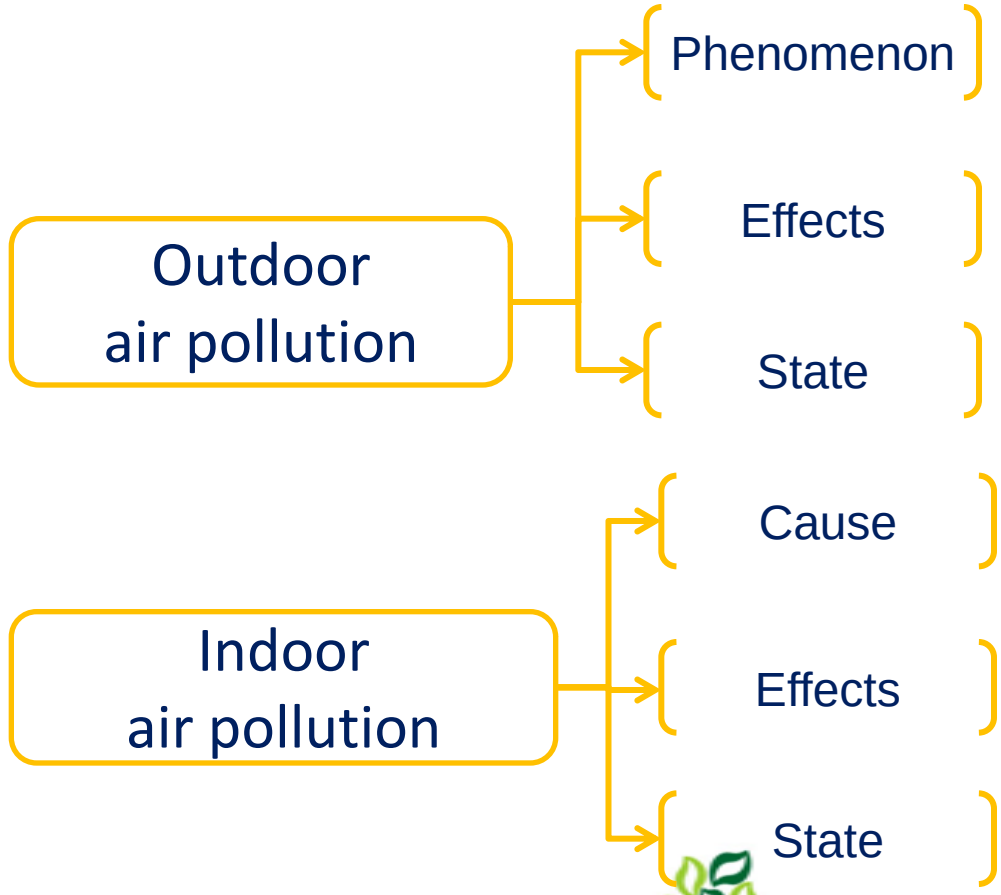
SKAA3913 ENVIRONMENTAL MANAGEMENT

Air Pollution (Effects & Controls)

AIR POLLUTION

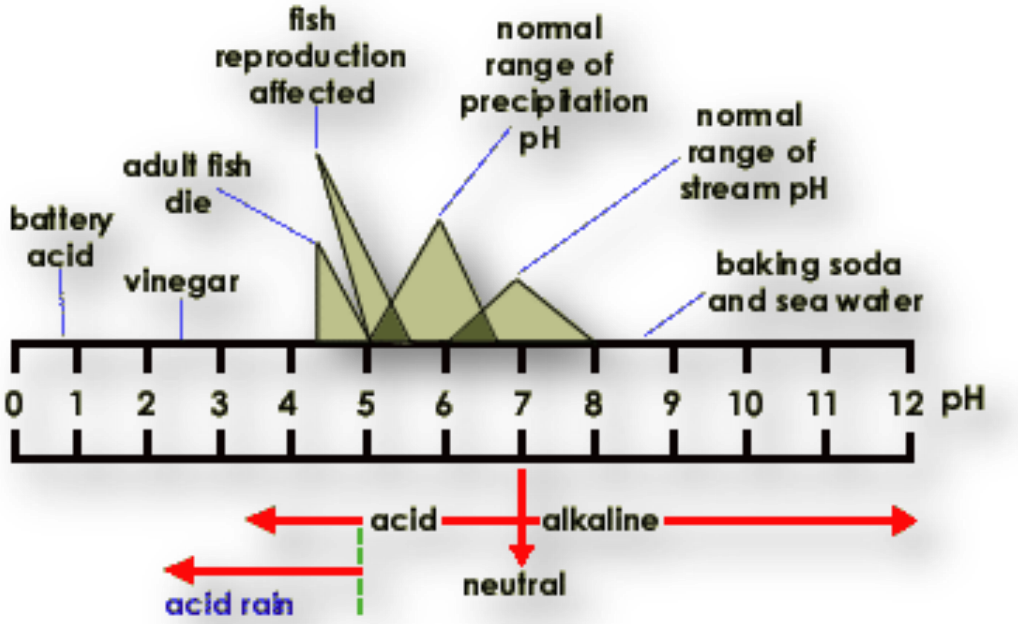
- Acid deposition
- Photochemical smog
- Haze
- Ozone
- Greenhouse effects



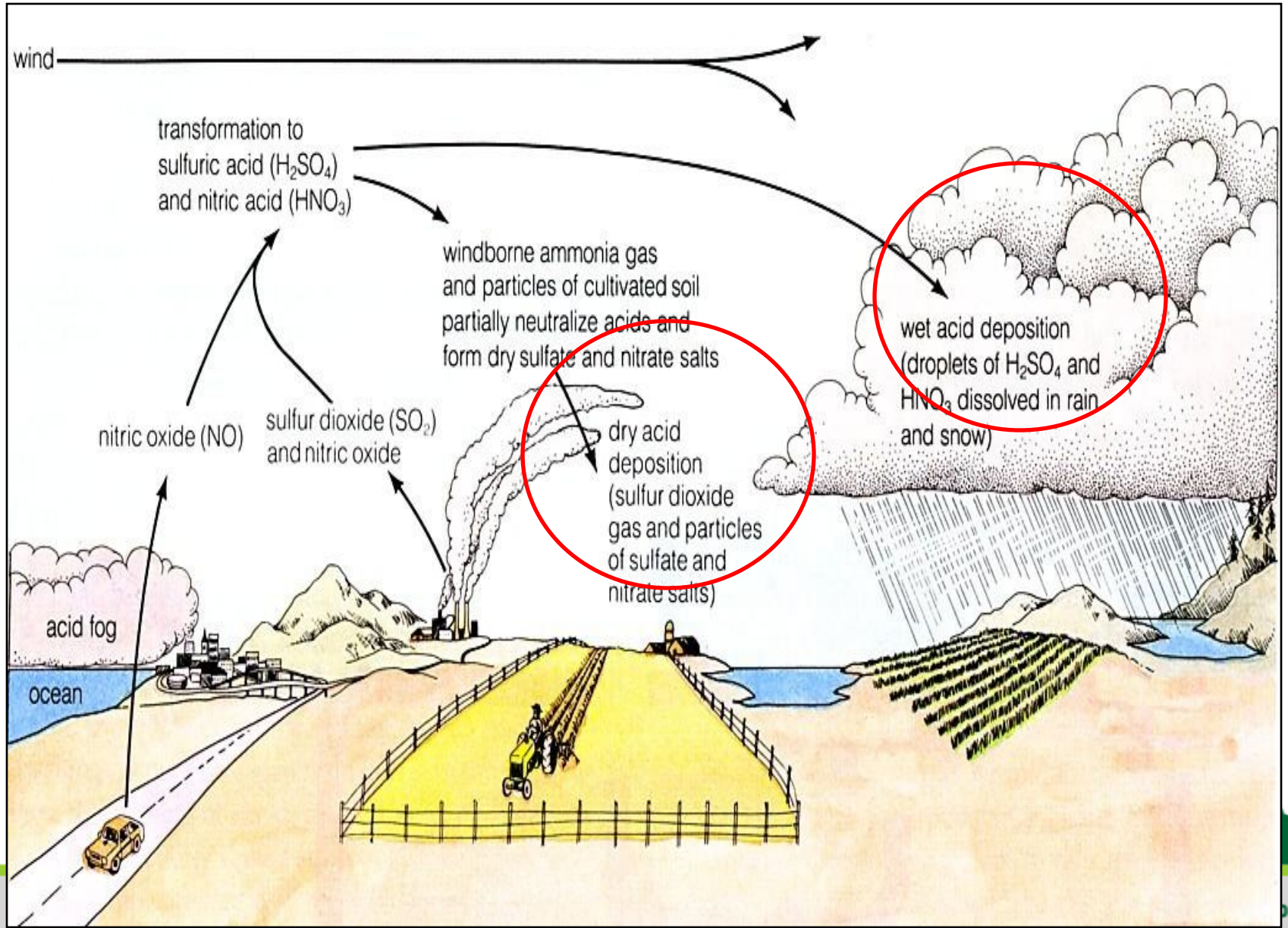
ACID DEPOSITION: PHENOMENON

- Emissions of sulphur oxides and nitrogen oxides, when combined with sunlight and water vapor, results in mild sulphuric or nitric acid.

- Acid deposition occurs when pH levels falls below 5. Some references indicate pH level below 5.6 as acid rain.

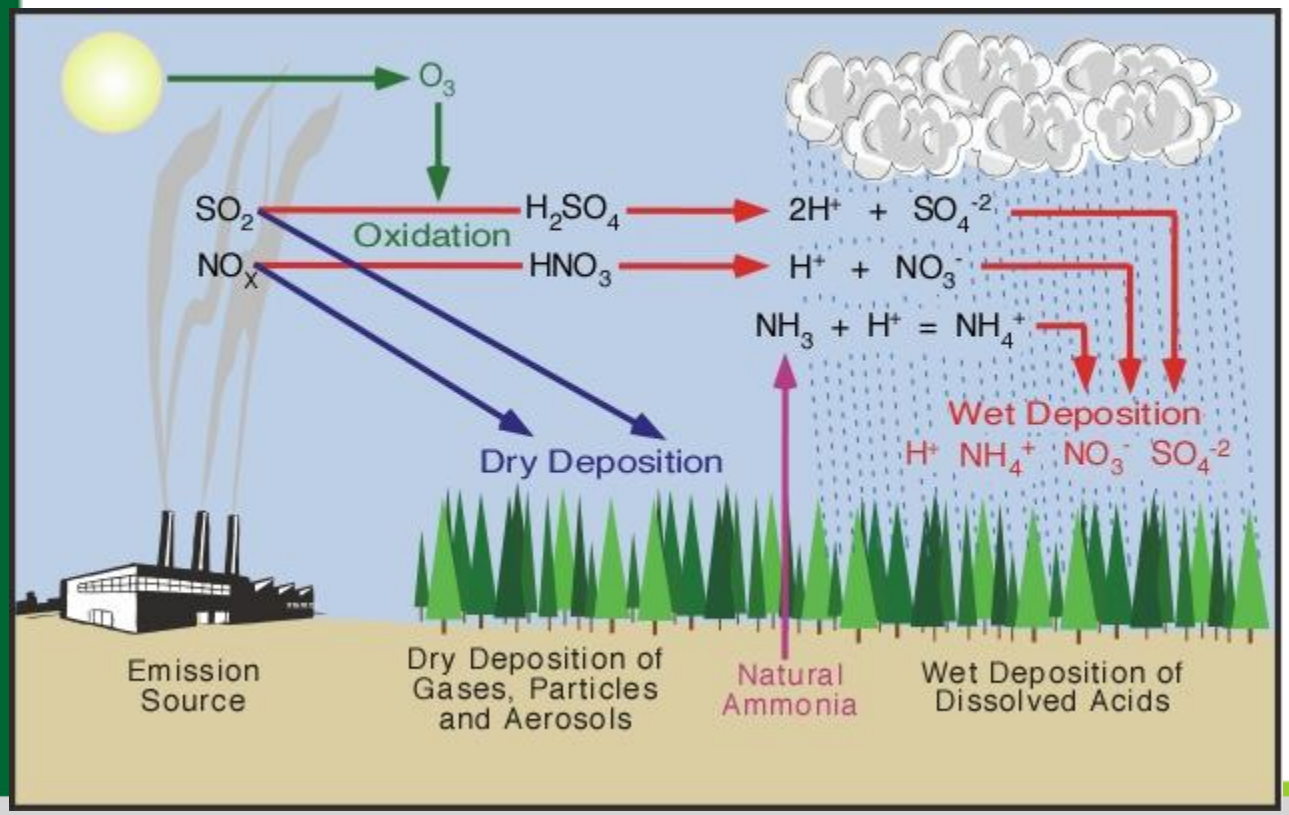


ACID DEPOSITION : PHENOMENON



ACID DEPOSITION : PHENOMENON

- Wet precipitation
  - rain, snow, or fog
- Dry precipitation
  - dust, smoke, or other aerosols (microscopic particles in the air)



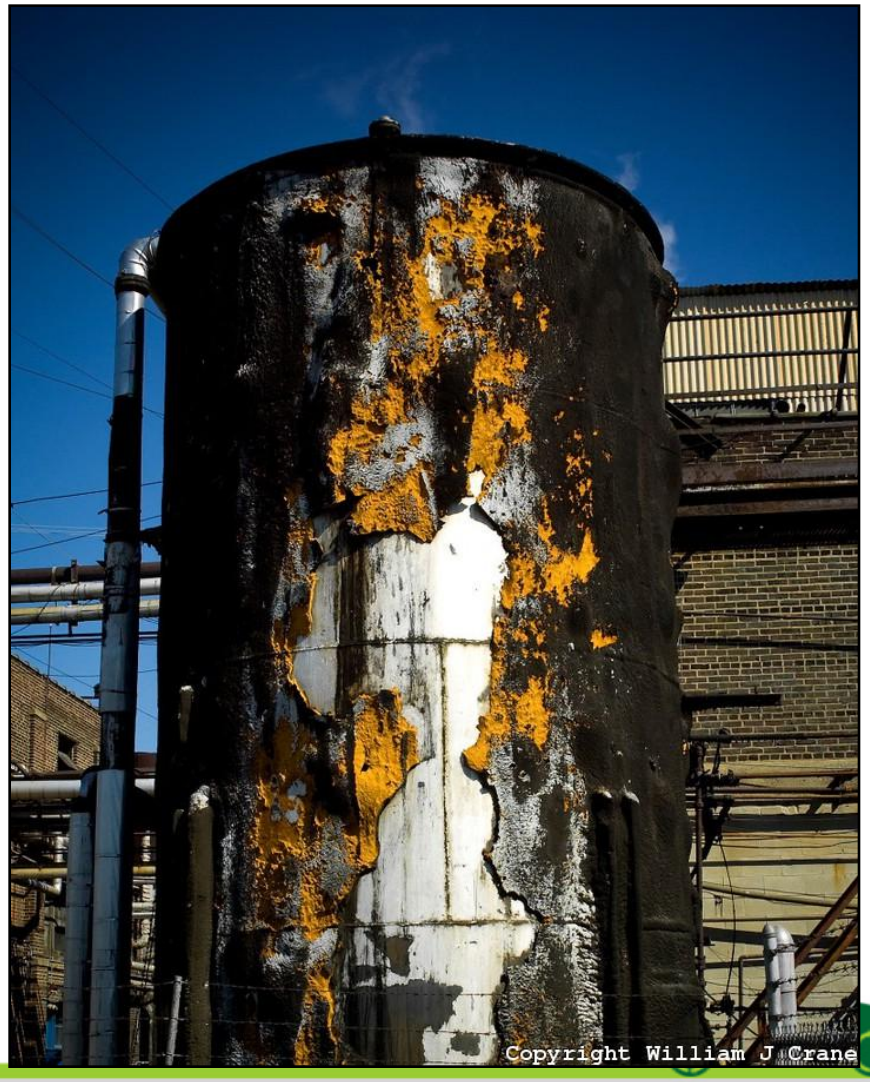
Dry deposition can then be converted into acids when these deposited chemicals meet water

ACID DEPOSITION: EFFECTS

- Effects of acid deposition
  - Damage materials → buildings, metals, car paints
  - Destroys aquatic life
  - Damages and kills plants
  - Releases ions of aluminium, lead, mercury and cadmium from soil and bottom sediments
  - Leaching of soil nutrients
  - Leaching of toxic metals such as copper and lead from pipes into drinking water
  - Aggravates respiratory illness

ACID DEPOSITION: EFFECTS

- Effects on buildings : acid dissolves limestone and marble



ACID DEPOSITION: EFFECTS

- Effects on statue : Build in year 1702 in Germany

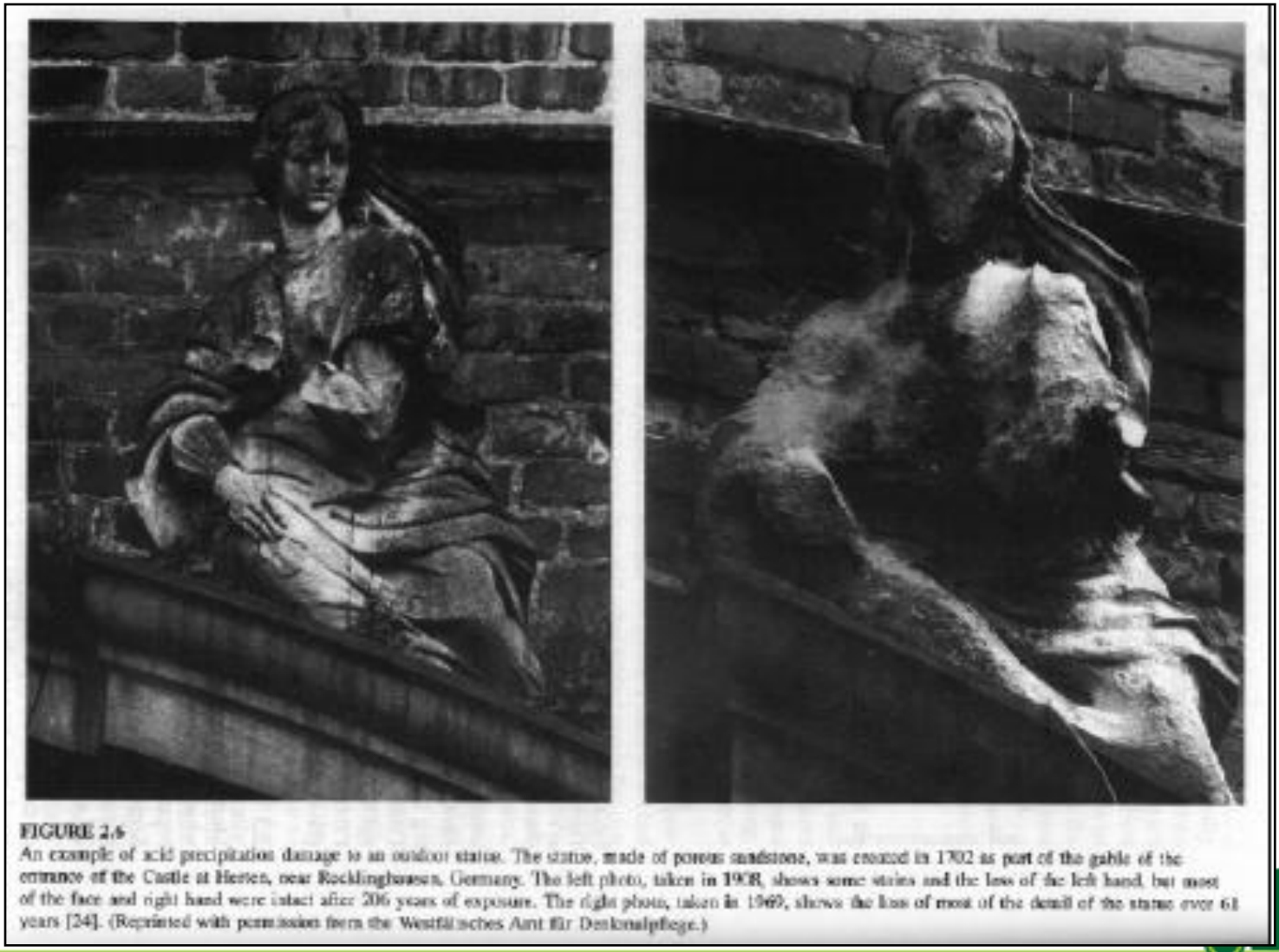


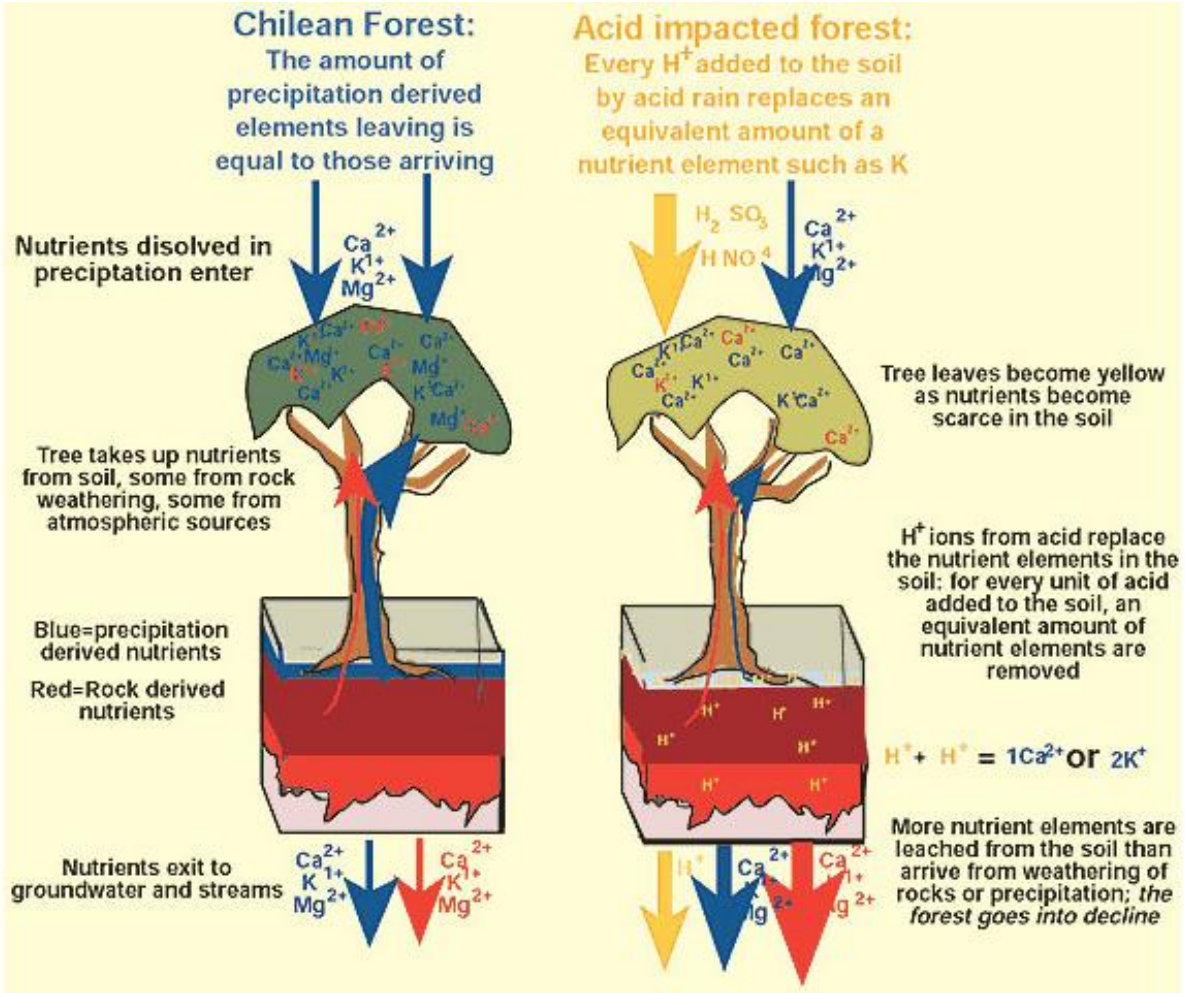
FIGURE 2.6
An example of acid precipitation damage to an outdoor statue. The statue, made of porous sandstone, was erected in 1702 as part of the gable of the entrance of the Castle at Herten, near Recklinghausen, Germany. The left photo, taken in 1908, shows some stains and the loss of the left hand, but most of the face and right hand were intact after 206 years of exposure. The right photo, taken in 1969, shows the loss of most of the detail of the statue over 61 years [24]. (Reprinted with permission from the Westfälisches Amt für Denkmalpflege.)

Taken in 1908

Taken in 1968

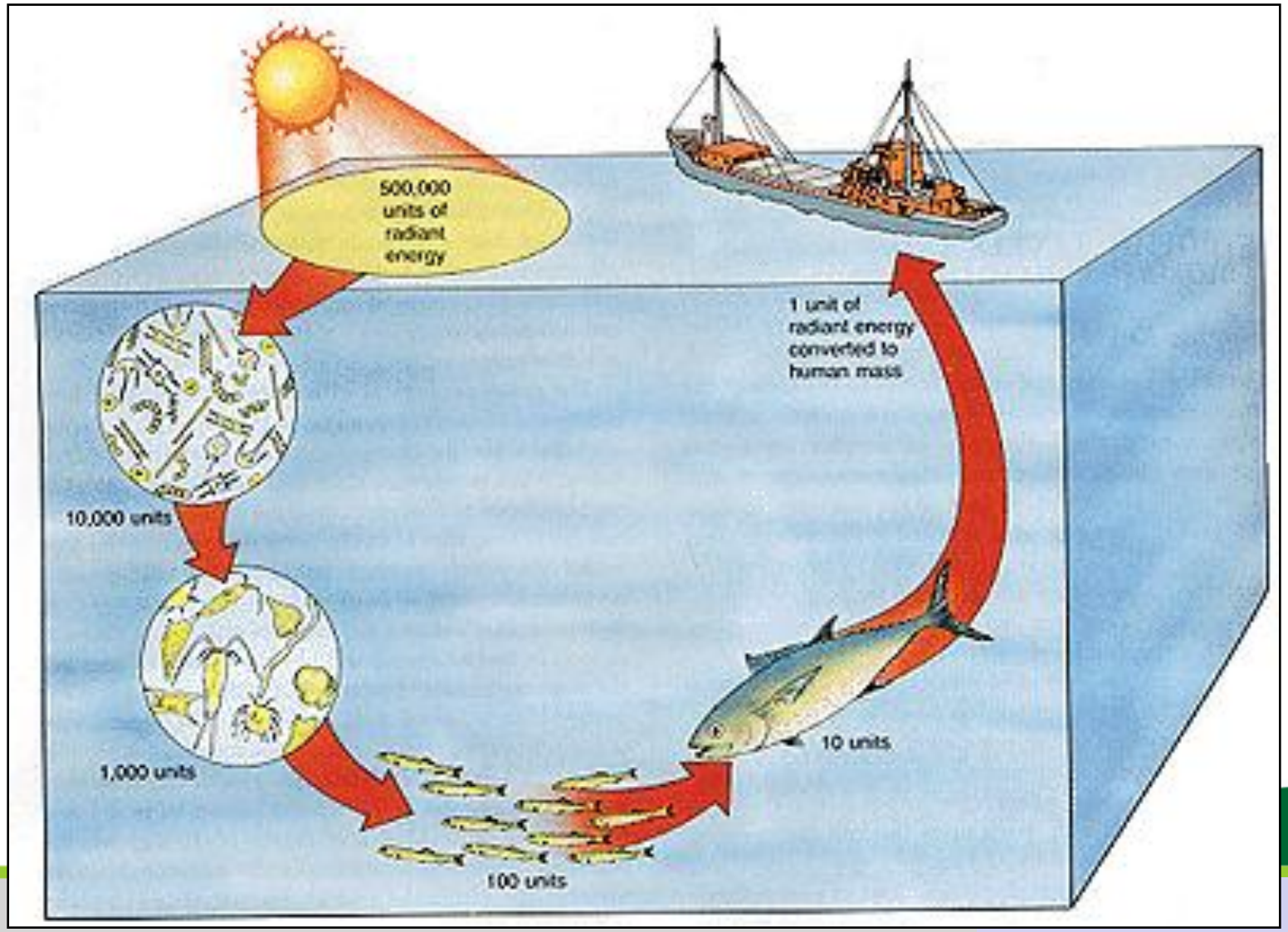
ACID DEPOSITION: EFFECTS

- Effects on forests: nutrient cycles



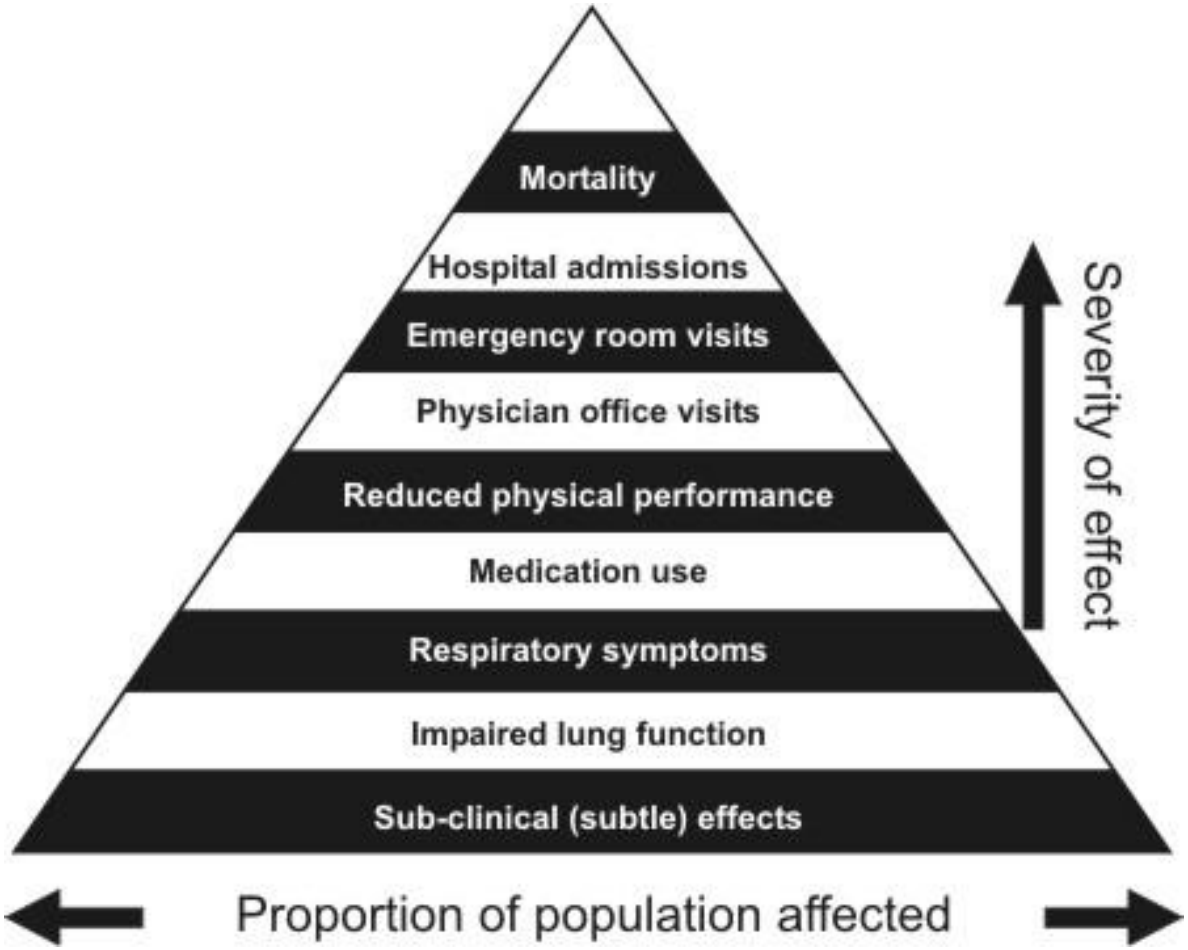
ACID DEPOSITION: EFFECTS

- Effects on aquatic life: caused the destruction of phytoplankton



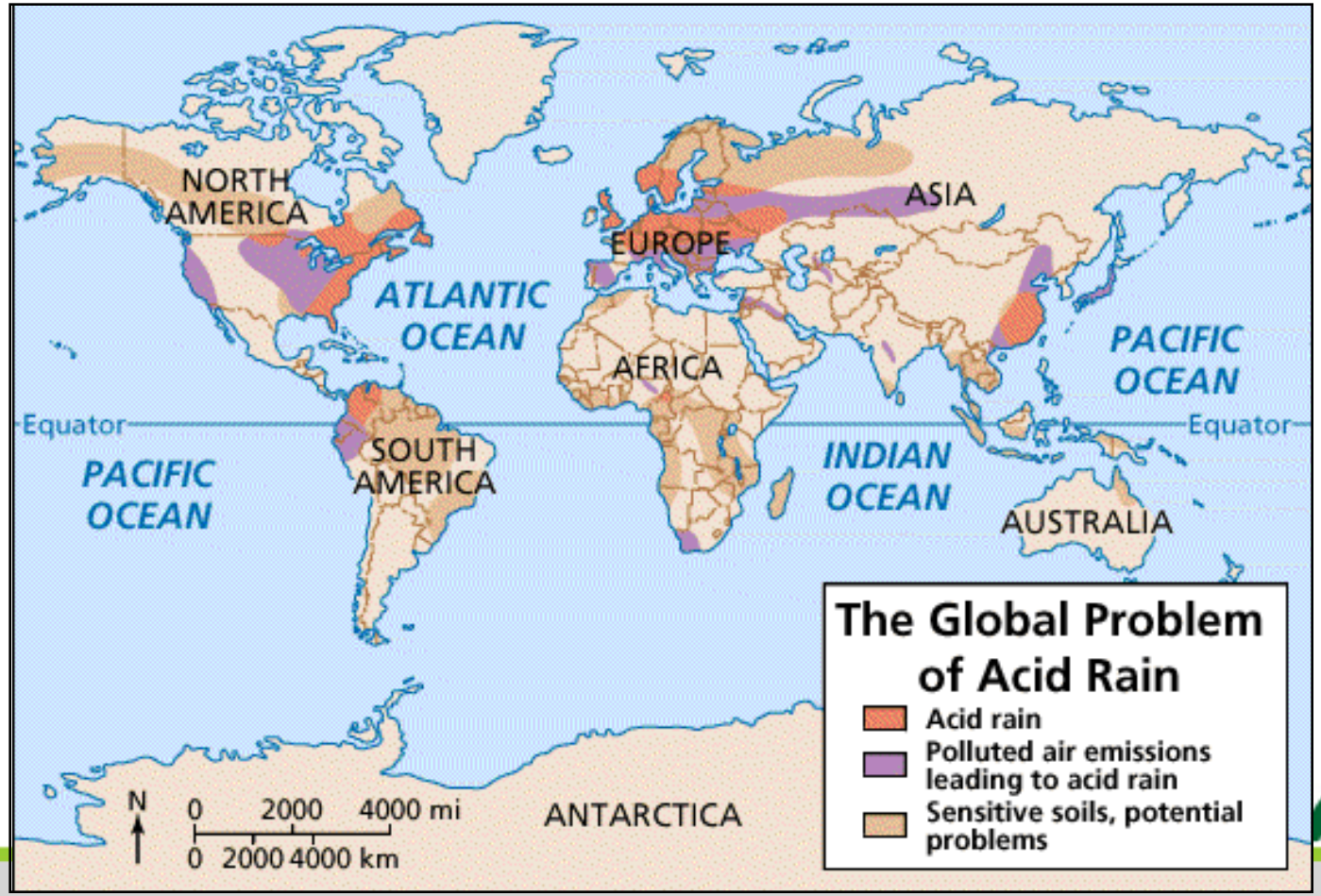
ACID DEPOSITION: EFFECTS

- Effects on health: health-related component of the acid rain phenomenon is the aspect of acidic aerosols



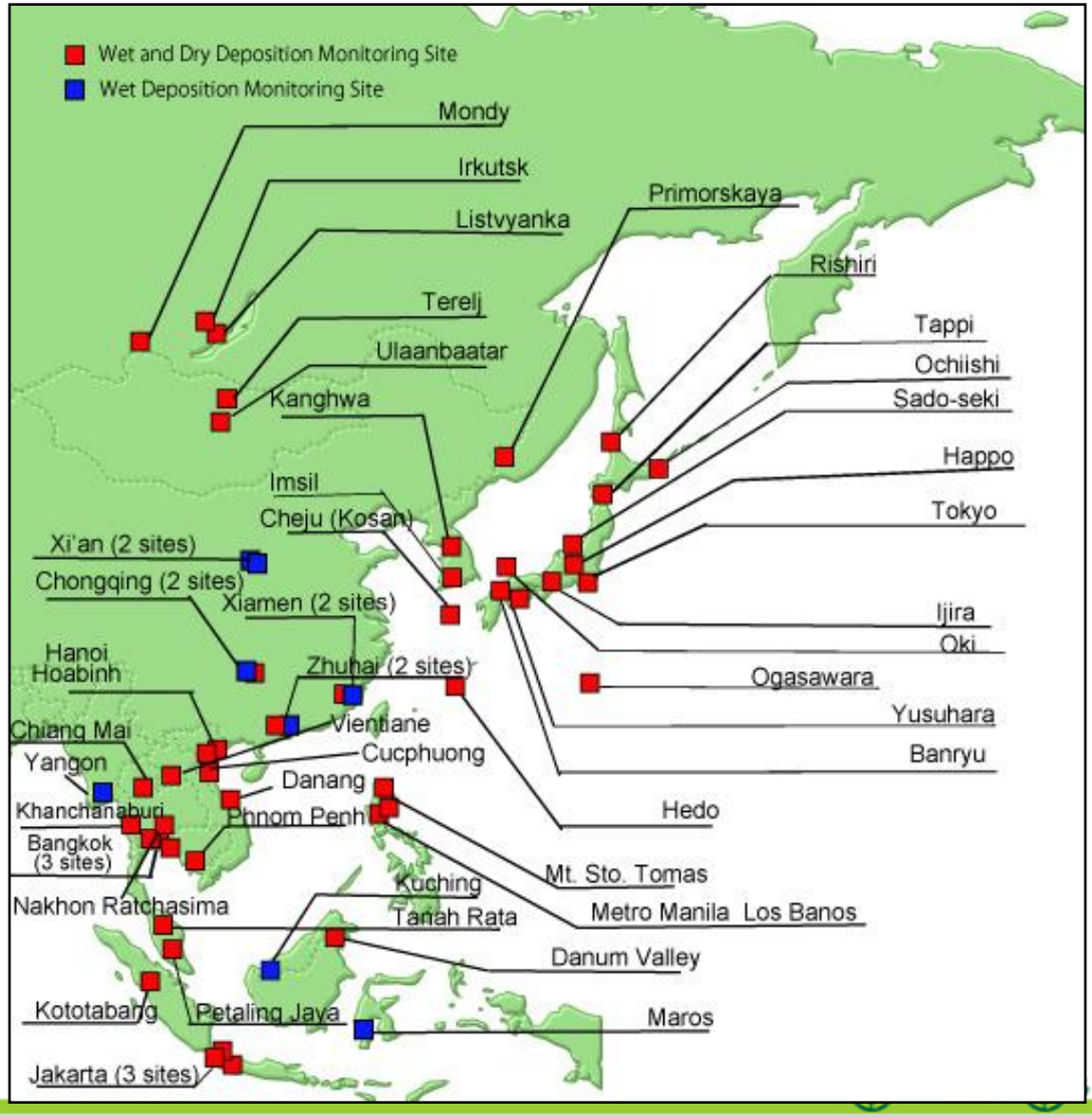
ACID DEPOSITION: STATE

- The prevalence of acid rain in the world.
- The more industrious and heavily populated areas, such as parts of the U.S., Europe and eastern China, are more prone to acid rain.



ACID DEPOSITION: STATE

- Wet and dry deposition monitoring sites in East Asia
- Cambodia, China, Indonesia, Japan, Lao P.D.R, Malaysia, Mongolia, Myanmar, Philippines, Republic of Korea, Russia, Thailand, Vietnam



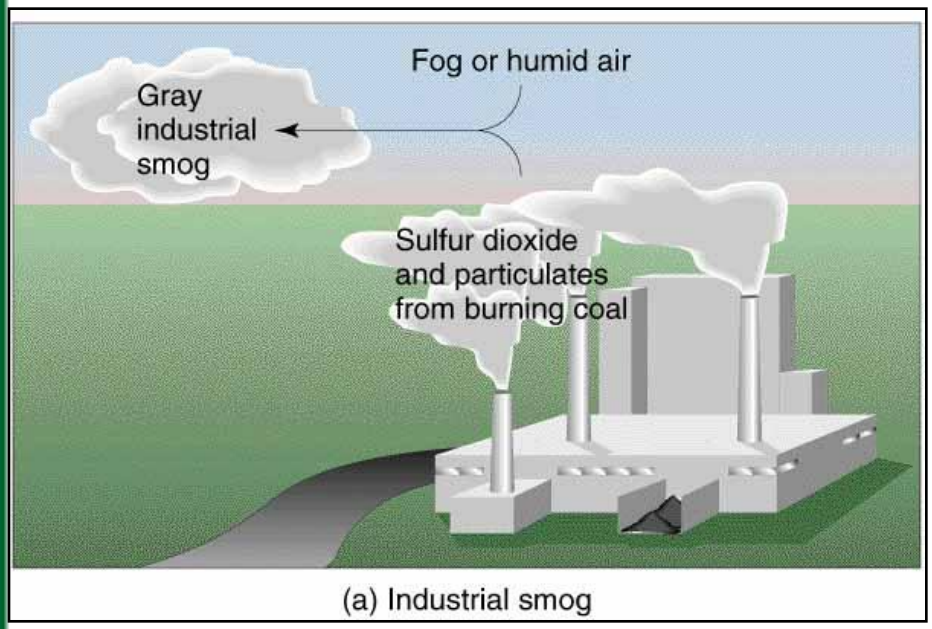
PHOTOCHEMICAL SMOG : PHENOMENON

- Smog is a synchrony of two words – smoke and fog ; can be of two types – industrial or winter smog and photochemical or summer smog

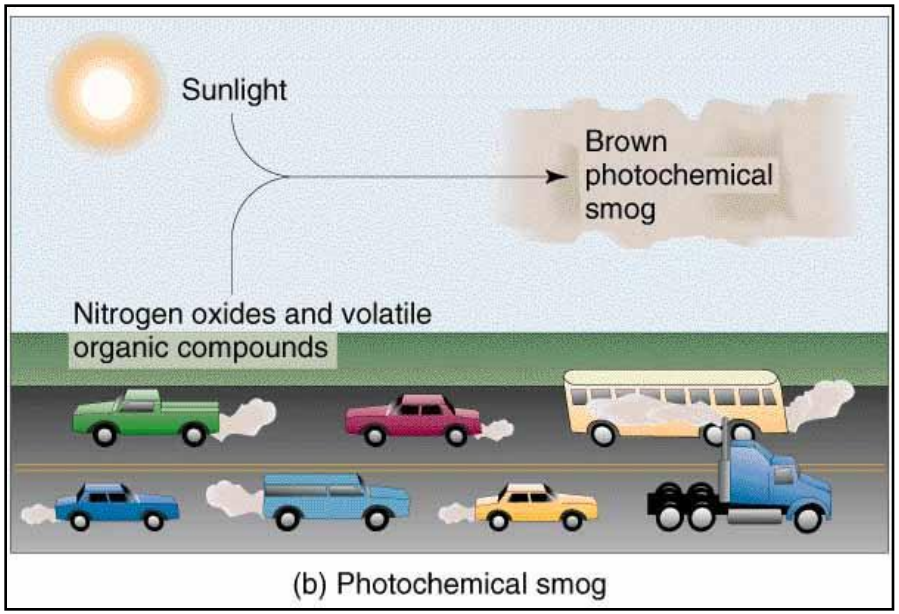
- Under certain meteorological conditions, the smoke and sulfur dioxide produced from the burning of coal can combine with fog to create **industrial smog**. But today, the use of cleaner (than coal) fuels has greatly reduced the occurrence of industrial smog in the industrialized areas.

- However, the massive burning of fuels in mobile devices in urban areas can create another atmospheric pollution problem known as **photochemical smog**.

PHOTOCHEMICAL SMOG : PHENOMENON



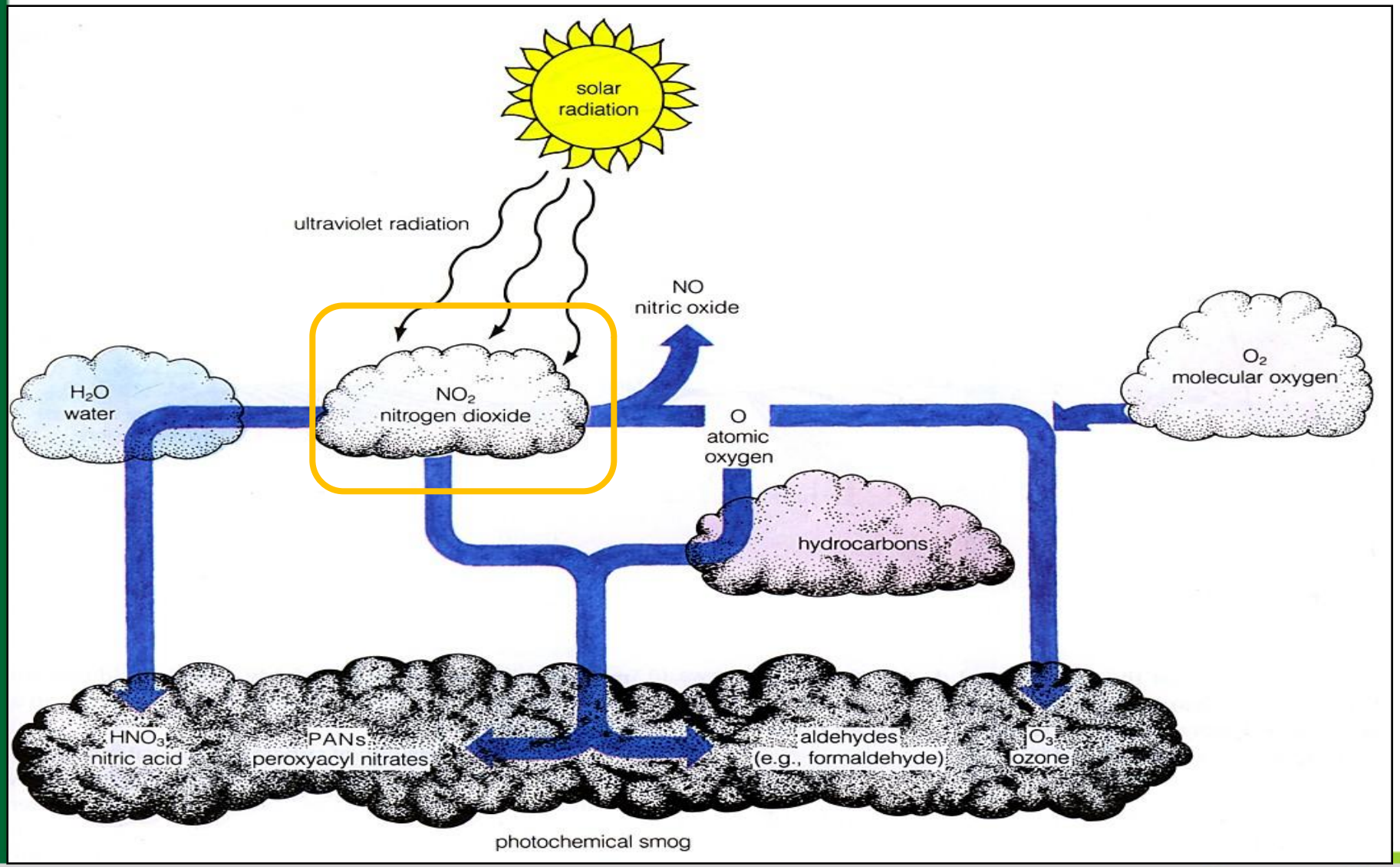
(a) Industrial smog



(b) Photochemical smog

- Industrial smog or gray smog occurs where coal is burned and the atmosphere is humid
- Photochemical smog or brown haze occurs where sunlight acts on vehicle pollutants

PHOTOCHEMICAL SMOG : PHENOMENON



PHOTOCHEMICAL SMOG : EFFECTS

- Effects on human health
  - Low concentrations of ground-level ozone can irritate the eyes, nose and throat. As smog increases, it can trigger more serious health problems, including:
    - Asthma, bronchitis, coughing and chest pain;
    - Increased susceptibility to respiratory infections;
    - Decreased lung function and physical performance.

PHOTOCHEMICAL SMOG : EFFECTS

- Effects on vegetation and materials
  - Sensitive crops, trees and other vegetation are harmed at lower ozone concentrations
  - Ground-level ozone can damage leaves, and reduce growth, productivity and reproduction. It can cause vulnerability to insects and disease, and even plant death.
  - When ozone levels are fairly high over a long period, agricultural crops can suffer significant harm.
  - Smog can also accelerate the deterioration of rubber, plastics, paints and dyes,..

PHOTOCHEMICAL SMOG : EFFECTS

- The enhanced greenhouse effect and acid rain
  - The pollutants emitted into atmosphere are implicated in numerous environmental problems.
  - Ozone, for example, is not only a major component of smog; it also contributes to the enhanced greenhouse effect, which is predicted to lead to global climate change.
  - Similarly, NOx - one of the building blocks of ground-level ozone - plays a major role in formation of acid rains.

HAZE : PHENOMENON

- Haze is a form of air which is exacerbated at certain times of the year under specific weather condition.
- It is caused by the presence of a large number of minute particles suspended in the atmosphere. These particles can be natural in origin or from human activities.
- Haze occurs particularly when there are high levels of air pollutants (esp. particulates), combined with dry, stable atmospheric conditions.
- Recent haze episodes are trans-boundary in nature.

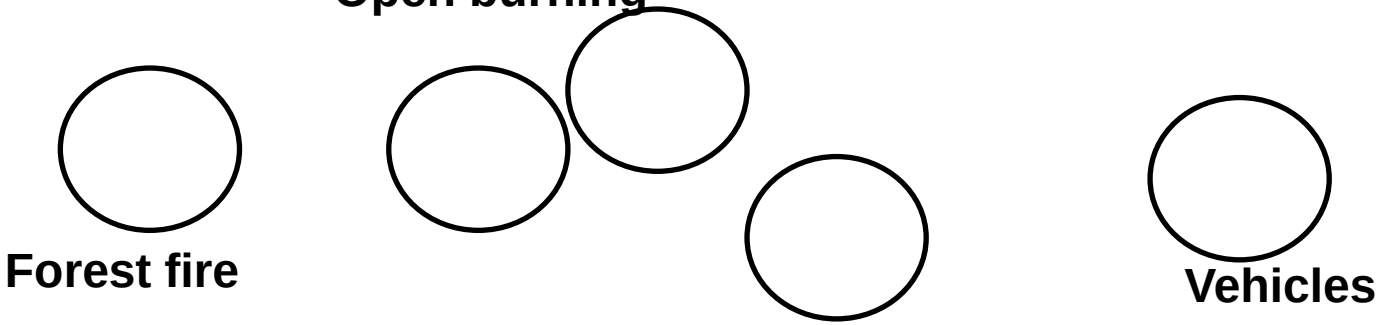
HAZE : PHENOMENON

Stable atmosphere

Topography

Wind

Open burning



Forest fire

Industries

Vehicles

HAZE: EFFECTS

- Particulate matter less than 10 micrometers in size, including fine particles less than 2.5 micrometers, can penetrate deep into the lungs.

- Exposure to particulate pollution - either alone or with other air pollutants - has been linked with premature death, difficult breathing, aggravated asthma, and increased respiratory symptoms in children.

- People most at risk from exposure to fine particulate matter are children, the elderly, and people with chronic respiratory problems.

HAZE : EFFECTS

- According to the Economic and Environment Program in Southeast Asia and WWF, the haze of 1997 cost the people of Southeast Asia some USD1.4 billion, mostly in short-term health costs.

- More than 40,000 persons were hospitalized for respiratory and other haze-related ailments. The long-term impacts on health of exposed children and elderly are unknown.

HAZE : EFFECTS

- Several gaseous compounds in the haze are likely to affect global environment and climate.
- Transport was also severely disrupted by haze. Closures of airports and cancellation of flights were common in the region.
- Economic losses from travel disruptions, were compounded by steep declines in tourist arrivals

HAZE : STATE

HAZE : STATE

Singapore on September 11, 2010

Singapore on October 21, 2010

HAZE : STATE

April 1983	Peninsula Malaysia, Sabah & Sarawak
15-30 August 1990	Peninsula Malaysia & western Sarawak
15-18 June 1991	Peninsula Malaysia & Sabah
10-22 September 1991	Sabah & Sarawak
27 Sep – 11 Oct. 1991	Peninsula Malaysia & Sarawak
15 Sep.- 6 Oct. 1994	Peninsula Malaysia, Sabah & Sarawak
August – Oct. 1997	Peninsula Malaysia, Sabah & Sarawak

HOW TO DIFFERENTIATE?

Haze

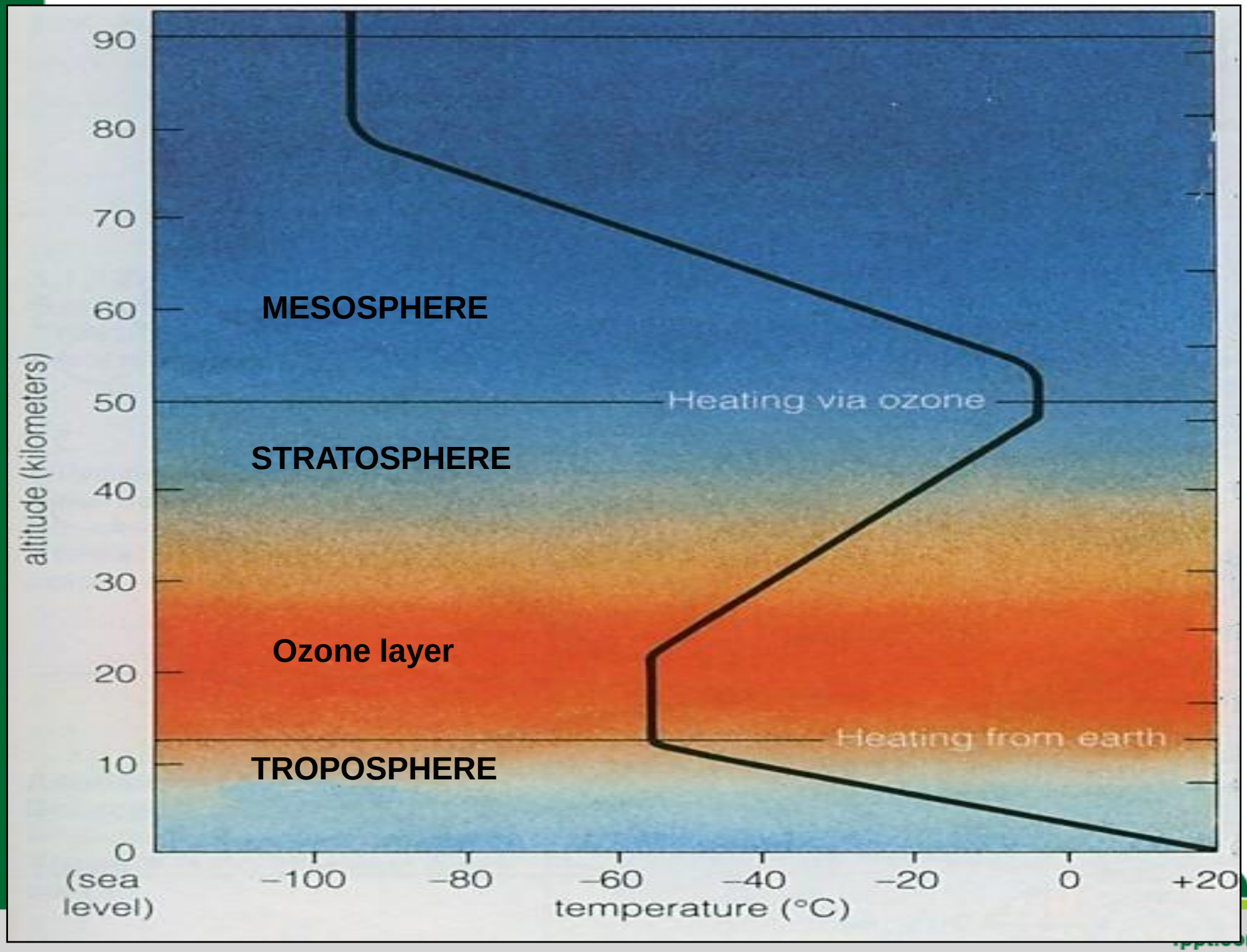
- Forms when fine particles of dust or salt disperse through the atmosphere
- Color : typically white, gray or even blue…some types of particles such as sulfates, scatter more light, particularly during humid conditions.
- Occurred distance from emission sources→ some particles directly emitted to the air; others are formed when gases carried many miles from the source of pollutants.

Photochemical Smog

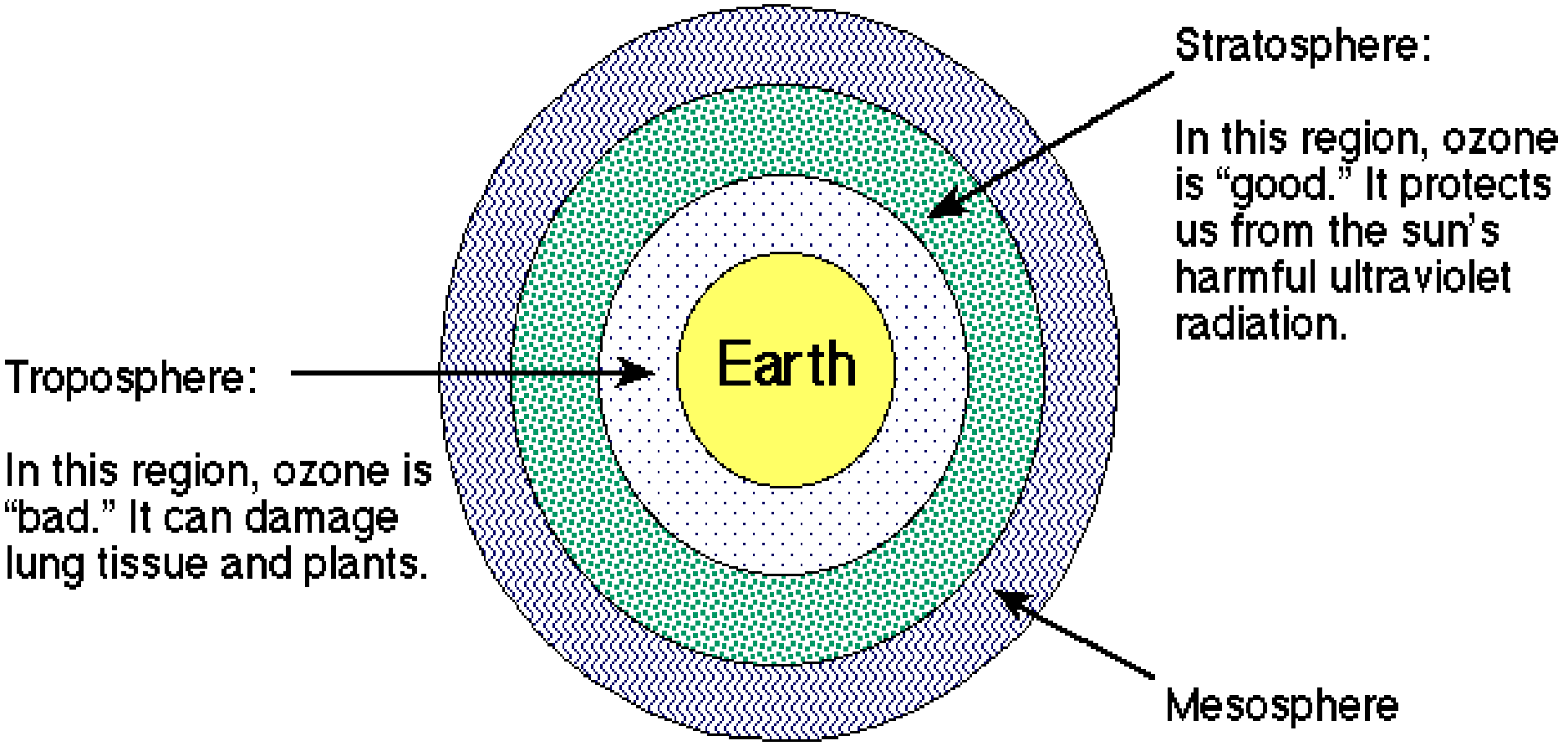
- Happens when the gasses mix with water vapor in the atmosphere, then react with sunlight, creating nasty form of "haze.“
- Color: white or brownish haze, usually noticeable during morning hours.
- Typically starts in warm, windless cities with heavy traffic, but because travels with wind, can also appear in rural areas

OZONE : PHENOMENON

- Ozone (O_3) is a naturally occurring gas in the stratosphere
- It is created when ultraviolet radiation (sunlight) strikes the stratosphere, dissociating (or "splitting") oxygen molecules (O_2) to atomic oxygen (O). The atomic oxygen quickly combines with further oxygen molecules to form ozone.
- In the stratosphere, it serves to absorb harmful solar UV rays.


MESOSPHERE
Heating via ozone
STRATOSPHERE
Ozone layer
Heating from earth
TROPOSPHERE
altitude (kilometers)
90
80
70
60
50
40
30
20
10
0
(sea level)
−100
−80
−60
−40
−20
0
+20
temperature (°C)

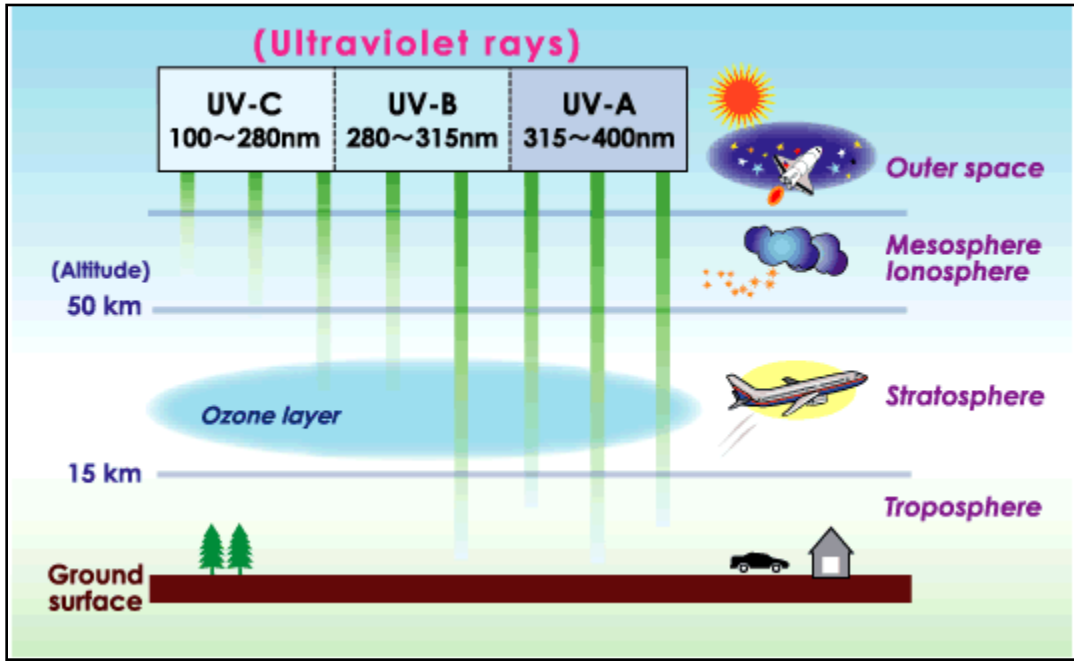
OZONE : PHENOMENON



Ozone in Earth's Atmosphere

OZONE : EFFECTS

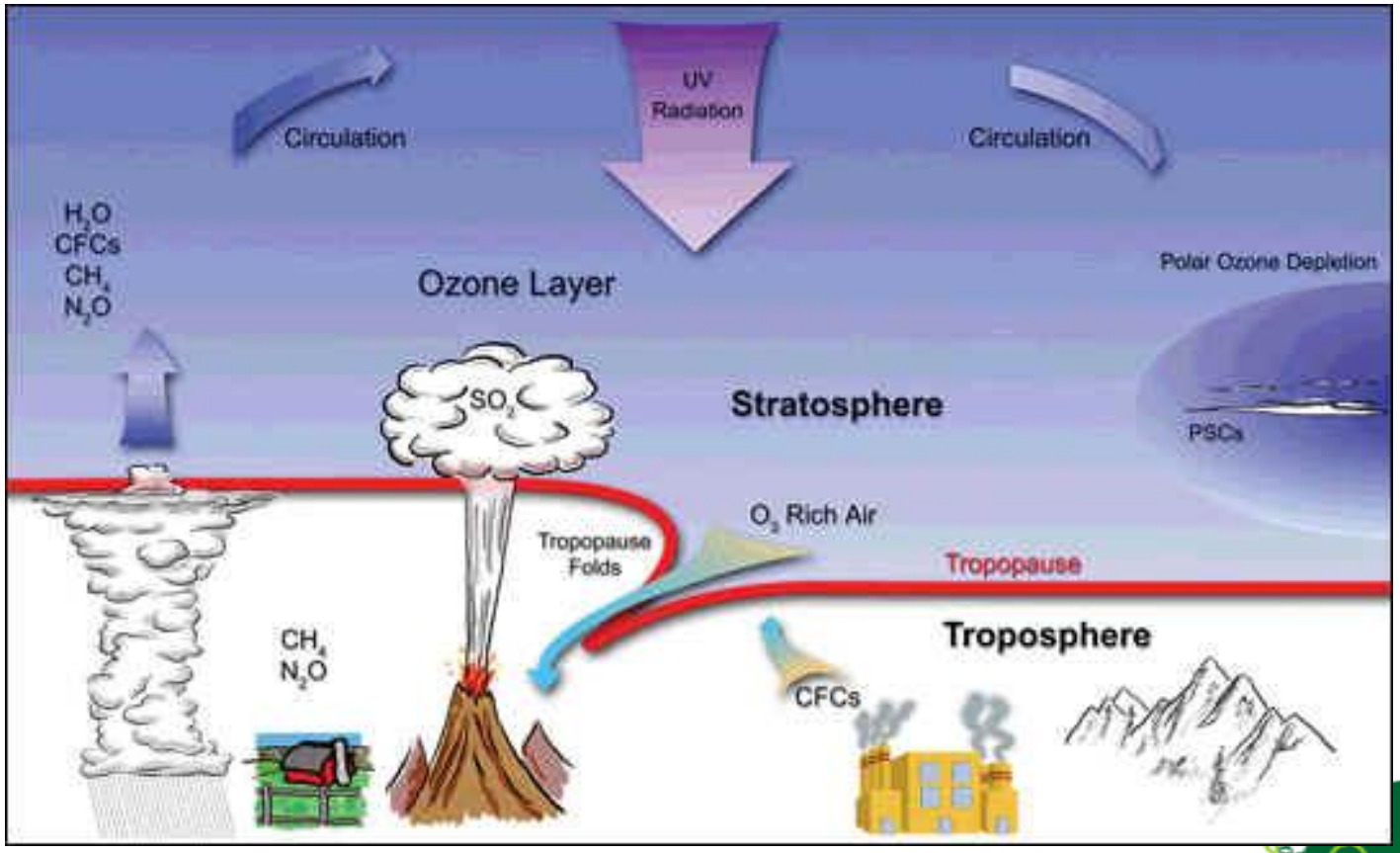
- Stratospheric ozone
  - Protects life on earth by absorbing harmful ultraviolet radiation



- Tropospheric ozone
  - Nausea
  - Headaches
  - Coughing
  - Respiratory problems
  - Damages plants
  - Ozone in the troposphere is a greenhouse gas

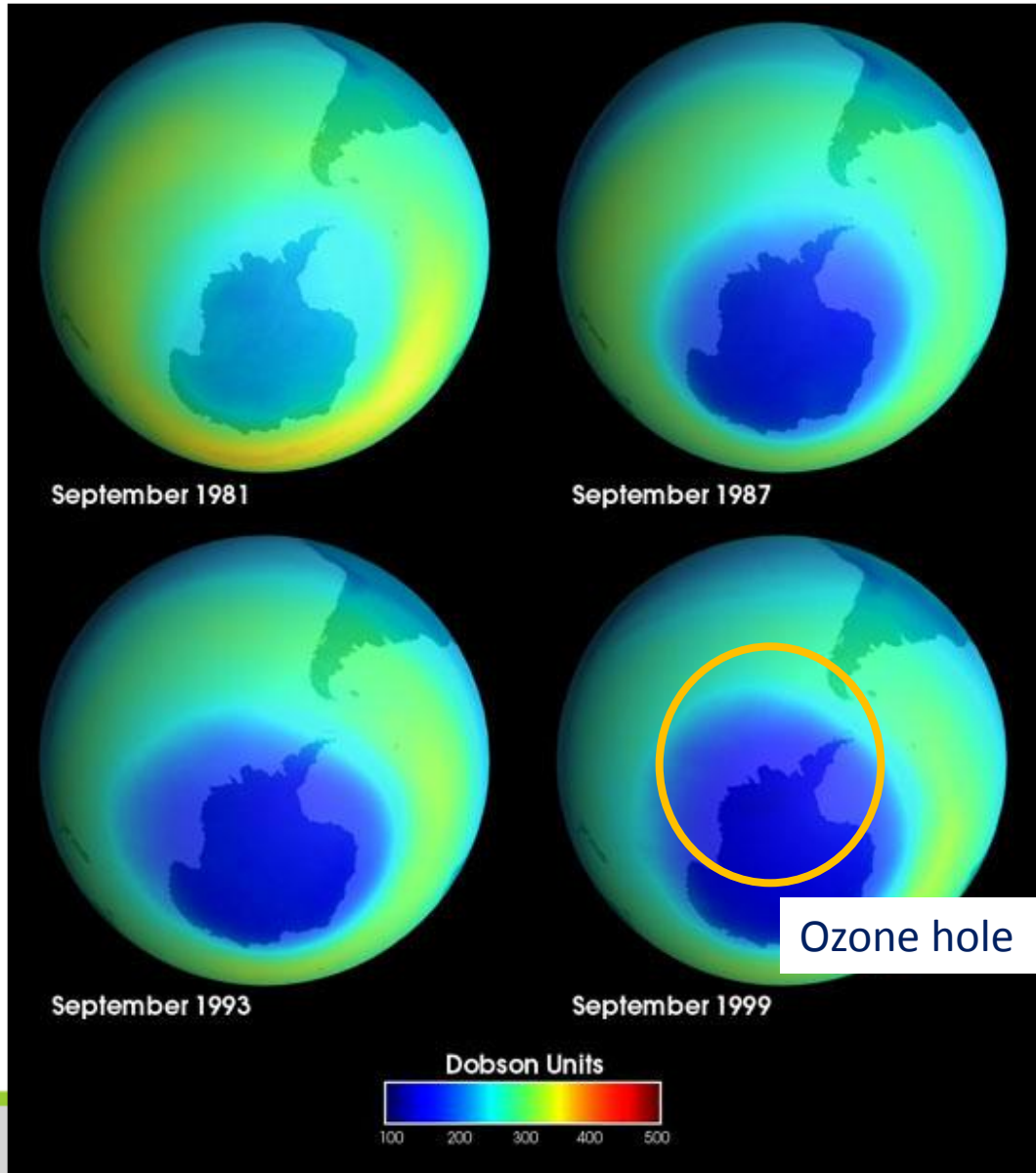
OZONE : EFFECTS

- Depletion of ozone in the stratosphere is caused by:
  - CFC ; Halon ; Methyl bromide ;Methyl chloroform; Carbon tetrachloride



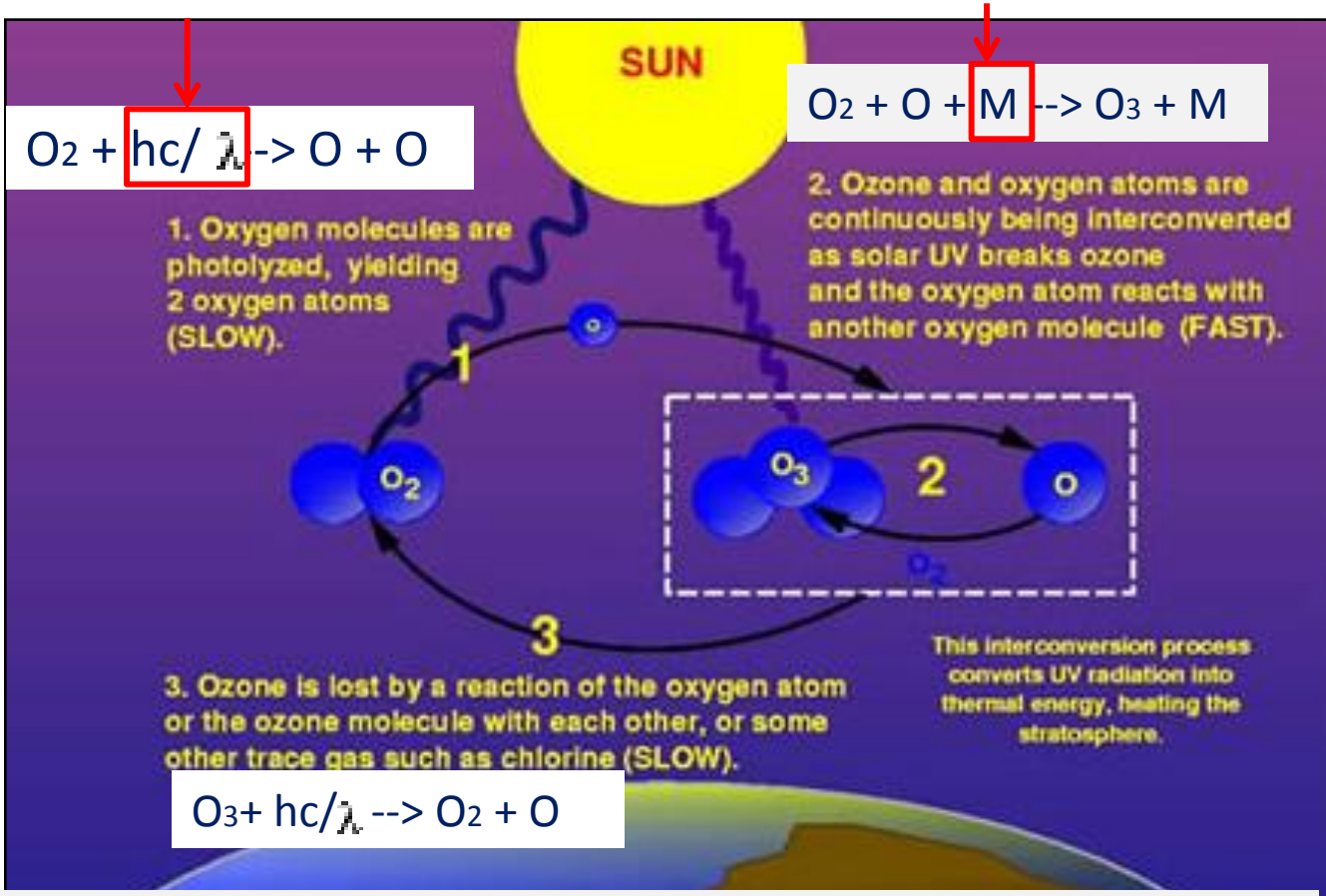
OZONE : EFFECTS

- Ozone depletion
- Ozone hole is the phenomenon of rapid and severe ozone depletion in the stratospheric Antarctic polar region
- Since the late 1970s, ozone depletion in the stratospheric Antarctic has become more and more severe



OZONE PHOTOCHEMISTRY

- Ozone is constantly produced and destroyed in a natural cycle
- Ozone production and destruction are balanced, ozone levels remain stable.

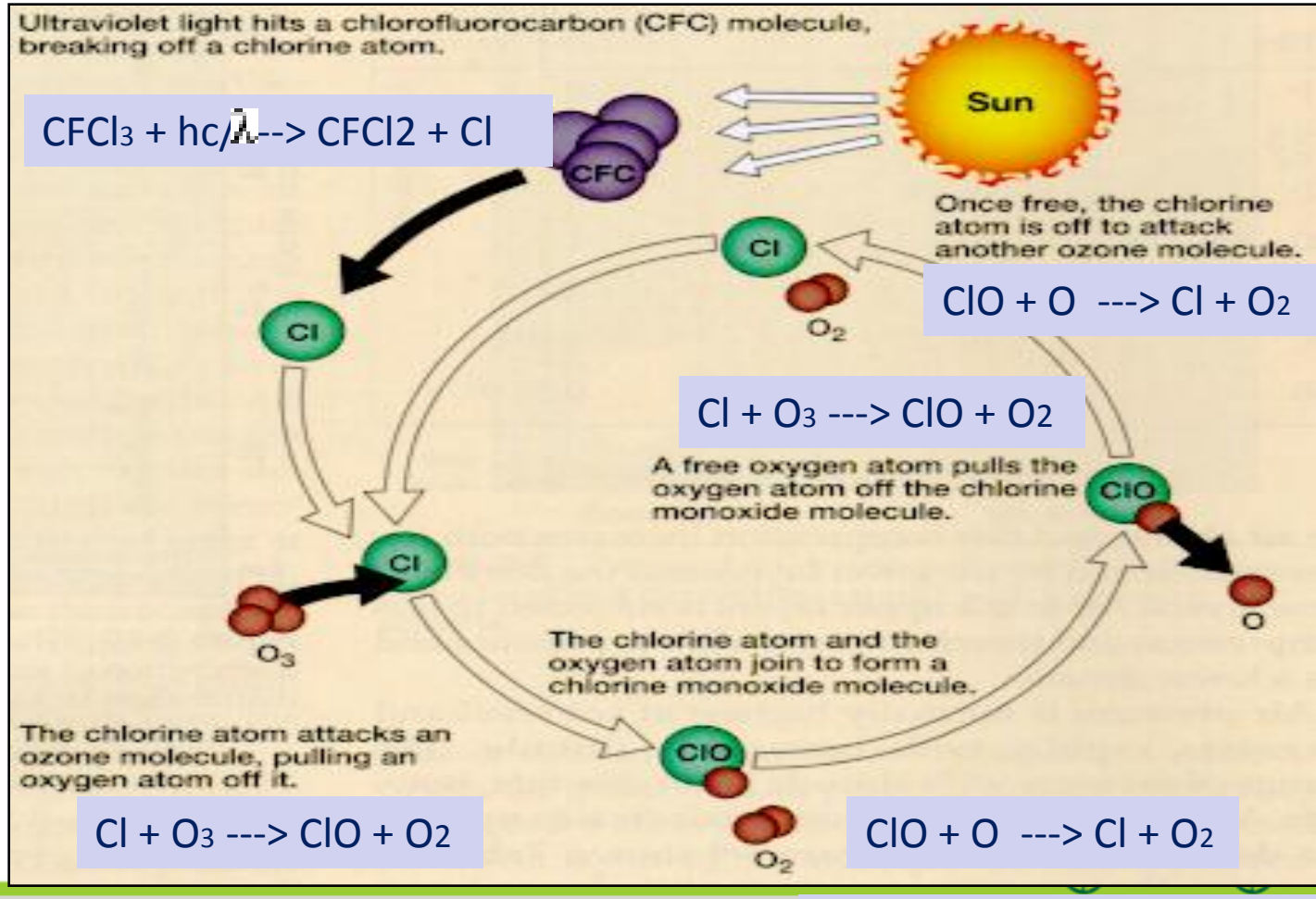


- Photon of light
- The M represents any other molecule (most probably N_2 or O_2 comprise 99% of the atmosphere)

This was the situation until past several decades.

OZONE DEPLETION

- However, various ozone-depleting substances (ODS), accelerate the destruction processes of the normal ozone levels



OZONE HOLE—WHY ANTARTICA?

1.Life span of CFCs

- Because CFCs have a life-span of several decades, they remain intact long enough to make their journey up into the stratosphere

- CFC don't react with other substances in the troposphere, and only break apart in the stratosphere when they are exposed to high-energy ultraviolet radiation → a process that could take up several years.

- Therefore, winds in the troposphere and stratosphere have sufficient time to distribute CFC molecules around the globe

OZONE HOLE—WHY ANTARTICA?

2. Weather conditions

- The weather conditions in the Antarctic are such that they encourage the creation of polar stratospheric clouds (PSCs).

- These clouds form only under persistently cold conditions, which is why they are usually only found in Antarctica

- PSCs can also be found in the Arctic, but because the weather is not as persistently cold, they are less common.

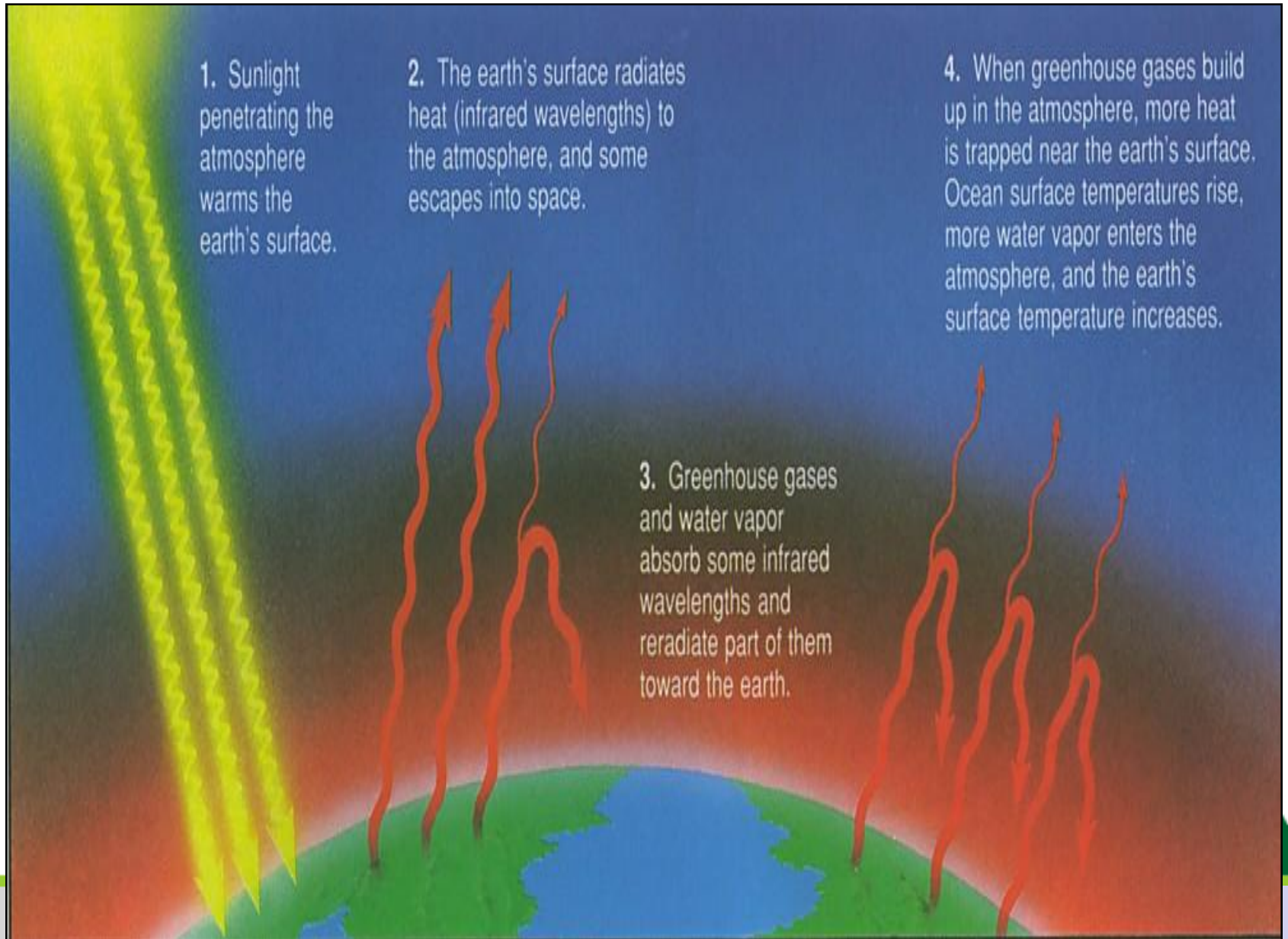
OZONE DEPLETION : EFFECTS

- Effects of ultraviolet (UV) radiation
  - Skin cancer
  - Eye cataracts (blurred vision & eventual blindness)
  - Severe sunburn
  - Suppression of human immune system
  - Decreased yields in food crops (rice, corn etc.)
  - Reduction in growth of marine phytoplankton
  - Increase global warming (greenhouse effect)

OZONE DEPLETION : EFFECTS

- Preventing Ozone Depletion (Montreal Protocol 1990)
  - Banning the use of CFC, halons, carbon tetrachloride and methyl chloroform
  - Substitute coolants in refrigerators and air conditioning with other cooling agents such as HFC (hydroflurocarbon) and HCFC (hydrochlorofluorocarbon) which are decomposed more rapidly in the atmosphere

GREENHOUSE EFFECT : PHENOMENON



GREENHOUSE EFFECT : PHENOMENON

- Gases:
  1. Carbon dioxide (CO_2)
     - Main causes
       - Burning of fossil fuel (automobiles, industries etc.)
       - Deforestation

  2. Chloroflurocarbons (CFC)
     - Main causes
       - Leaking of old air conditioners & refrigerators
       - Production of plastic foams
       - Propellants in spray cans

GREENHOUSE EFFECT : PHENOMENON

3. Methane (CH_4)
   - Main causes
     - Solid waste dumping grounds & landfills
     - Burning of forest & grasslands
     - Agricultural waste

4. Nitrous oxide (N_2O)
   - Main causes
     - Nylon production
     - Decomposition of nitrogen fertilizers
     - Burning of fossil fuels

5. Tropospheric ozone
   - Main cause
     - Photochemical smog

GREENHOUSE EFFECT: STATE

- CO_2 production in 2003 :
  - 8 billion tonnes / year
- Sources :
  - 6.5 billion tonnes from burning of fossil fuels
  - 1.5 billion tonnes from deforestation
- Future estimates :
  - 12 billion tonnes in 2035

GREENHOUSE EFFECT: STATE

- Trends of CO2 in the atmosphere

	1900	1970s	2000	2100
Parts per million (ppm) of CO_2 in atmosphere	280	295	360	400-900

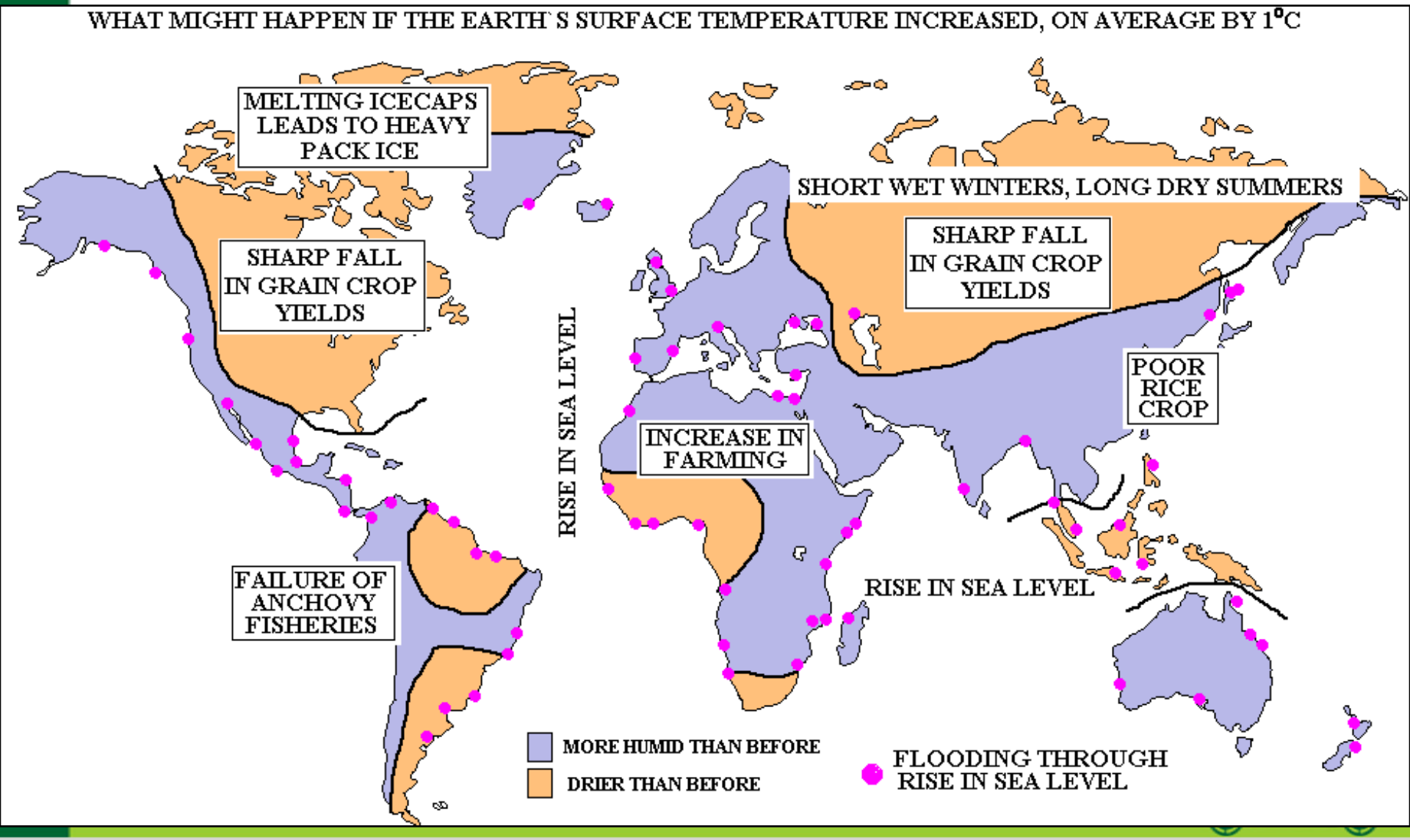
GREENHOUSE EFFECT: GLOBAL WARMING

- Sea level will rise as ice caps melt--inundating many coastal cities
  - sea level rose 9 cm during 1901-2000
  - predicted level of rise for 2001-2100 is 9 to 88 cm

- Weather pattern changes – causing some regions to get drier and some wetter

- Warmer temperatures leads to increase evaporation, more condensation and more energy potential for storms. So storms become more frequent & increase in intensity– which can lead to an increase in coastal erosion.

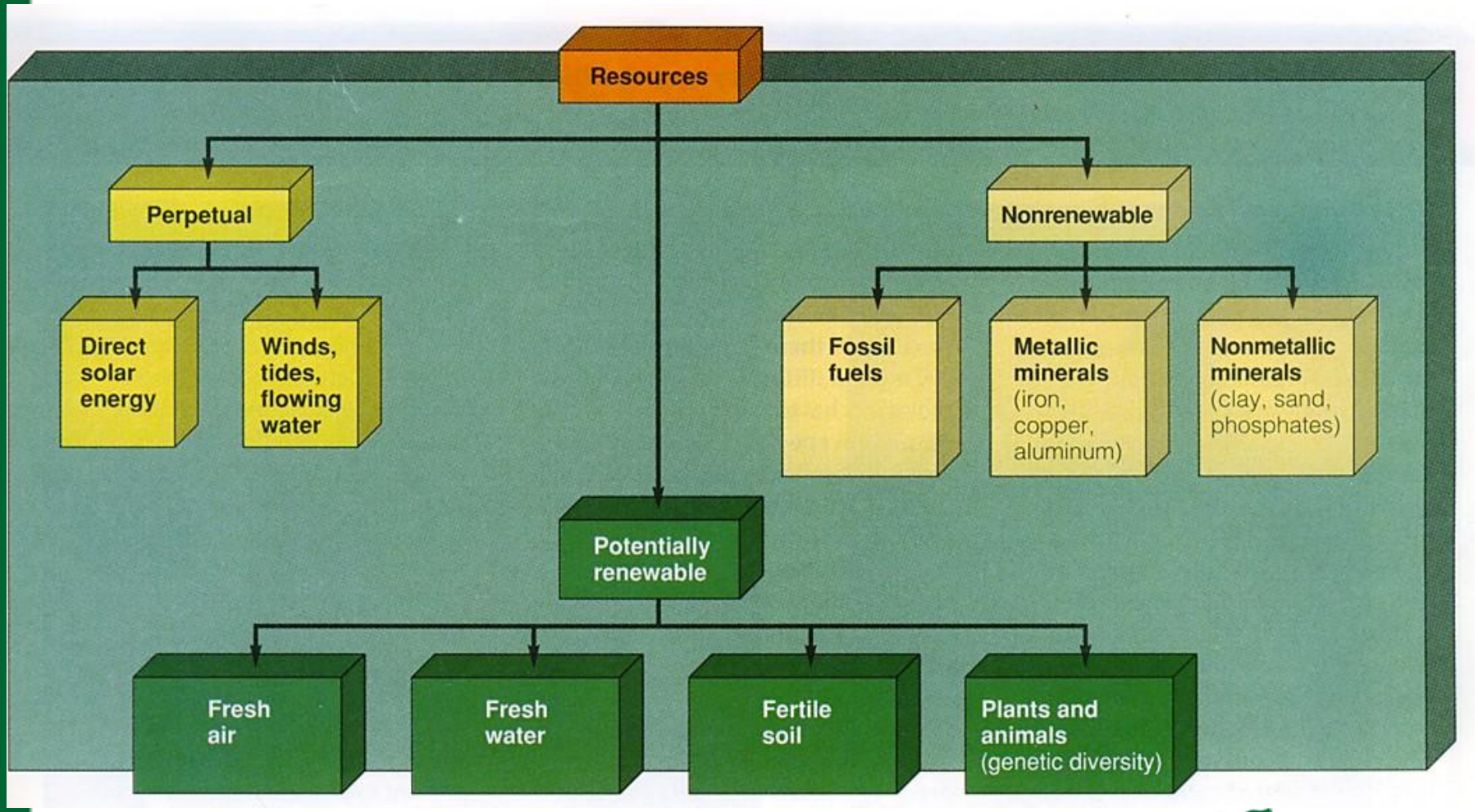
GREENHOUSE EFFECT: GLOBAL WARMING



GREENHOUSE EFFECT: GLOBAL WARMING

- To prevent:
  - Reducing current fossil fuel use.
  - Improving energy efficiency.
  - Shifting to perpetual and renewable energy resources that do not emit CO2
  - Stopping deforestation
  - Stopping marine pollution that kills phytoplankton

GREENHOUSE EFFECT: GLOBAL WARMING

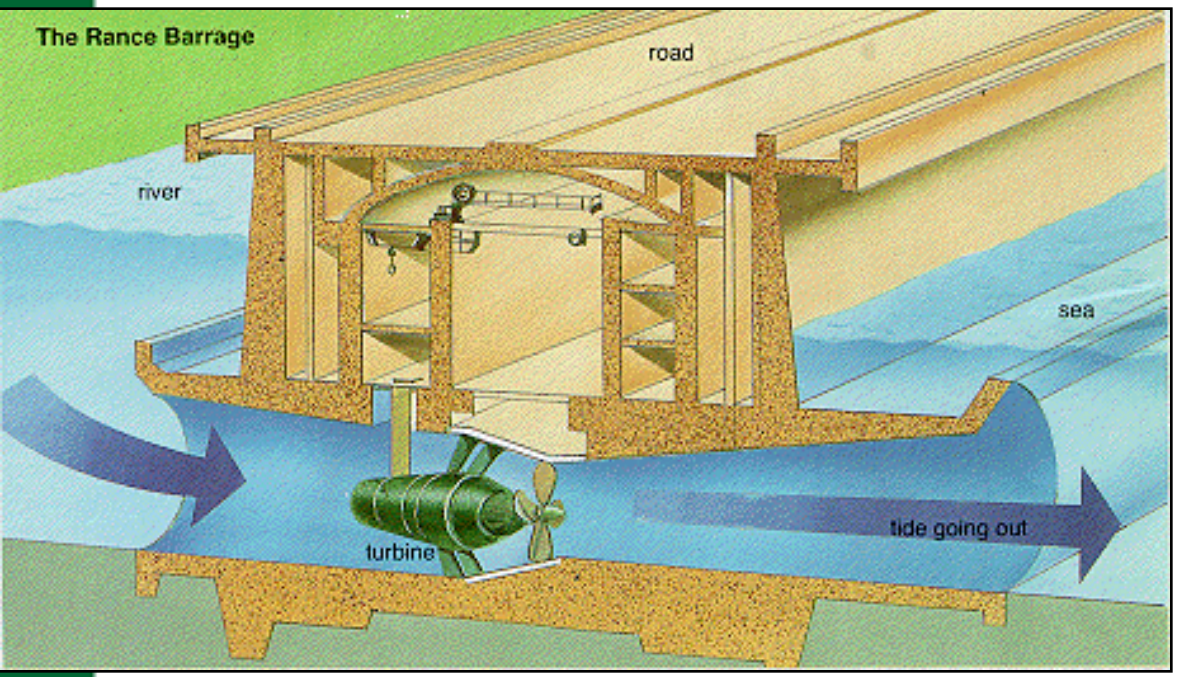


SHIFTING TO PERPETUAL AND RENEWABLE ENERGY RESOURCES

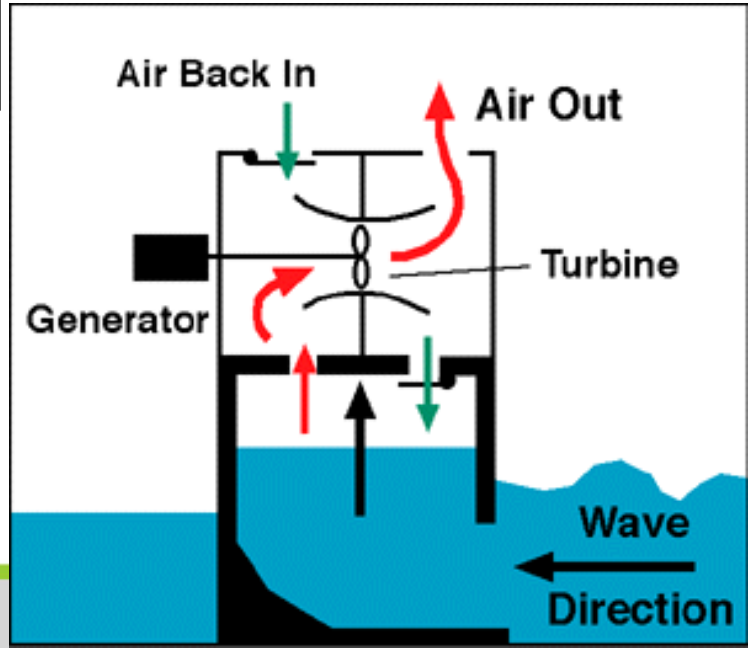
GREENHOUSE EFFECT: GLOBAL WARMING

Solar panel

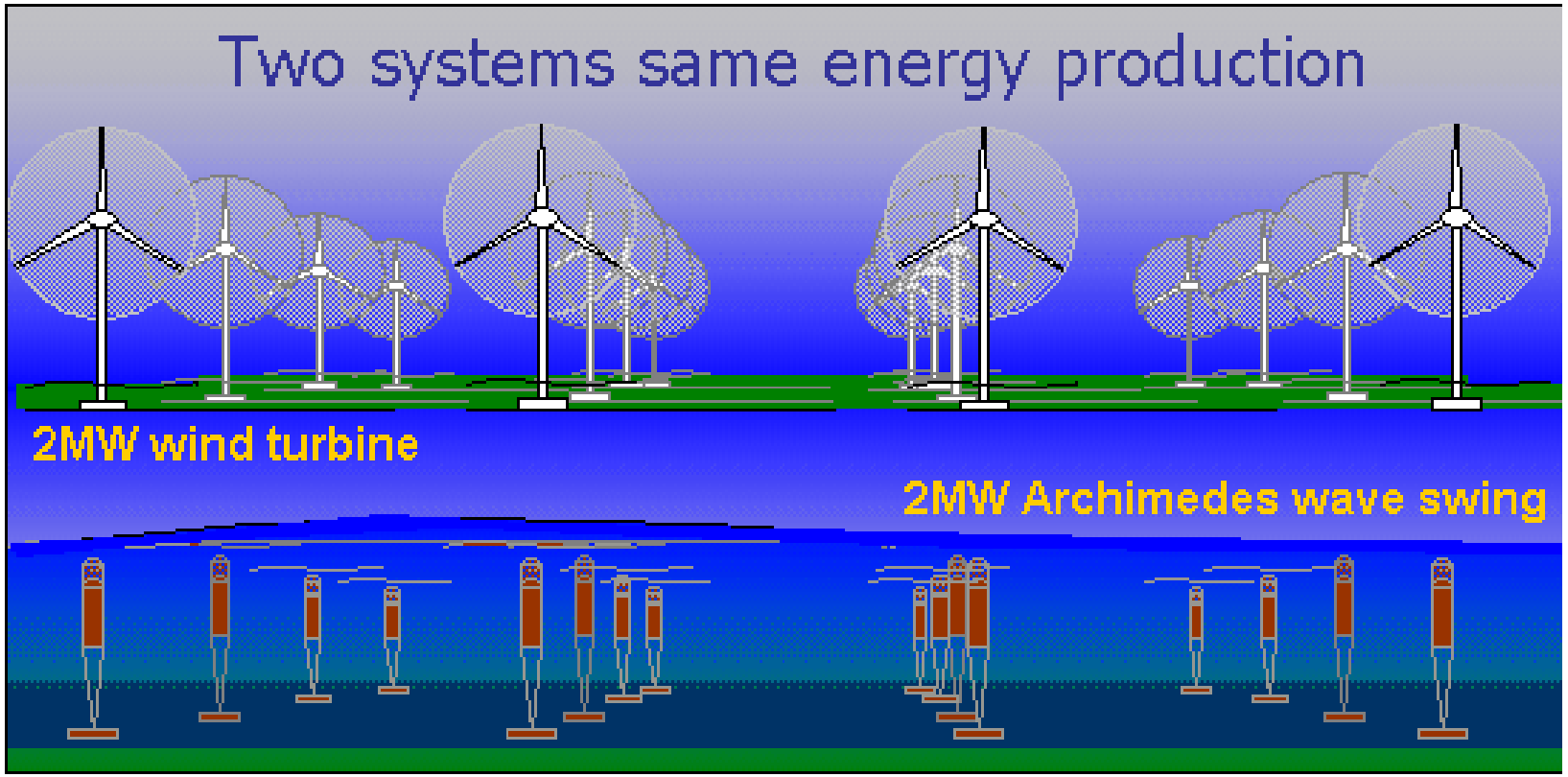
GREENHOUSE EFFECT: GLOBAL WARMING



Wave and tidal energy



GREENHOUSE EFFECT: GLOBAL WARMING



Wave and Wind

GREENHOUSE EFFECT: GLOBAL WARMING

Prevent logging activities &start with REFORESTATION

INDOOR POLLUTION : CAUSE

- Most of human will spend 80-90% of their live indoors
- Pollution exposure at home and work place is often greater than outdoors
- Indoor Air Quality (IAQ) refers to the nature of the conditioned (heat/cool) air that circulates throughout space or area where we work and live.

INDOOR POLLUTION : CAUSE

- **Indoor air pollution** comprises a mixture of contaminants penetrating from outdoors and those generated indoors

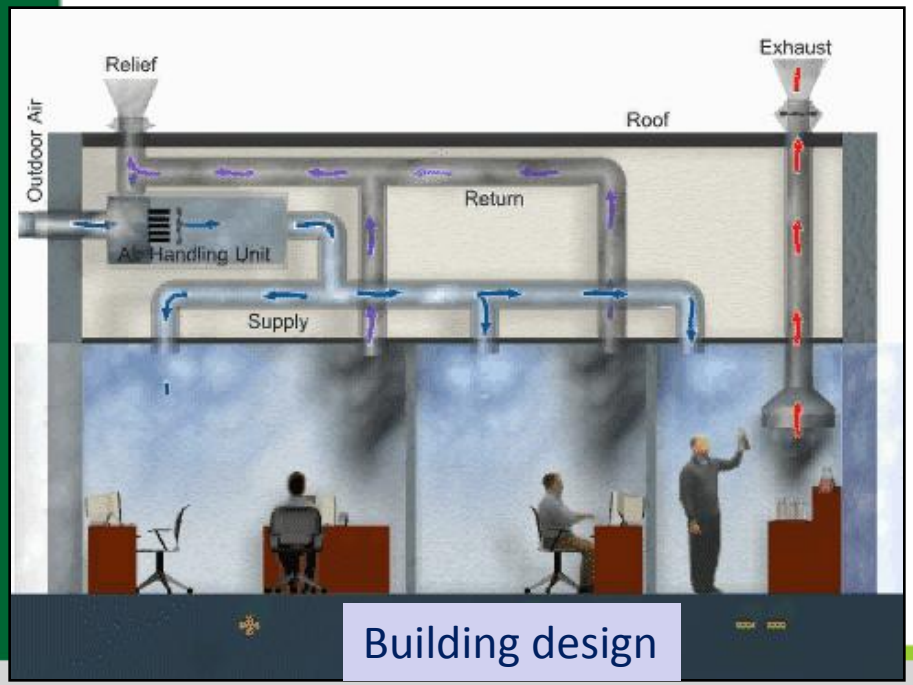
- It is estimated that indoor air pollutants levels are 25-62% greater than outside levels and can posed serious health problems (The California Air Resources Board)

- Primary source of indoor air quality problems:
  - Outdoor air
  - Building and construction material & furnishings
  - Building occupants and activities
  - Inadequate building design and maintenance

INDOOR POLLUTION : CAUSE

Occupants activities

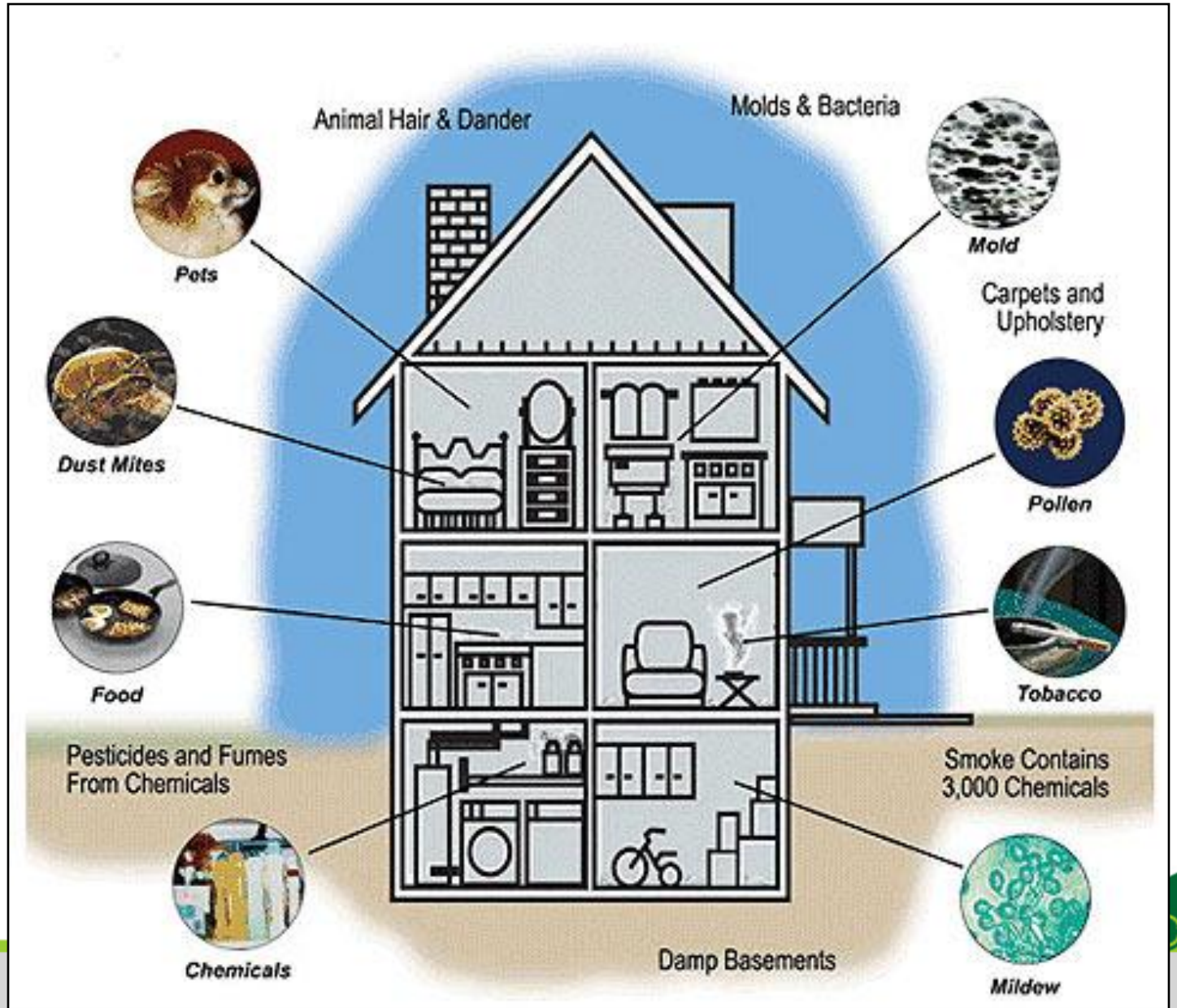
Outdoor air



Building design

Construction material

INDOOR POLLUTION : CAUSE



INDOOR POLLUTION : SOURCES

- How can we categorized these contaminants?

Combustion products

- Tobacco smoke
- Carbon monoxide
- Carbon dioxide
- Nitrogen dioxide
- Sulphur dioxide

VOC

- Pesticide & fungicide
- Alcohols
- Benzene
- Chloroform

Respirable particulates

- Water vapor
- Carbon Dioxide

Biologics & bioaerosols

- Molds & fungi
- Bacteria
- Viruses
- Nonviable microbial

Radionuclides

- Radon
- Radon progeny

Odors

- Odors associated with any of the above

INDOOR POLLUTION : CAUSE

- The relative importance of any single source depends on:
  - how much of a given pollutant it emits
  - how hazardous those emissions are ... Example: an improperly adjusted gas stove can emit significantly more carbon monoxide

- Factor effects indoor air pollution levels:
  - Inadequate ventilation can increase indoor pollutant levels
    - by not bringing in enough outdoor air to dilute emissions from indoor sources
    - by not carrying indoor air pollutants out of the home.
  - High temperature
  - Humidity levels and lighting

INDOOR POLLUTION : EFFECT

- The World Health Organization states that “indoor air pollution from solid fuel use is responsible for more than 1.6 million annual deaths and 2.7% of the global burden of disease

- This makes this risk factor the second biggest environmental contributor to ill health, behind unsafe water and sanitation.

- Radon and environmental tobacco smoke (ETS) are the two indoor air pollutants of greatest concern from a health perspective.

INDOOR POLLUTION : EFFECT

- Radon
  - Naturally occurring gas that is odorless, colorless, and radioactive comes from soil under basements
  - Long term exposure can cause lung cancer

- Environmental tobacco smoke (ETS)
  - Smoke emitted from the burning of a cigarette, pipe, or cigar, and smoke inhaled by a smoker.
  - It is a complex mix of more than 4,000 chemical compounds, containing many known or suspected carcinogens and toxic agents, including particles, carbon monoxide, and formaldehyde.
  - Deadliest indoor air pollutant

INDOOR POLLUTION : EFFECT

- Mold
  - Moisture in vents, carpets
  - Allergy sympthoms, breathing problems, headache, fatique

- Carbon monoxide
  - Malfunctioning furnace, gas appliances, cars
  - Blood cannot carry oxygen
  - Feel sleepy, nausea, dizzy, cause death

INDOOR POLLUTION : EFFECT

- Asbestos
  - Roofing, flooring, insulation, brakes
  - Negative effect if deteriorates
  - Can cause asbestosis (scarring of lungs) and mesothelioma (type of lung cancer)

- Lead
  - Old homes, toys, lead crystal dishes
  - Causes behavior & learning problems, slow growth, hearing problems, headaches

Pollutants	Indoor sources	Potential Health Effects
Environmental smoke	Cigarettes, cigars and pipes.	Respiratory problems, bronchitis and pneumonia in children, emphysema, lung cancer, and heart disease
Organic Chemicals	Aerosol sprays, solvents, glues, cleaning agents, pesticides, moth repellents, air fresheners.	Eye, nose, and throat irritation; headaches; damage to liver; various types of cancer.
Carbon Monoxide	Improper vented or malfunctioning gas appliances, wood stoves, and tobacco smoke.	Headache; nausea; angina; impaired vision and neural functioning.
Respirable Particles	Cigarettes, wood stoves, fireplaces, aerosol sprays, and house dust	Eye, nose and throat irritation; increased susceptibility to respiratory infections and bronchitis; lung cancer
Biological Agents (Bacteria, Viruses, Fungi, Animal Dander, Mites)	House dust; pets; bedding; poorly maintained air conditioners, humidifiers and dehumidifiers; wet or moist structures; furnishings.	Allergic reactions; asthma; eye, nose, and throat irritation; humidifier fever, influenza, and other infectious diseases.
Asbestos	Damaged or deteriorating insulation, fireproofing, and acoustical materials.	Asbestosis, lung cancer, mesothelioma, and other cancers.
Lead	Sanding or open-flame burning of lead paint; house dust.	Nerve and brain damage, particularly in children; kidney damage; growth retardation.
Radon	Soil under buildings, some earth-derived construction materials, and groundwater.	Lung cancer.

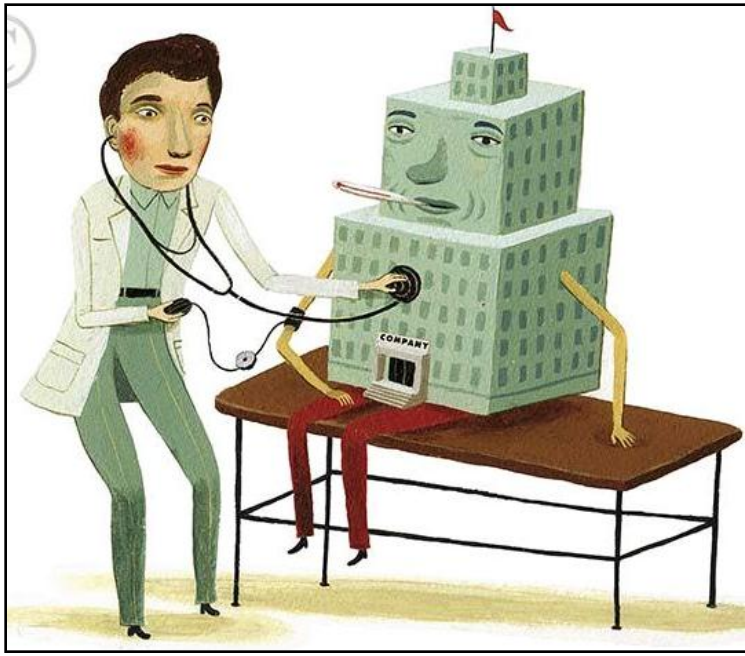
- Sources and potential health effects

- Immediate effects show up after a single exposure or repeated exposures
  - irritation of eyes, nose, and throat, headaches, dizziness, and fatigue
- Long term effects show up either years after exposure has occurred or only after long or repeated periods of exposure
  - include some respiratory diseases, heart disease, and cancer…

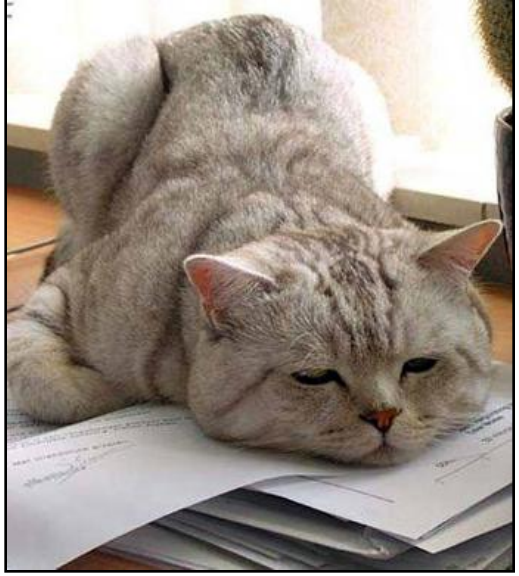
Source: Frost & Sullivan

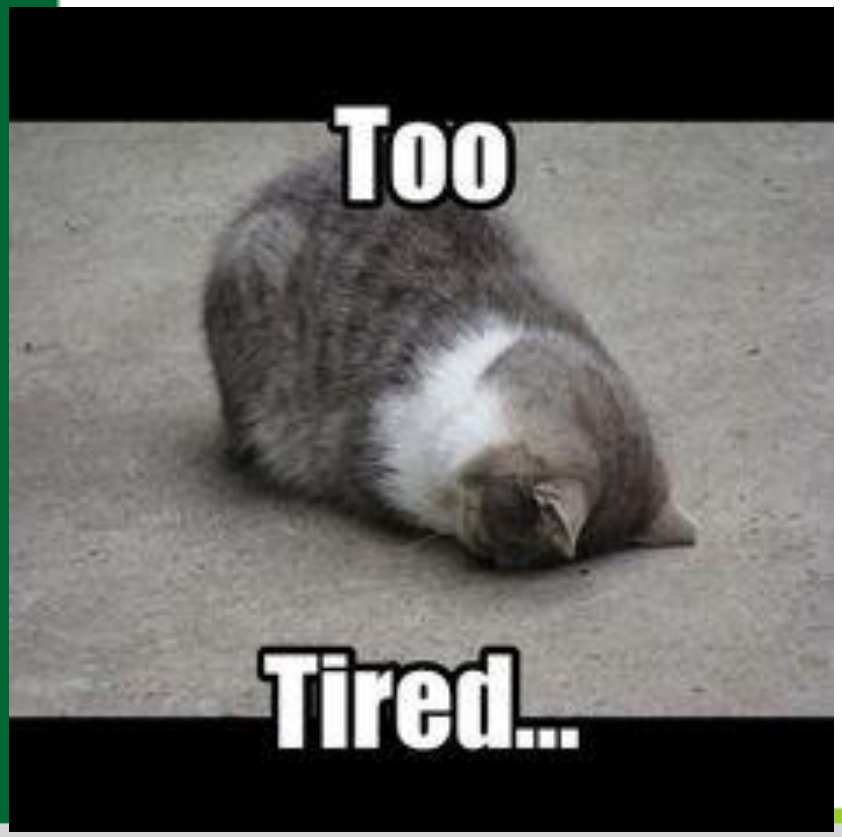
INDOOR POLLUTION : EFFECT

- Sick building syndrome (SBS)
  - The feeling of illness among majority of occupants of a conditioned space



  - Cause:
    - Building closed up to save energy….no air circulation
    - Effects of fumes intensified
  - Symptoms:
    - Headache, eye or throat irritation, cough, itchy skin, dizziness
    - Feel better when get fresh air





QUESTIONS?

Critical Thinking Group Activities

Refer notes as guidelines:

1. Prepare presentation material.
2. Each group have 15-20 minutes to present during class.
3. Everybody have to explain their part

Your topics is:

- Acid deposition → Group 1 & Group 8
- Smog and Haze → Group 2 & Group 7
- Ozone→ Group 3 & Group 6
- Indoor Pollution→ Group 4 & Group 5