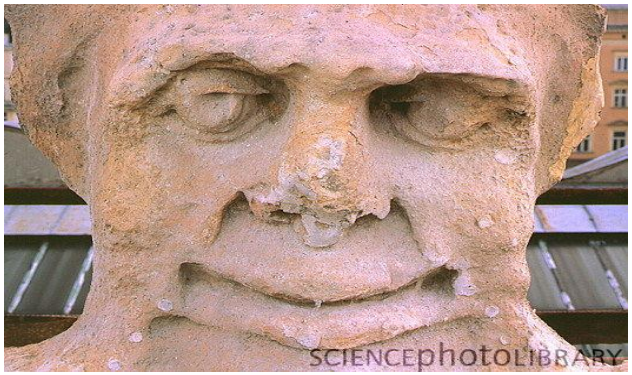
Dependence of deposition on particulate aerodynamic diameter











Effects of Air Pollution on Buildings

Effects of air pollution on buildings

For limestone, the acidic water reacts with the calcium to form calcium sulfate:

$$CaCO_3 + H_2SO_4 \longrightarrow CaSO_4 + 2H^+ + CO_3^{2-}$$

The calcium sulfate is soluble so it is easily washed away during the next rain storm

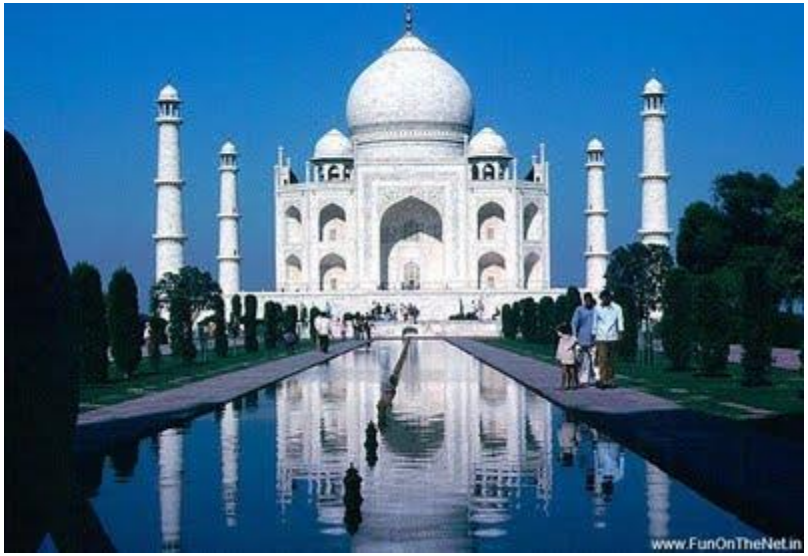
Statue carved in 1702 photographed in 1908 (left) and 1969 (right).

Continued…

Chemicals produced by industries escaped into the atmosphere.

For example: the emissions from oil and refinery at Mathura and the numerous coal-burning industries at Agra contains sulphur dioxide (SO_2), which cause acid rain responsible for damaging the marbles of Taj Mahal.

Effect of air pollution on materials



On Stones

Deterioration of limestone, widely used as building material.

$SO_2 + H_2O + CaCO_3 \longrightarrow CaSO_4 + CaSO_4.\ 2H_2O$

On Metals

Corrosion of the surface.

On Fabrics and Dyes

Loss of tensile strength, fading of colors of fabrics.

Rubber

Ozone cracks the rubber products under tension.

Effects of Air Pollution on Plants

Effects of Air Pollution on Plants

Air pollution commonly leads to oxidation damage of both crop plants and wild species

Common damage to leaf structure

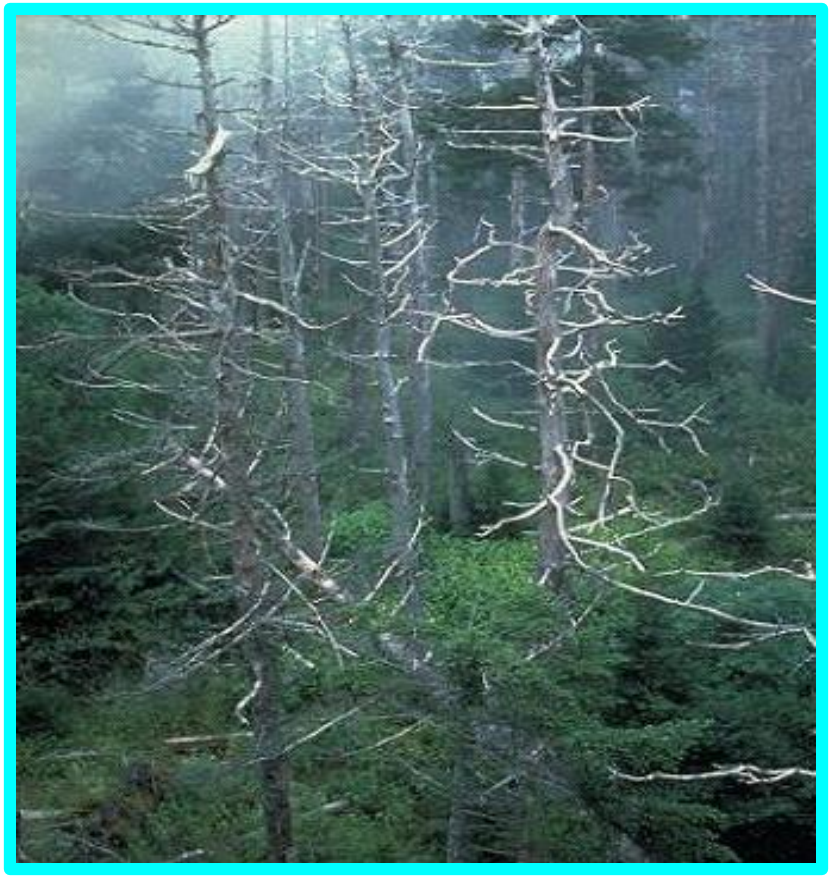
Disease	Symptoms	
Nacrosis	Dead Areas on Leaf	
Chlorosis	Loss or reduction of chlorophyll causing yellowing of leaf	
Epinasty	Downward curling of leaf	
Abscission	Dropping of leaves.	

Sources, Effects of Air Pollutants on Vegetation

Pollutants	Sources	Effects on Vegetation
Aldehydes	Photochemical reactions	The upper portions of Alfalfa etc. will be affected to **Narcosis** if 250 ppm of aldehydes is present for 2 hrs duration.
Ozone (O_3)	Photochemical reaction of hydrocarbon and nitrogen oxides from fuel combustion, refuse burning, and evaporation from petroleum products.	All ages of tobacco leaves, beans, grapes, pine, pumpkins and potato are affected. Fleck, stipple, bleaching**, bleached spotting, pigmentation, growth suppression**, and early abscission are the effects.
Peroxy Acetyl Nitrate (PAN)	The sources of PAN are the same as ozone	Young spongy cells of plants are affected if 0.01 ppm of PAN is present in the ambient air for more than 6 hrs.
Nitrogen dioxide (NO_2)	High temperature combustion of coal, oil, gas, and gasoline in power plants and internal combustion engines.	Irregular, white or brown collapsed lesion on intercostals tissue and near leaf margin. Suppressed growth is observed in many plants.
Ammonia & Sulfur dioxide	Thermal power plants, oil and petroleum refineries.	Bleached spots, bleached areas between veins, bleached margins, chlorosis, growth suppression, early abscission, and reduction in yield and tissue collapse occur.
Chlorine (Cl_2)	Leaks in chlorine storage tanks, hydrochloric acid mists.	If 0.10 ppm is present for at least 2 hrs, the epidermis and mesophyll of plants will be affected.
Hydrogen fluoride, Silicon tetrafluoride	Phosphate rock processing, aluminum industry, and ceramic works and fiberglass manufacturing.	Epidermis and mesophyll of grapes, large seed fruits, pines and fluorosis in animals occur if 0.001 ppm of HF is present for 5 weeks.
Pesticides & Herbicides	Agricultural operations	Defoliation, dwarfing, curling, twisting, growth reduction and killing of plants may occur.
Particulates	Cement industries, thermal power plants, blasting, crushing and processing industries.	Affects quality of plants, reduces vigor & hardness and interferences with photosynthesis due to plugging leaf stomata and blocking of light.
Mercury (Hg)	Processing of mercury containing ores, burning of coal and oil.	Greenhouse crops, and floral parts of all vegetations are affected; abscission and growth reduction occur in most of the plants.

Air pollution effects on trees

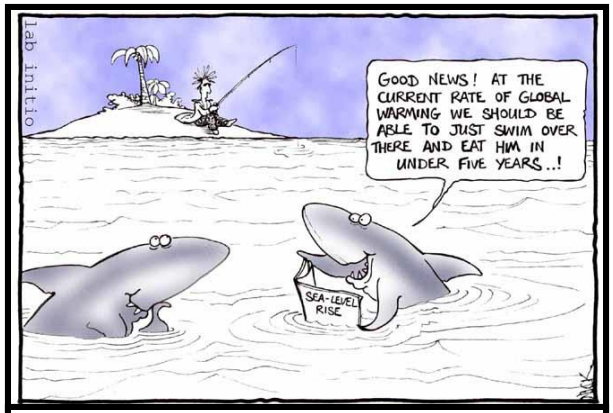
Trees killed by acid rain in the Great Smoky Mountains.

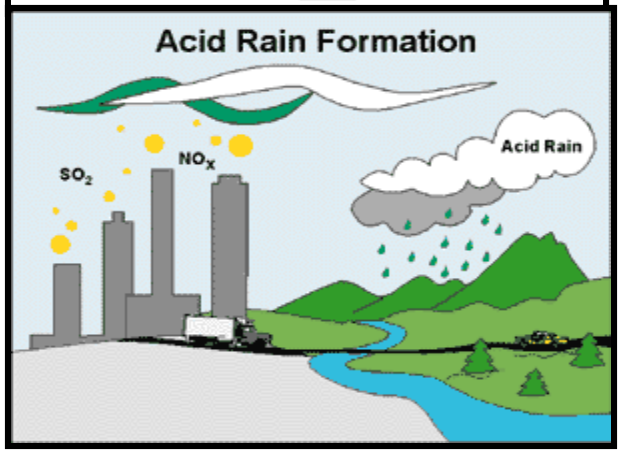


Continued…

Acid rain is a rain or any other form of precipitation that is unusually acidic, i.e. elevated levels of hydrogen ions (low pH). i.e acid deposition

Acid rain can eat through stone and metal. It has accelerated the natural weathering process of this scarred stone angel's face.

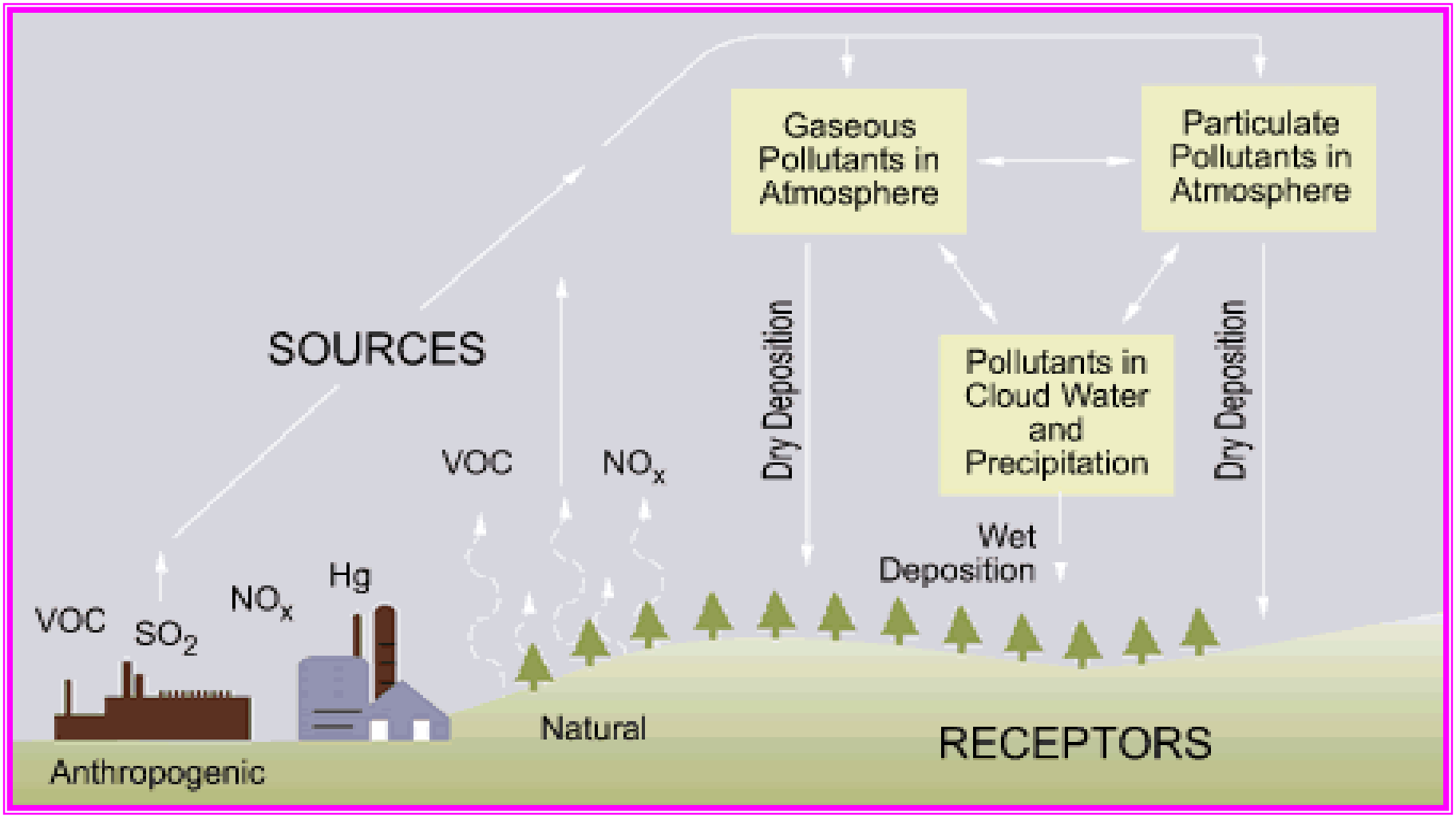




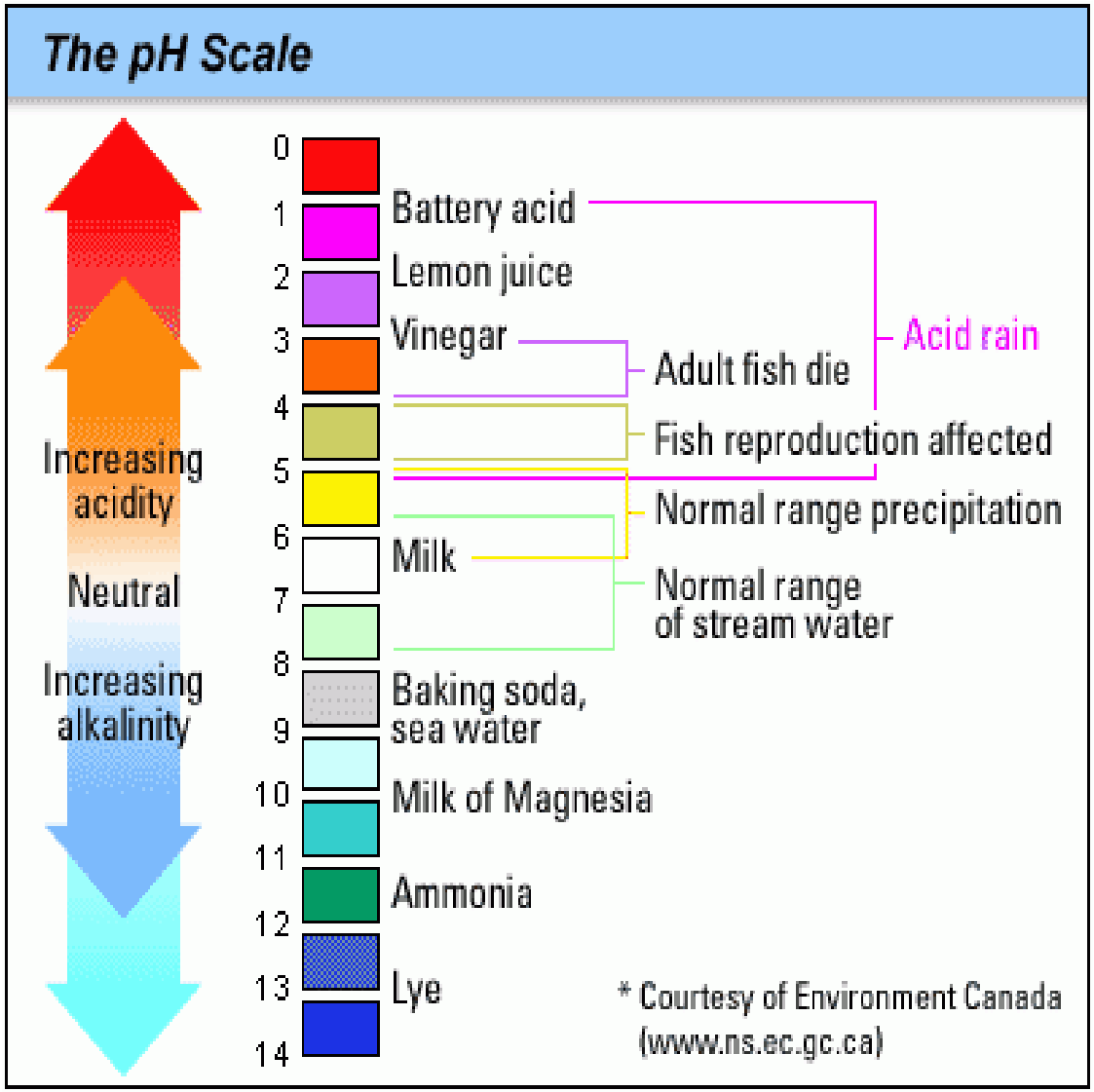
Global Consequences of Air Pollution

Acid Rain

Acid rain is a rain or any other form of precipitation that is unusually acidic, i.e. elevated levels of hydrogen ions (low pH). i.e acid deposition



Acid Rain

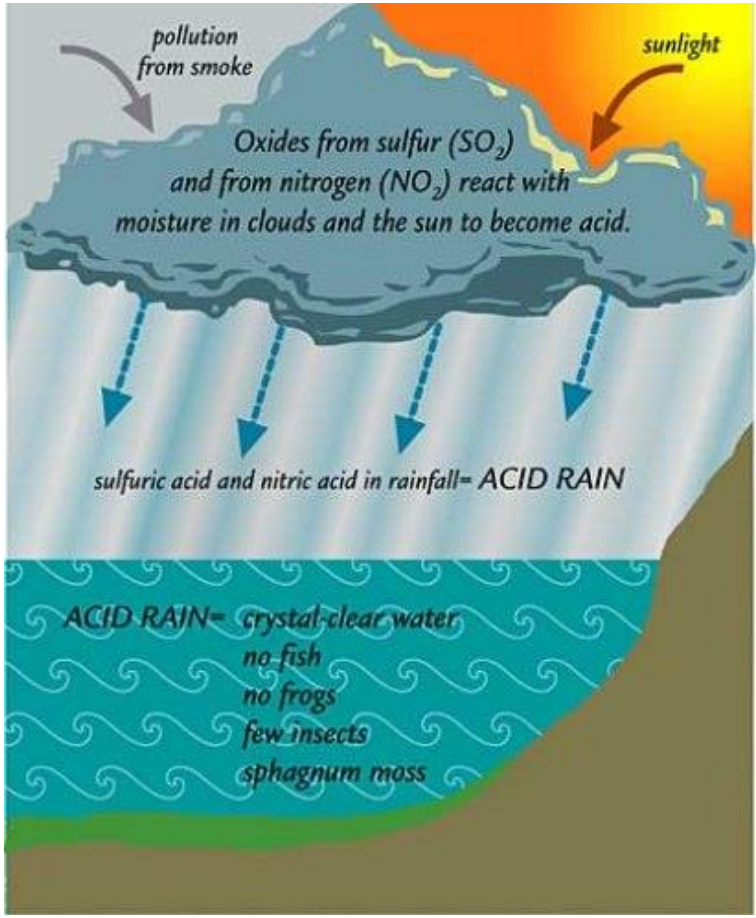

The pH Scale
Increasing acidity
Neutral
Increasing alkalinity
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Battery acid
Lemon juice
Vinegar
Adult fish die
Fish reproduction affected
Acid rain
Normal range precipitation
Milk
Normal range of stream water
Baking soda, sea water
Milk of Magnesia
Ammonia
Lye
* Courtesy of Environment Canada (www.ns.ec.gc.ca)

Effects of Acid Rain

1. On buildings/ materials

2. Trees and forests

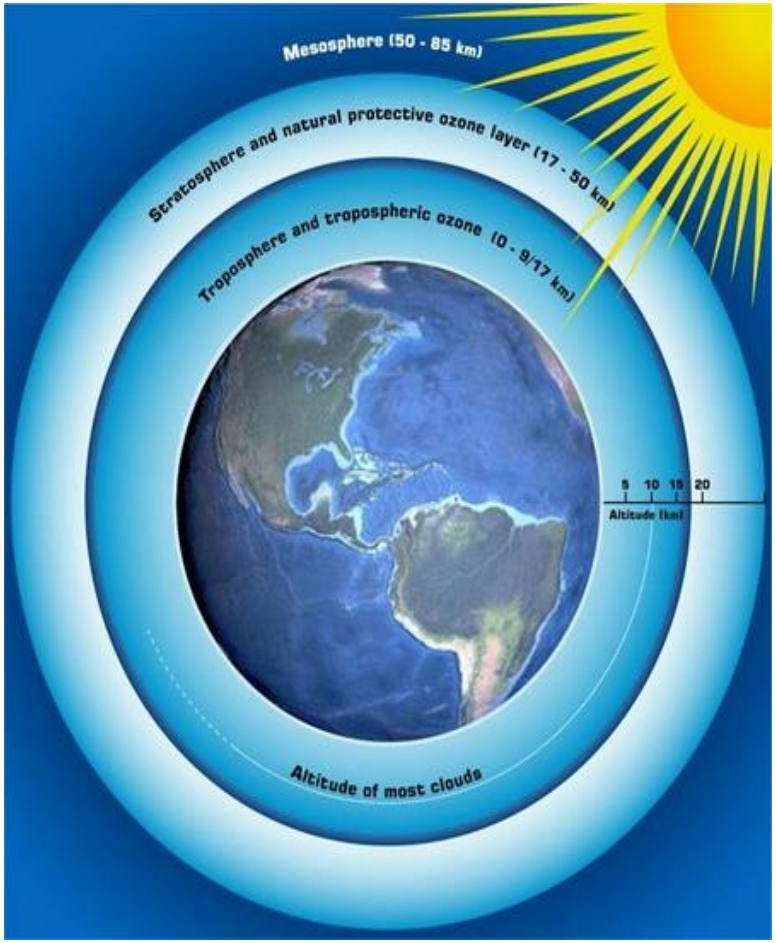
3. On aquatic life



Ozone Layer Depletion

Ozone layer

- The ozone layer is a layer in Earth's Atmosphere which contains relatively high concentrations of ozone.
- It absorbs 97–99% of the sun's high frequency ultraviolet light, which is potentially damaging to life on earth.
- Over 90% of the ozone in Earth's atmosphere is present here



Depletion of Ozone Layer

- A thinning ozone layer leads to a number of serious health risks for humans.
- Causes greater incidences of skin cancer and eye cataracts, with children being particularly vulnerable.
- Serious impacts on biodiversity.
- Increased UV-B rays reduce levels of plankton in the oceans and subsequently diminish fish stocks.
- Adverse effects on plant growth reduces agricultural productivity.
- A direct negative economic impact is the reduced lifespan of certain materials like plastics

Destruction of Ozone

- Four main "families" of chemicals responsible for catalyzing ozone destruction:

1. Nitrogen oxides: NO_x
   - NO + NO_2
2. Hydrogen oxides: HO_x
   - OH + HO_2
3. Chlorine: ClO_x
   - Cl + ClO
4. Bromine: BrO_x
   - Br + BrO

A common type of catalytic destruction cycle (there are others)

$$Y + O_3 \rightarrow YO + O_2$$

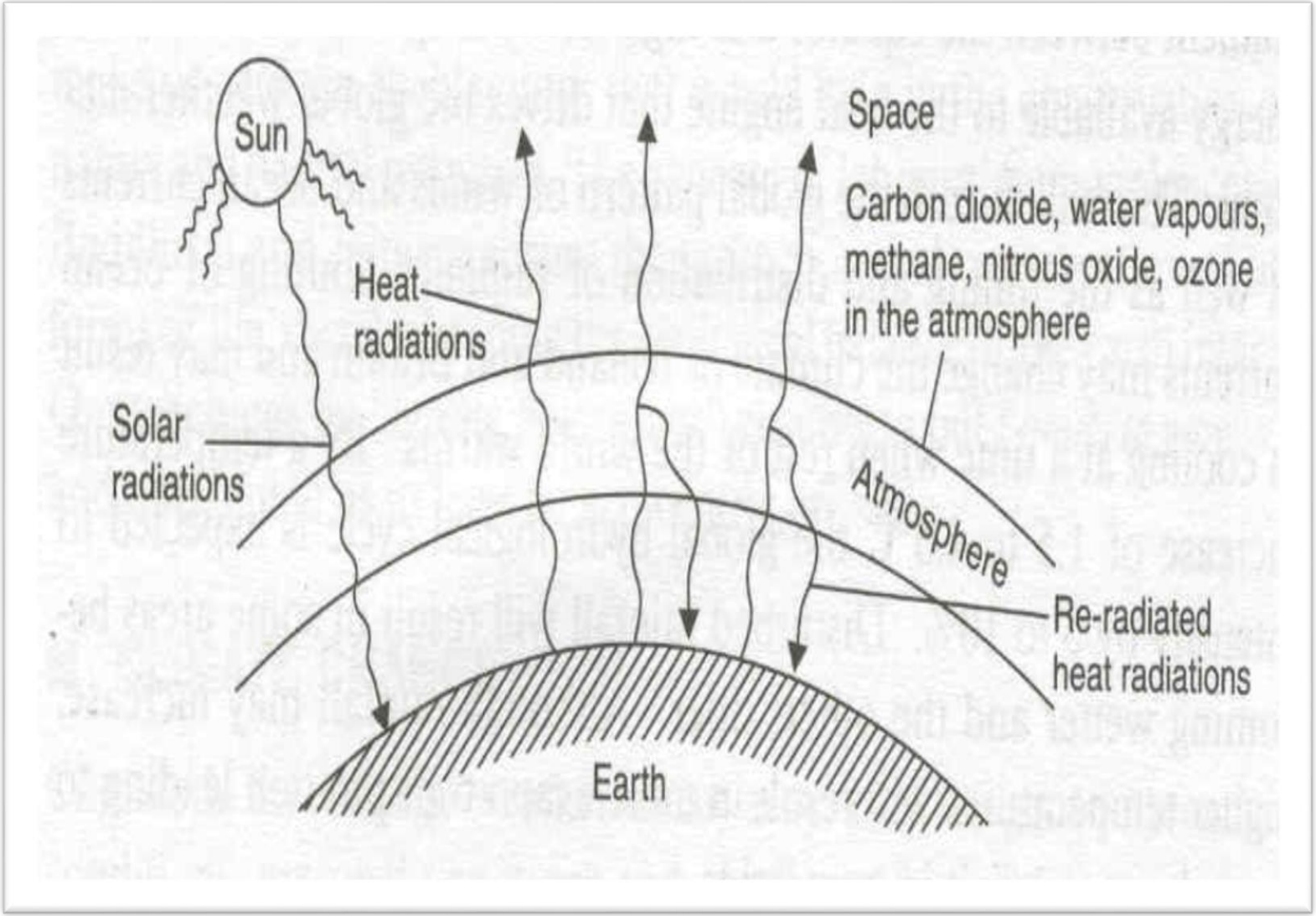
$$YO + O \rightarrow Y + O_2$$

where Y = NO, OH, Cl or Br

Global Worming

Global warming is the increase in the average temperature of earth near-surface air and oceans since the mid-20th century and its projected continuation.

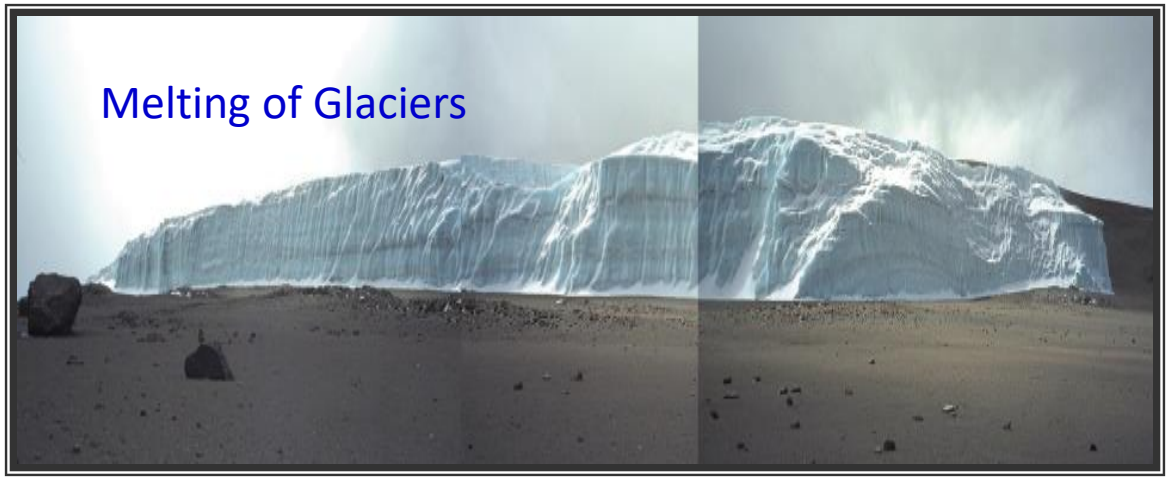
The Green House Effect



Effects of Global Warming

- Global temperature Increase
- Rise in sea level
- Effect on health
- Impact on agriculture
- Impact on ecology
- Impact on water resources
- Impact on air quality

Effects of Global Warming



Air pollution effects on endangered species

Endangered species, including bald eagles needs protection from acid rain.

Thank you!