

Pollution and Environmental protection BOT. 346

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Forms of pollution

The major forms of pollution are listed :

Air pollution:- the release of chemicals and particulates into the atmosphere. Common gaseous pollutants include carbon monoxide, sulfur dioxide, chlorofluorocarbons (CFCs) and nitrogen oxides produced by industry and motor vehicles.

Photochemical ozone and smog are created as nitrogen oxides and hydrocarbons react to sunlight. Particulate matter, or fine dust is characterized by their micrometre size PM10 to PM2.5.

Light pollution:- includes light trespass, over-illumination and astronomical interference.

Noise pollution:- which encompasses roadway noise, aircraft noise, industrial noise as well as high-intensity sonar.

Soil contamination occurs when chemicals are released by spill or underground leakage. Among the most significant soil contaminants are hydrocarbons, heavy metals, MTBE, herbicides, pesticides and chlorinated hydrocarbons.

Radioactive contamination, resulting from 20th century activities in atomic physics, such as nuclear power generation and nuclear weapons research, manufacture and deployment.

Thermal pollution, is a temperature change in natural water bodies caused by human influence, such as use of water as coolant in a power plant.

Water pollution, by the discharge of wastewater from commercial and industrial waste (intentionally or through spills) into surface waters; discharges of untreated domestic sewage, and chemical contaminants, such as chlorine, from treated sewage; release of waste and contaminants into surface runoff flowing to surface waters (including urban runoff and agricultural runoff, which may contain chemical fertilizers and pesticides); waste disposal and leaching into groundwater; eutrophication and littering.

Pollution is the introduction of contaminants into the natural environment that cause adverse change.

Pollution can take the form of **chemical substances** or **energy**, such as noise, heat or light.

Pollution is often classed as point source or nonpoint source pollution.

Pollutants, the components of pollution, can be either foreign substances/energies or naturally occurring contaminants.

The Blacksmith Institute issues an annual list of the world's worst polluted places.

A pollutant is a waste material that pollutes air, water or soil. Three factors determine the severity of a pollutant: its chemical nature, the concentration and the persistence.

Pollution Sources

- *Point sources* are direct discharges to a single point;
 - examples include discharges from sewage treatment plants, injection wells, and some industrial sources.

Pollution Sources

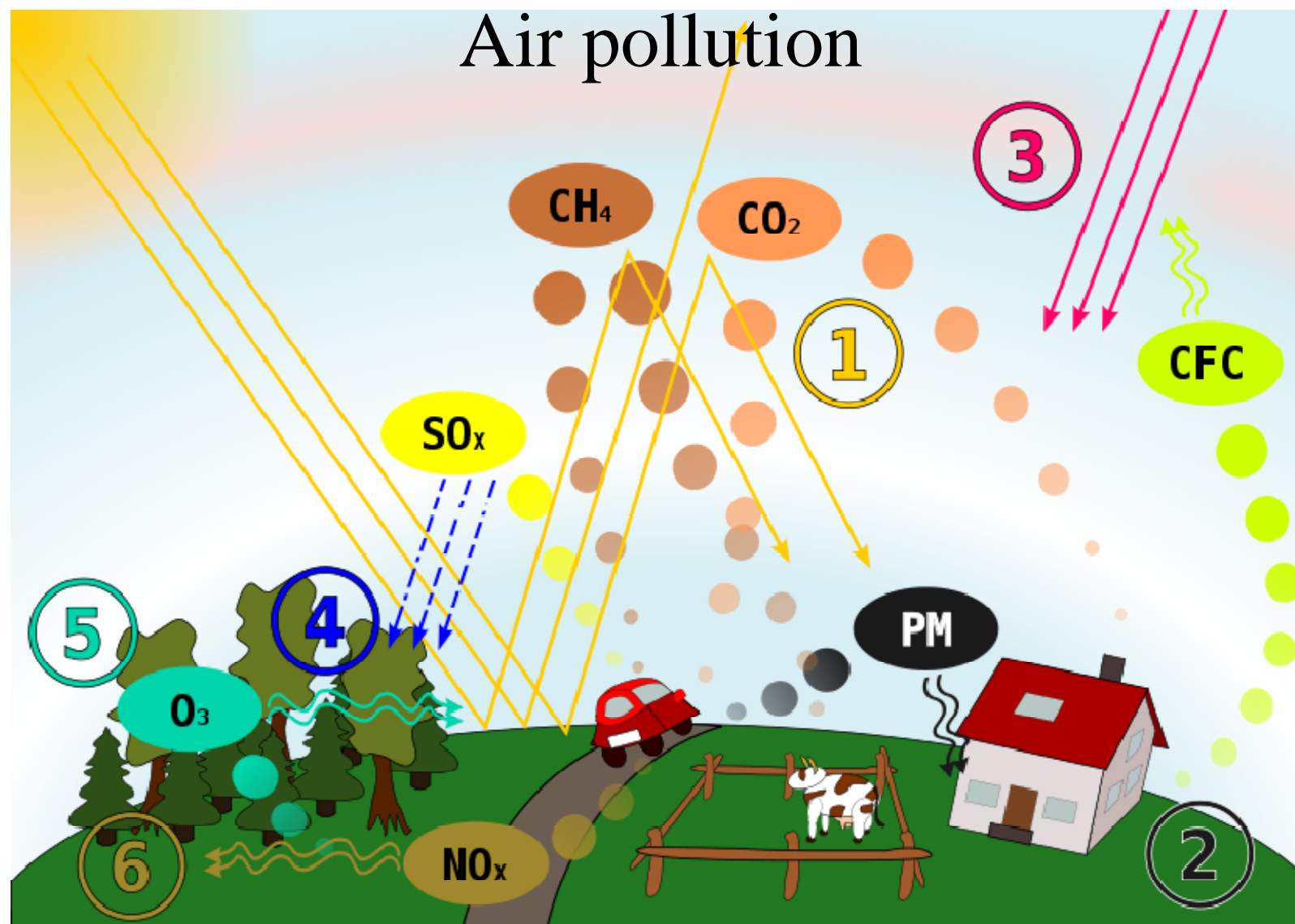
- *Non-point sources* are diffused across a broad area and their contamination cannot be traced to a single discharge point.
 - Examples include runoff of excess fertilizers, herbicides, and insecticides from agricultural lands and residential areas; oil, grease, and toxic chemicals from urban runoff and energy production; and sediment from improperly managed construction sites, crop and forest lands, and eroding stream banks.

Air pollution

- q Air pollution is the introduction of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms, or cause damage to the natural environment or built environment, into the atmosphere.
- q The atmosphere is a complex dynamic natural gaseous system that is essential to support life on planet Earth. Stratospheric ozone depletion due to air pollution has long been recognized as a threat to human health as well as to the Earth's ecosystems. 9

q Indoor air pollution and urban air quality are listed as two of the world's worst pollution problems in the 2008 Blacksmith Institute World's Worst Polluted Places report

q Major primary pollutants produced by human activity include: ????



Schematic drawing, causes and effects of air pollution: (1) greenhouse effect, (2) particulate contamination, (3) increased UV radiation, (4) acid rain, (5) increased ground level ozone concentration, (6) increased levels of nitrogen oxides ¹¹

Water pollution

Water pollution is the contamination of water bodies (e.g. lakes, rivers, oceans, aquifers and groundwater). Water pollution occurs when pollutants are discharged directly or indirectly into water bodies without adequate treatment to remove harmful compounds.

Water pollution affects plants and organisms living in these bodies of water. In almost all cases the effect is damaging not only to individual species and populations, but also to the natural biological communities.

Soil contamination or soil pollution

Soil contamination or soil pollution is caused by the presence of xenobiotic (human-made) chemicals or other alteration in the natural soil environment

Frist lecture introduction

Ancient cultures

- ∨ Air pollution has always accompanied civilizations.
- ∨ Pollution started from the prehistoric times when man created the first fires.
- ∨ According to a 1983 article in the journal Science, "soot found on ceilings of prehistoric caves provides ample evidence of the high levels of pollution that was associated with inadequate ventilation of open fires."

- q The industrial revolution gave the birth to environmental pollution as we know it today.
- q The emergence of great factories and consumption of huge quantities of coal and other fossil fuels gave rise to unprecedented air pollution and the large volume of industrial chemical discharges added to the growing load of untreated human waste

Modern awareness

- Ø Pollution became a popular issue after World War II, due to radioactive fallout from atomic warfare.
- Ø Then a non-nuclear event, The Great Smog of 1952 in London, killed at least 4000 people. This prompted some of the first major modern environmental legislation.
- Ø The development of nuclear science introduced radioactive contamination, which can remain lethally radioactive for hundreds of thousands of years.

Environment : Pollution present widely in the environment.

There are a number of effects :

Biomagnification describes situations where toxins (such as heavy metals) may pass through trophic levels, becoming exponentially more concentrated in the process.

Carbon dioxide emissions cause ocean acidification, the ongoing decrease in the pH of the Earth's oceans as CO₂ becomes dissolved.

Invasive species can out compete native species and reduce biodiversity. Invasive plants can contribute debris and biomolecules (allelopathy) that can alter soil and chemical compositions of an environment, often reducing native species competitiveness.

The emission of greenhouse gases leads to global warming which affects ecosystems in many ways.

Nitrogen oxides are removed from the air by rain and fertilise land which can change the species composition of ecosystems.

Smog can reduce the amount of sunlight received by plants to carry out photosynthesis and leads to the production of tropospheric ozone which damages plants.

Soil can become infertile and unsuitable for plants. This will affect other organisms in the food web.

Sulfur dioxide and nitrogen oxides can cause acid rain which lowers the pH value of soil.

The Atmosphere

∅ The atmosphere of Earth is a layer of gases surrounding the planet Earth that is retained by Earth's gravity.

∅ The atmosphere protects life on Earth by absorbing **ultraviolet solar radiation**, **warming the surface through heat retention** (greenhouse effect), and **reducing temperature extremes between day and night**

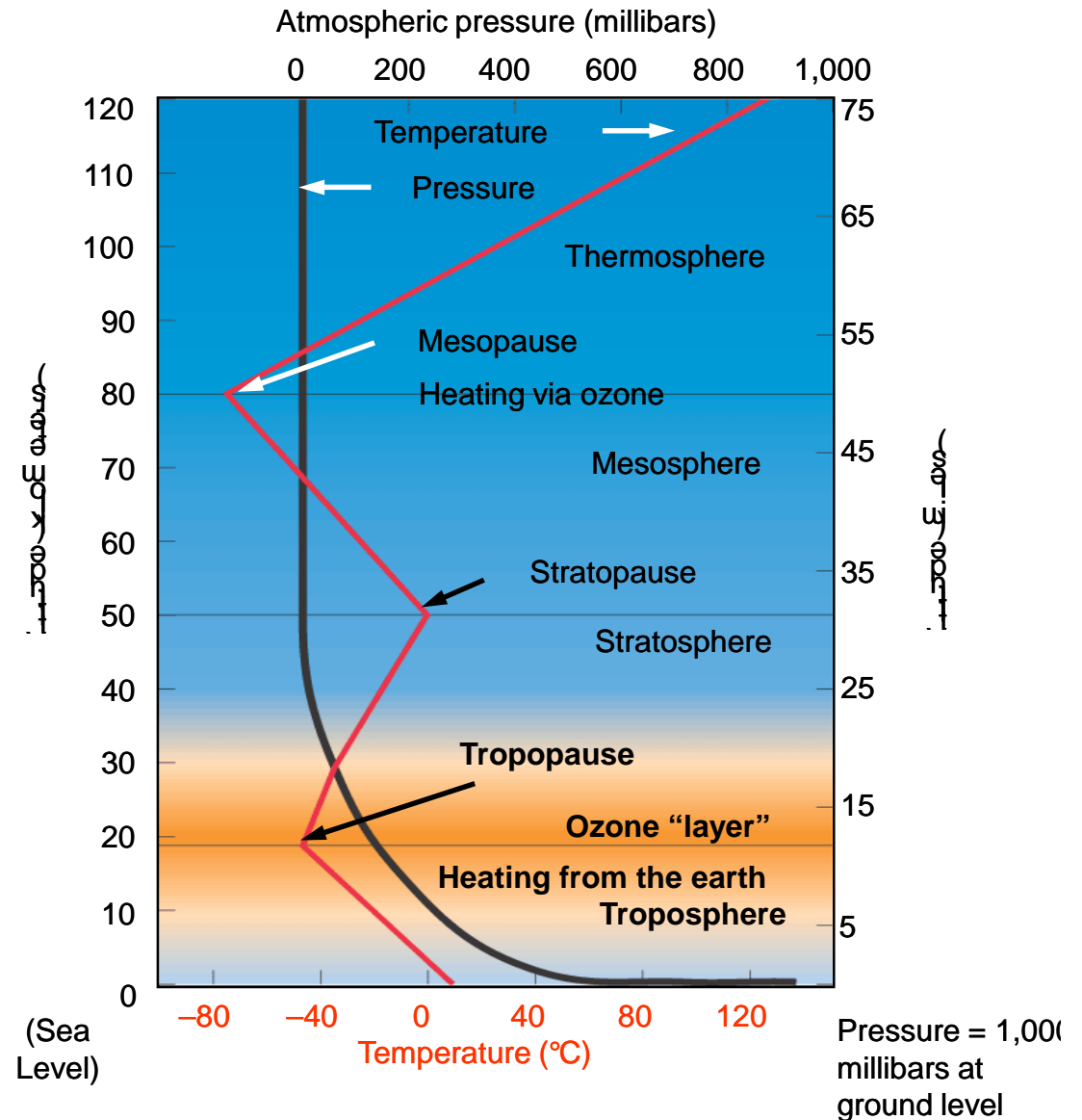
∅ Air pressure and density decrease in the atmosphere as height increases.

∅ Earth's atmosphere can be divided into five main layers.

Atmospheric stratification

Separation of layers due
to differences in
temperature and
variations in absorption
of solar energy

Most of our weather in
the troposphere



Ø Troposphere begins at the surface and extends to between 9 km at the poles and 17 km at the equator

Ø Troposphere is mostly heated by transfer of energy from the earth surface. The lowest part is warmest and temperature decreases with altitude.

Ø Ozone layer is mainly located in the lower portion of the stratosphere from about 15–35 km though the thickness varies seasonally and geographically.

Ø About 90% of the ozone in our atmosphere is contained in the stratosphere.

Air

Air is the name given to atmosphere used in breathing and photosynthesis.

Air is mainly composed of :

78.09% nitrogen,

20.95% oxygen,

0.93% argon,

0.039% carbon dioxide,

1% water vapor

small amounts of other gases.

Air pollution

Ø Air pollution is the introduction of **chemicals**, **particulate matter**, or **biological materials** that cause harm or discomfort to humans or other living organisms, or cause damage to the natural environment or built environment, into the atmosphere.

Ø Stratospheric, ozone depletion due to air pollution recognize as a threat to human health as well as to the Earth's ecosystems.

What Are the Major Air Pollution Problems ?

Three major outdoor air pollution problems are

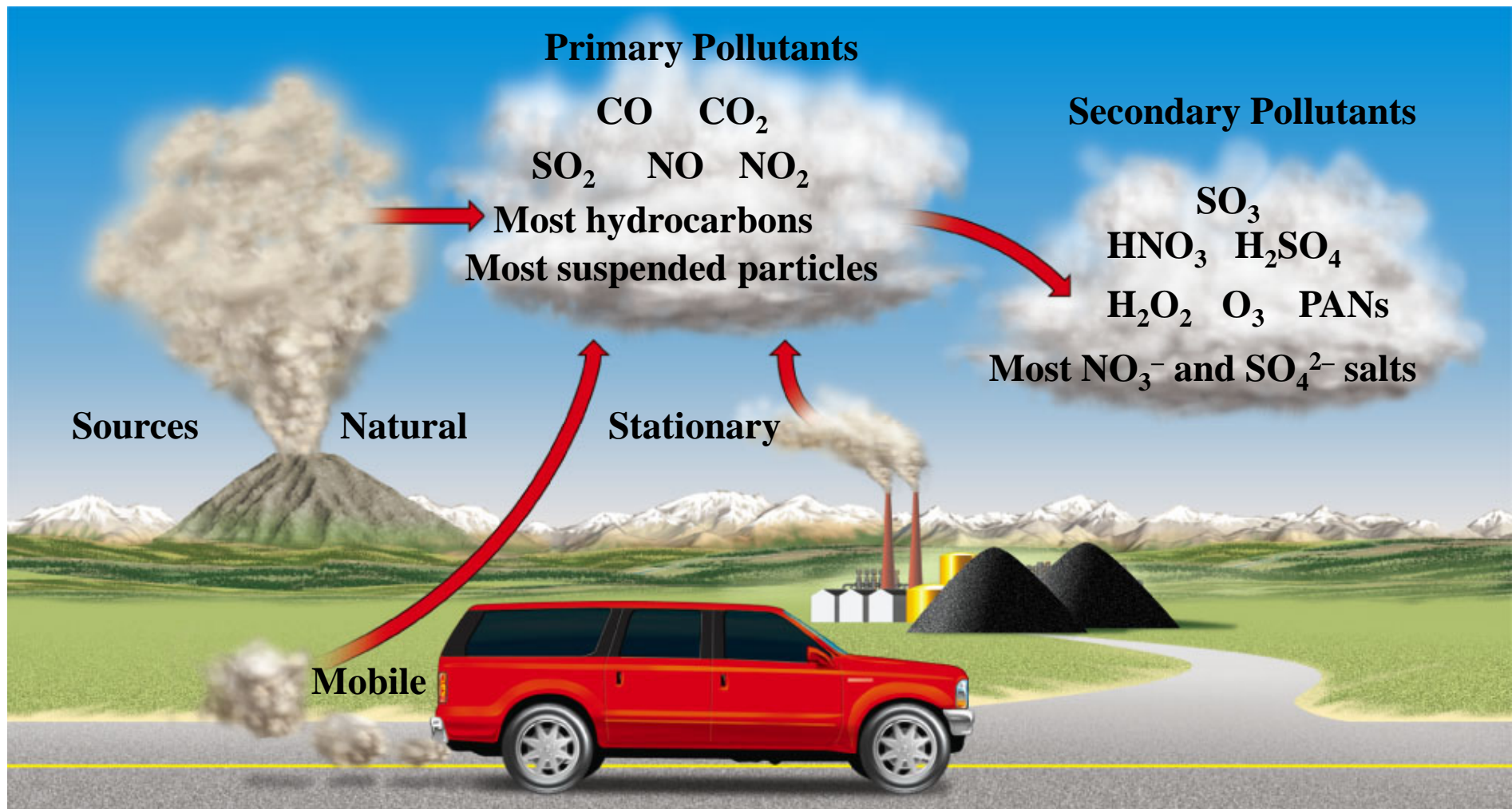
- 1) **industrial smog** from burning coal,
- 2) **photochemical smog** from motor vehicle and industrial emissions,
- 3) **acid deposition** from coal burning and motor vehicle exhaust.

Air Pollutants can be classified as **primary or secondary**.

- q **primary pollutants**: directly emitted from directly from identifiable sources, ash from a volcanic eruption, the carbon monoxide gas from a motor vehicle exhaust or **sulfur dioxide** released from factories.
- q **Secondary pollutants** which are produced in the atmosphere when certain chemical reactions take place among primary pollutants..
- q An important example of a secondary pollutant is ground level ozone — one of the many secondary pollutants that make up photochemical smog.

0 Air Pollutants can be in the form of solid particles, liquid droplets, or gases. In addition, they may be natural or man-made

Sources and Types of Air Pollutants



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primary air pollutants may react with one another or with other chemicals in the air to form secondary air pollutants.

Major primary pollutants produced by human activity include:

1- Sulphur oxides (SO_x) - especially sulfur dioxide, a chemical compound with the formula SO_2 .

Ø SO_2 is produced by volcanoes and in various industrial processes.

Ø coal and petroleum contain sulfur compounds, their combustion generates sulfur dioxide.



Before flue-gas desulfurization was installed, the emissions from this power plant contained excessive amounts of sulfur dioxide

2- Nitrogen oxides (NO_x) - especially nitrogen dioxide are emitted from:

- high temperature combustion.
- produced naturally during thunderstorms by electrical discharge.

Nitrogen dioxide (NO₂) brownish gas irritates the respiratory system originates from combustion (N₂ in air is oxidized); NO_x sum of NO, NO₂, other oxides of N

3- Carbon monoxide (CO)- is a colourless, odorless, non-irritating but very poisonous gas.

- Vehicular exhaust is a major source of carbon monoxide.

Carbon monoxide reduces blood's ability to carry O₂

Carbon monoxide produces incomplete combustion

4- Carbon dioxide (CO₂) - a colourless, odorless, non-toxic greenhouse gas also associated with ocean acidification, emitted from sources such as combustion, cement production, and respiration.

- It is otherwise recycled in the atmosphere in the carbon cycle.

5- Volatile organic compounds - VOCs are an important outdoor air pollutant. Divide into the separate categories of methane (CH₄) and non-methane (NMVOCs).

Methane is an extremely efficient greenhouse gas which contributes to enhanced global warming.

6-Particulate matter (PM) – Particulaes less than 2.5 microns in diameter is referred to as or fine particles, are tiny particles of solid or liquid suspended in a gas.

In contrast, aerosol refers to particles and the gas together.

Sources:

Human activities burning fossil fuels in vehicles, power plants and various industrial processes

Natural from volcanoes, dust storms, forest and grassland fires, living vegetation, and sea spray
heart disease, altered lung function and lung cancer.

"fine" particles

8-Toxic metals, such as lead, cadmium and copper.

9- Chlorofluorocarbons (CFCs) - harmful to the ozone layer emitted from products currently banned from use.

10- Ammonia (NH₃) - emitted from agricultural processes.

q Ammonia contributes significantly to the nutritional needs of terrestrial organisms

11- Odors — such as from garbage, sewage, and industrial processes.

12-Radioactive pollutants - produced by nuclear explosions, nuclear events, war explosives, and natural processes such as the radioactive decay of radon.

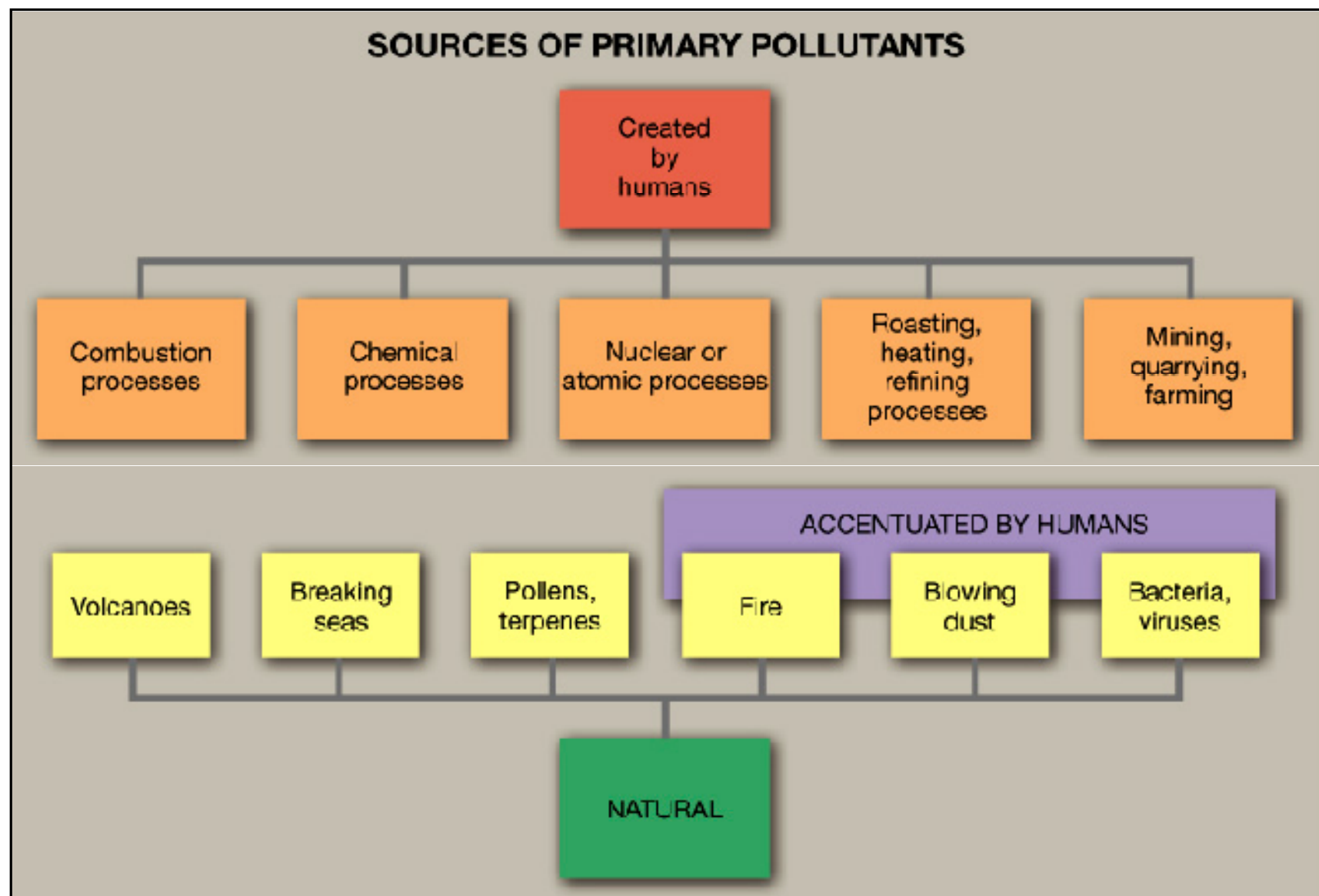
Secondary pollutants include

- Atmospheric sulfuric acid is one example of a secondary pollutant.
- Air pollution in urban and industrial areas is often called **smog**.
- **Smog** is a kind of air pollution; the word "smog" is a portmanteau of smoke and fog.
- **Photochemical smog**, a noxious mixture of gases and particles, is produced when strong sunlight triggers **photochemical reactions** in the atmosphere.
- The major component of photochemical smog is **ozone**.
- Although considerable progress has been made in controlling air pollution, the quality of the air we breathe remains a serious public health problem.

Sources of air pollution

Sources can be classified into two major categories which are:

Search????



Air pollutant impacts

- Ozone depletion
- Greenhouse effect
- acidification
- smog formation
- eutrophication
- human health
- ecosystem health

Ozone depletion

The ozone layer protects the Earth from the ultraviolet rays sent down by the sun. If the ozone layer is depleted by human action, the effects on the planet could be catastrophic.

Ozone Depletion - Causes

Only a few factors combine to create the problem of ozone layer depletion. The production and emission of CFCs, chlorofluorocarbons, is by far the leading cause.

Ozone Depletion - Effects

Even minor problems of ozone depletion can have major effects. Every time even a small amount of the ozone layer is lost, more ultraviolet light from the sun can reach the Earth. causing more skin cancer, eye damage, and possible harm to crops.

Photochemical smog or Ozone

The tropospheric Ozone (O_3) is a photochemical oxidant and the major component of smog.

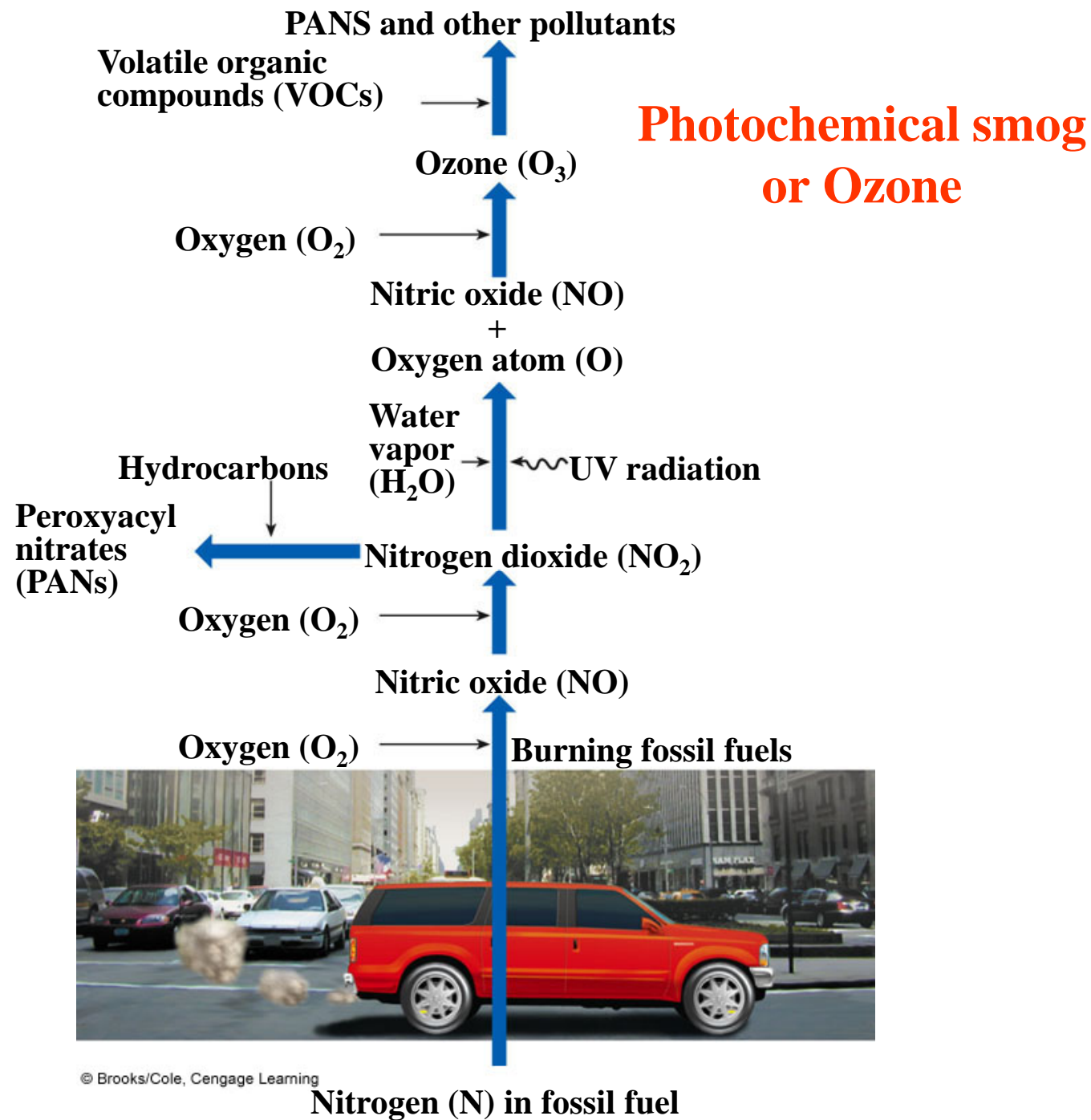
O_3 in the upper atmosphere is beneficial to life by shielding the earth from harmful ultraviolet radiation from the sun, high concentrations of O_3 at ground level are a major health and environmental concern.

O_3 is not emitted directly into the air but is formed through complex chemical reactions

Formation

ozone formation occurs when nitrogen oxides (NO_x), carbon monoxide (CO) and volatile organic compounds (VOCs) react in the atmosphere in the presence of sunlight.

NO_x , CO, and VOCs are called ozone precursors.



Global Outlook: Photochemical Smog in Santiago, Chile



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Denver's Brown Cloud:



<http://www.infrastructurist.com/wp-content/uploads/brown-cloud.jpg>

Health effects

- q Irritation of the respiratory system, causing coughing, throat irritation,
- q Reduced lung function, making it more difficult to breathe deeply and vigorously
- q Aggravation of asthma..
- q Increased susceptibility to respiratory infections.
- q Inflammation and damage to the lining of the lungs.

The “Greenhouse Effect”

- i The Earth’s surface thus receives energy from two sources: the sun & the atmosphere
 - As a result the Earth’s surface is $\sim 33^{\circ}\text{C}$ warmer than it would be without an atmosphere

Greenhouse gases are transparent to shortwave but absorb longwave radiation

- Thus the atmosphere stores energy

Greenhouse gases are those that can absorb and emit infrared radiation

Natural greenhouse gases

Water vapor (H_2O)

Carbon dioxide (CO_2)

Methane (CH_4)

Nitrous Oxide (N_2O)

Non-greenhouse gases

the major atmospheric constituents, nitrogen (N_2), oxygen (O_2), and argon (Ar), are not greenhouse gases.

because molecules containing two atoms of the same element such as N_2 and O_2

monatomic molecules such as Argon (Ar) have no net change in their dipole moment when they vibrate and hence are almost totally unaffected by infrared light.

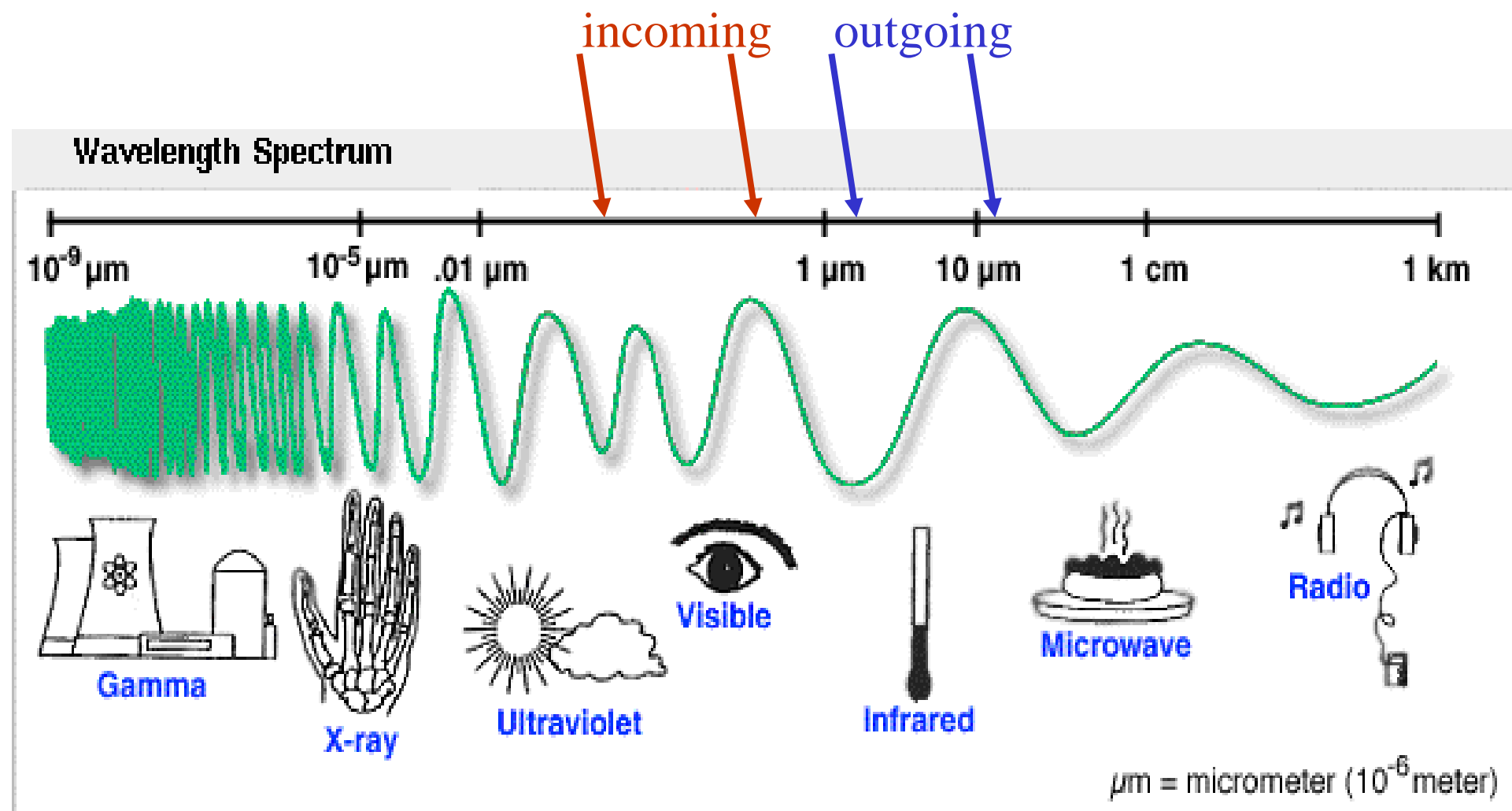
Atmospheric concentrations of greenhouse gases are determined by the balance **between sources** (emissions of the gas from human activities and natural systems) **and sinks** (the removal of the gas from the atmosphere by conversion to a different chemical compound)

Solar radiation passes through the atmosphere to warm the planetary surface,

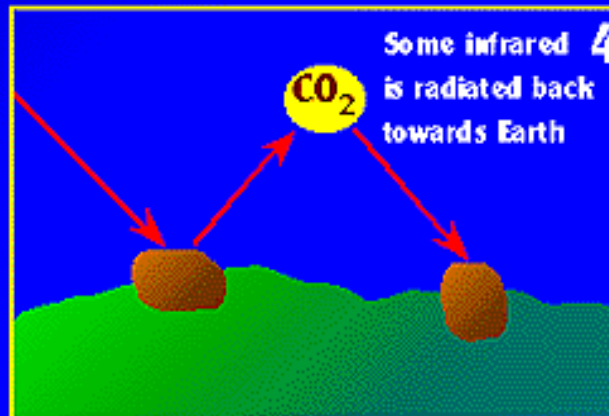
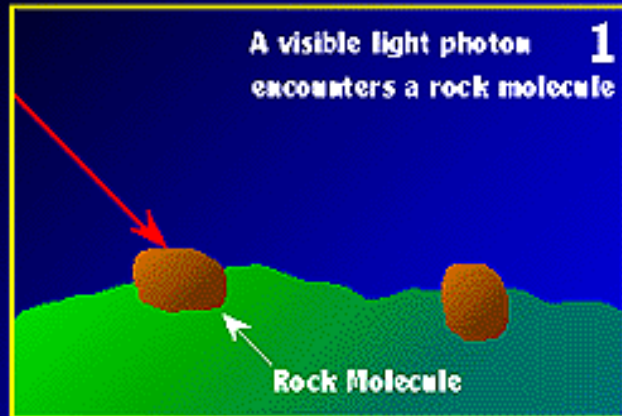
Infrared radiation is absorbed by greenhouse gases, which in turn re-radiate much of the energy to the surface and lower atmosphere.

The mechanism is named after the effect of solar radiation passing through glass and warming a greenhouse, but the way it retains heat is fundamentally different as a greenhouse works by reducing airflow, isolating the warm air inside the structure so that heat is not lost by convection

Electromagnetic Spectrum



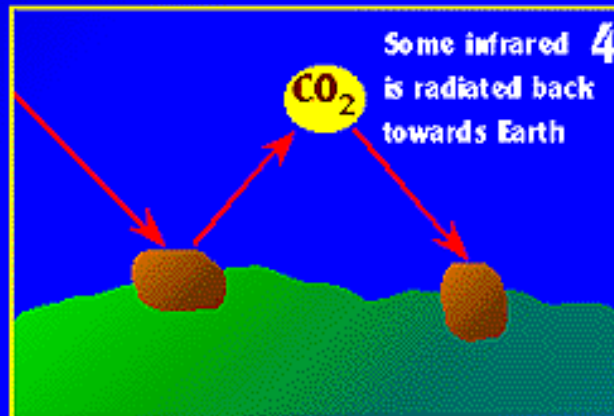
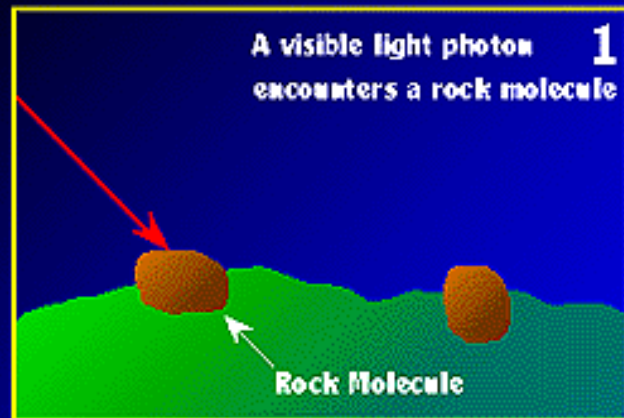
The Earth's Temperature - A Balancing Act



1. Shorter, high
Energy wavelengths
Hit the earth's
Surface

2. Incoming energy
Is converted to heat

The Earth's Temperature - A Balancing Act

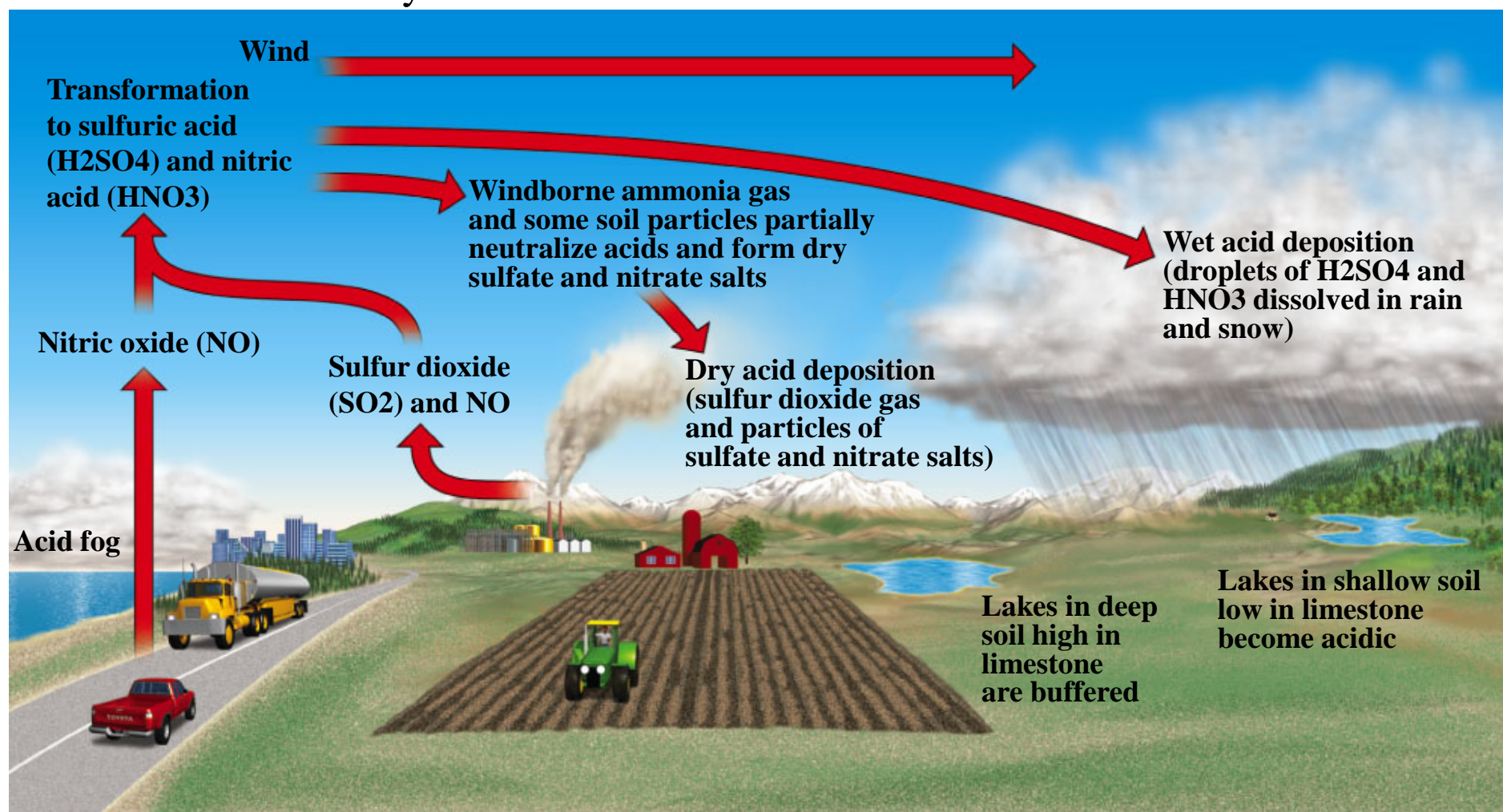


3. Longer, infrared
Wavelengths hit
Greenhouse gas
Molecules in the
atmosphere

4. Greenhouse gas
Molecules in the
Atmosphere emit
Infrared radiation
Back towards earth

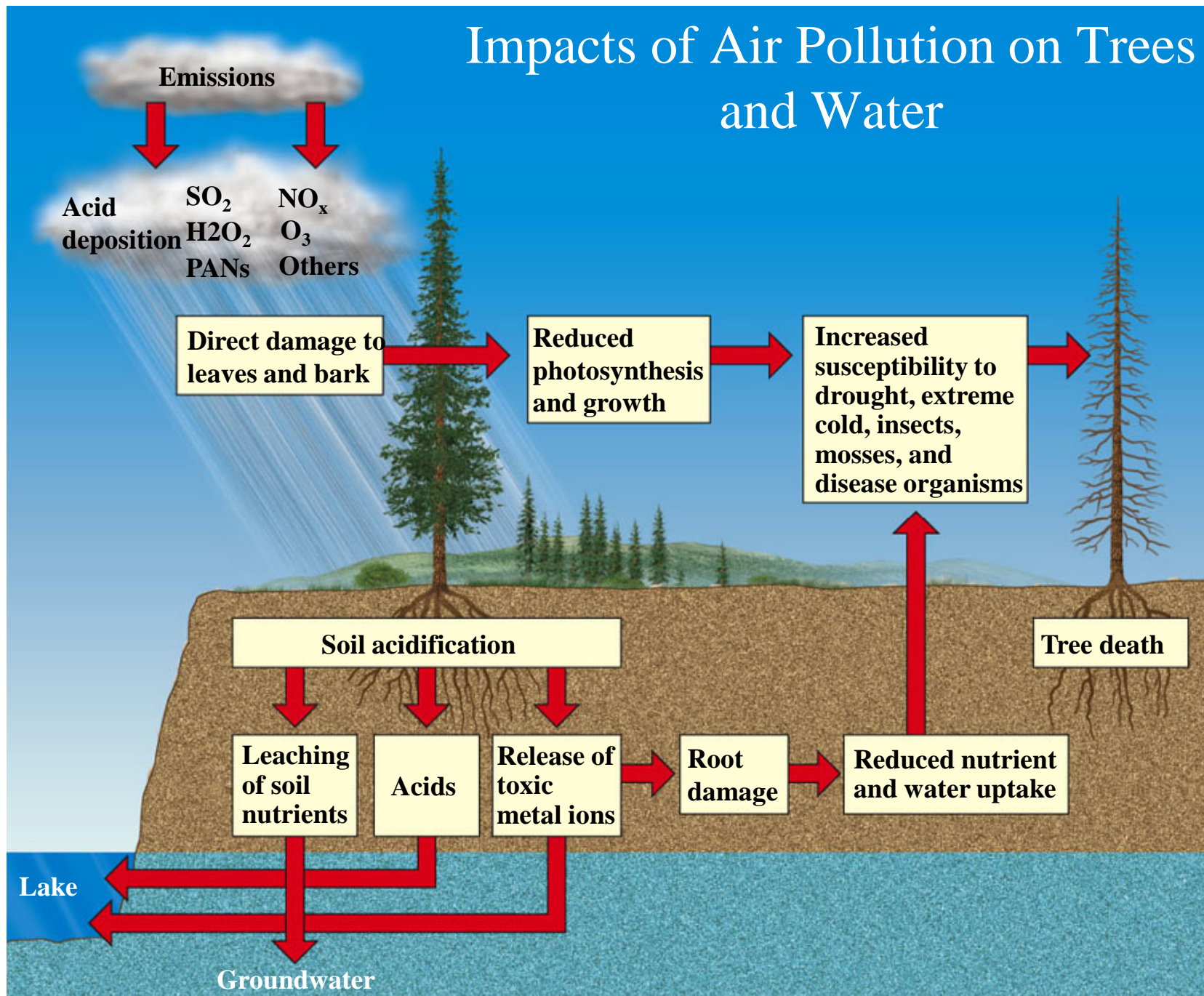
Acid Deposition

Acid deposition consists of rain, snow, dust, or gas with a pH lower than 5.6, is commonly called acid rain. Soils and lakes vary in their ability to buffer or remove excess acidity.

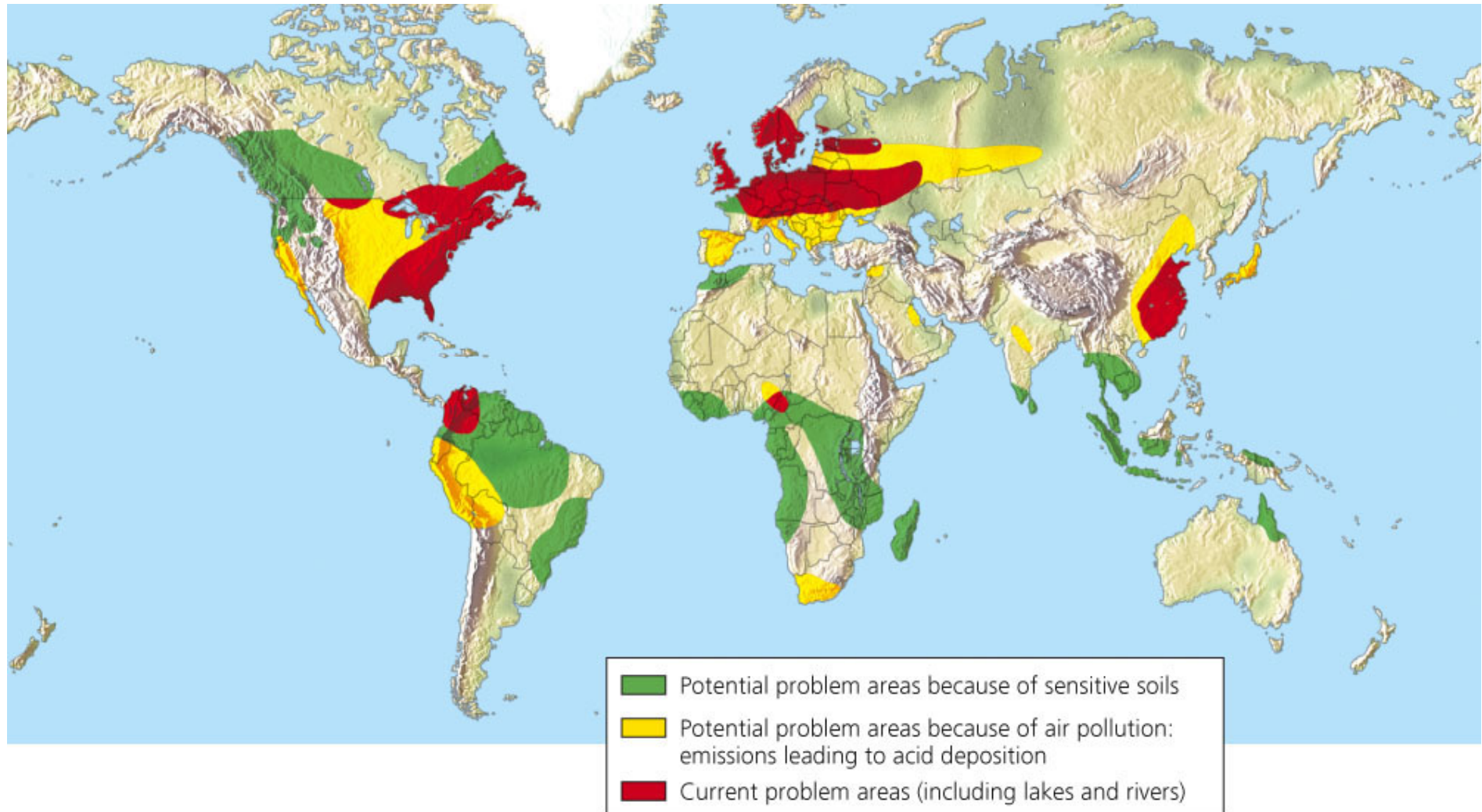


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Q: What are three ways in which your daily activities contribute to acid deposition?



Current and Potential Problems with Acid Deposition

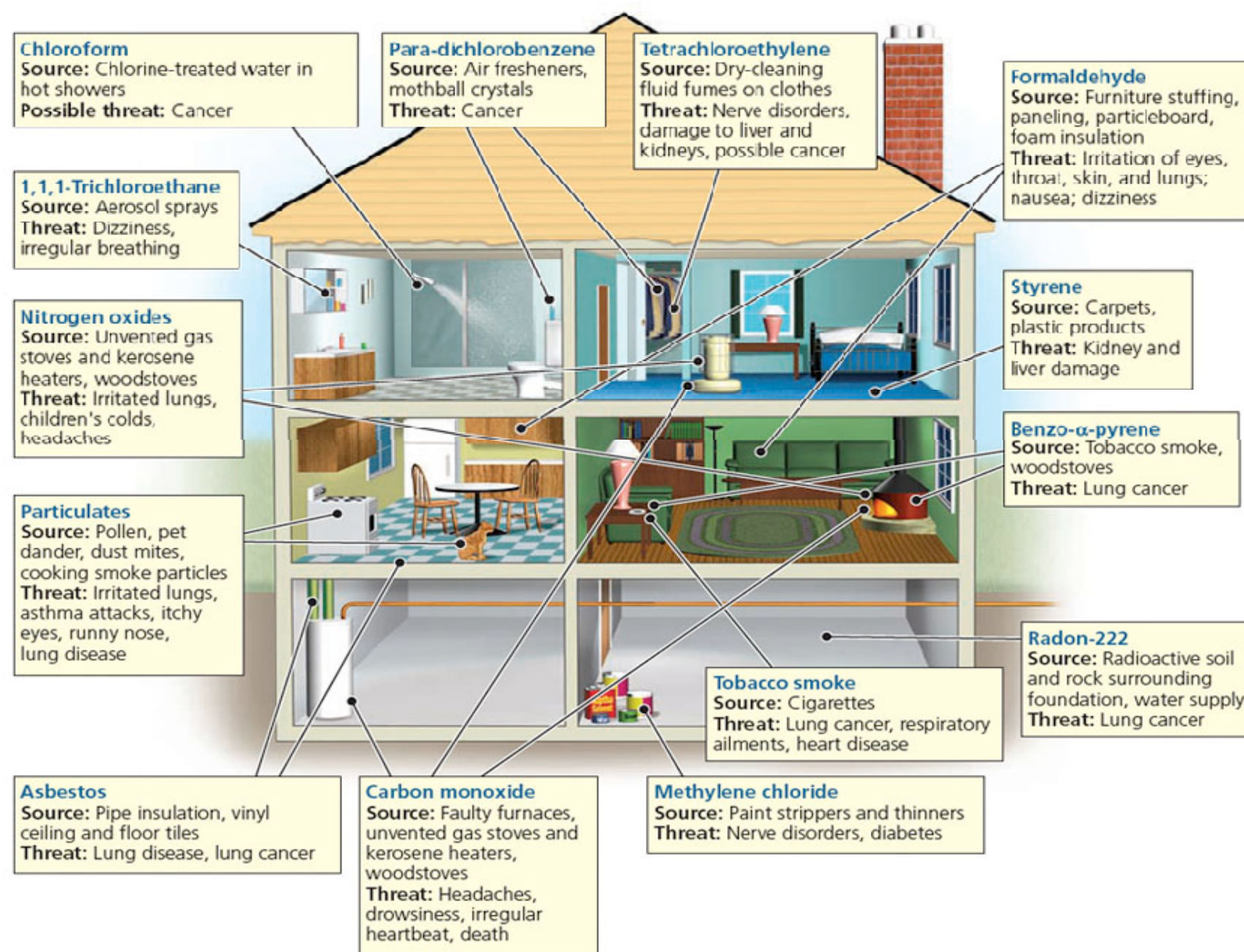


Where is the worst acid deposition?

Harmful Effects of Acid Deposition

- Respiratory diseases in humans
- Toxic metal leaching
- Structural damage
- Kills fish and other aquatic organisms
- Leaches plant nutrients from soil
- Acid clouds and fog at mountaintops

Some Important Indoor Air Pollutants



INDOOR AIR POLLUTION

- Indoor air pollution usually is a greater threat to human health than outdoor air pollution.
- the four most dangerous indoor air pollutants are:
 - Tobacco smoke.
 - Formaldehyde.
 - Radioactive radon-222 gas.
 - Very small fine and ultrafine particles.

Health effects of pollution

