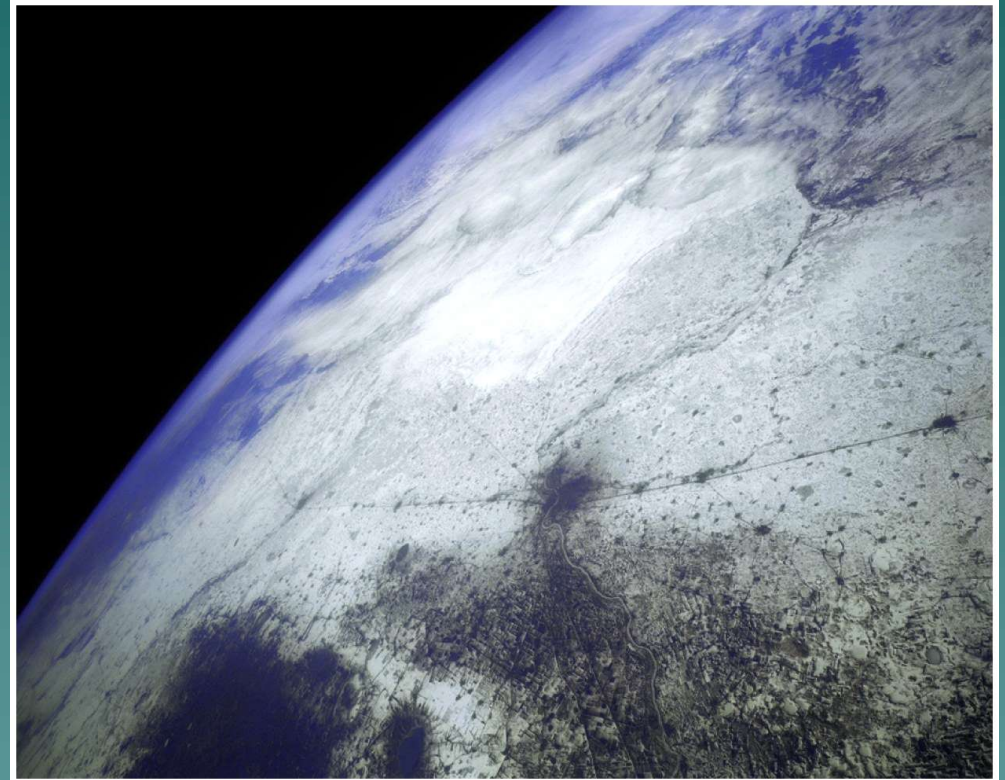


Air Pollution



Atmosphere as a Resource

- Atmospheric Composition
 - Nitrogen 78.08%
 - Oxygen 20.95%
 - Argon 0.93%
 - Carbon dioxide 0.04%
- Ecosystem services
 - Blocks UV radiation
 - Moderates the climate
 - Redistributes water in the hydrologic cycle



Types and Sources of Air Pollution

- o Air Pollution

- Chemicals added to the atmosphere by natural events or human activities in high enough concentrations to be harmful

- o Two categories

- Primary Air Pollutant

- Harmful substance that is emitted directly into the atmosphere

- Secondary Air Pollutant

- Harmful substance formed in the atmosphere when a primary air pollutant reacts with substances normally found in the atmosphere or with other air pollutants

Major Air Pollutants

Table 20.1 Major Air Pollutants

<i>Pollutant</i>	<i>Composition</i>	<i>Primary or Secondary</i>	<i>Characteristics</i>
<i>Particulate matter</i>			
Dust	Variable	Primary	Solid particles
Lead	Pb	Primary	Solid particles
Sulfuric acid	H ₂ SO ₄	Secondary	Liquid droplets
<i>Nitrogen oxides</i>			
Nitrogen dioxide	NO ₂	Primary	Reddish-brown gas
<i>Sulfur oxides</i>			
Sulfur dioxide	SO ₂	Primary	Colorless gas with strong odor
<i>Carbon oxides</i>			
Carbon monoxide	CO	Primary	Colorless, odorless gas
Carbon dioxide*	CO ₂	Primary	Colorless, odorless gas
<i>Hydrocarbons</i>			
Methane	CH ₄	Primary	Colorless, odorless gas
Benzene	C ₆ H ₆	Primary	Liquid with sweet smell
<i>Ozone</i>	O ₃	Secondary	Pale blue gas with acrid odor
<i>Air toxics</i>			
Chlorine	Cl ₂	Primary	Yellow-green gas

* Discussed in Chapter 21.

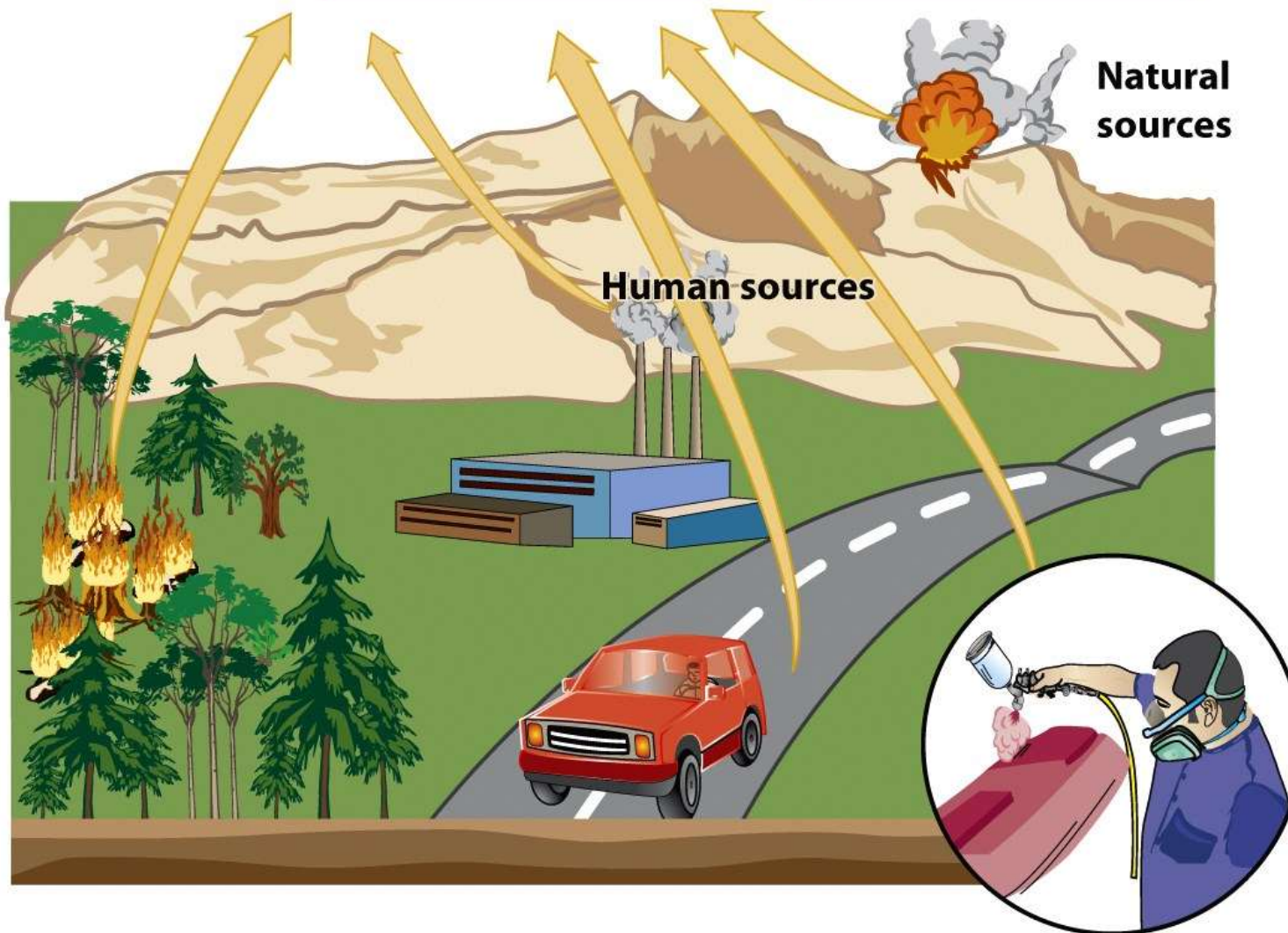
Source: Environmental Protection Agency.

Primary air pollutants


CO
SO₂ NO CO₂
NO₂
Most hydrocarbons
Most particulates

Secondary air pollutants

HNO₂ SO₃
HNO₃ H₂SO₄
H₂O₂ O₃ PANs
Most NO₃⁻ and SO₄²⁻
salts



Major Classes of Air Pollutants

- o Particulate Material
 - o Nitrogen Oxides
 - o Sulfur Oxides
 - o Carbon Oxides
 - o Hydrocarbons
 - o Ozone
- 
- A stylized, dark teal silhouette of a mountain range is positioned in the bottom right corner of the slide, adding a decorative element to the background.

Particulate Material

- Thousands of different solid or liquid particles suspended in air
 - Includes: soil particles, soot, lead, asbestos, sea salt, and sulfuric acid droplets
- Dangerous for 2 reasons
 - May contain materials with toxic or carcinogenic effects
 - Extremely small particles can become lodged in lungs

Nitrogen and Sulfur Oxides

o Nitrogen Oxides

- Gases produced by the chemical interactions between atmospheric nitrogen and oxygen at high temperature
- Problems
 - Greenhouse gases
 - Cause difficulty breathing

o Sulfur Oxides


- Gases produced by the chemical interactions between sulfur and oxygen
- Causes acid precipitation

Carbon Oxides and Hydrocarbons

- o Carbon Oxides

- Gases carbon monoxide (CO) and carbon dioxide (CO₂)
- Greenhouse gases

- o Hydrocarbons

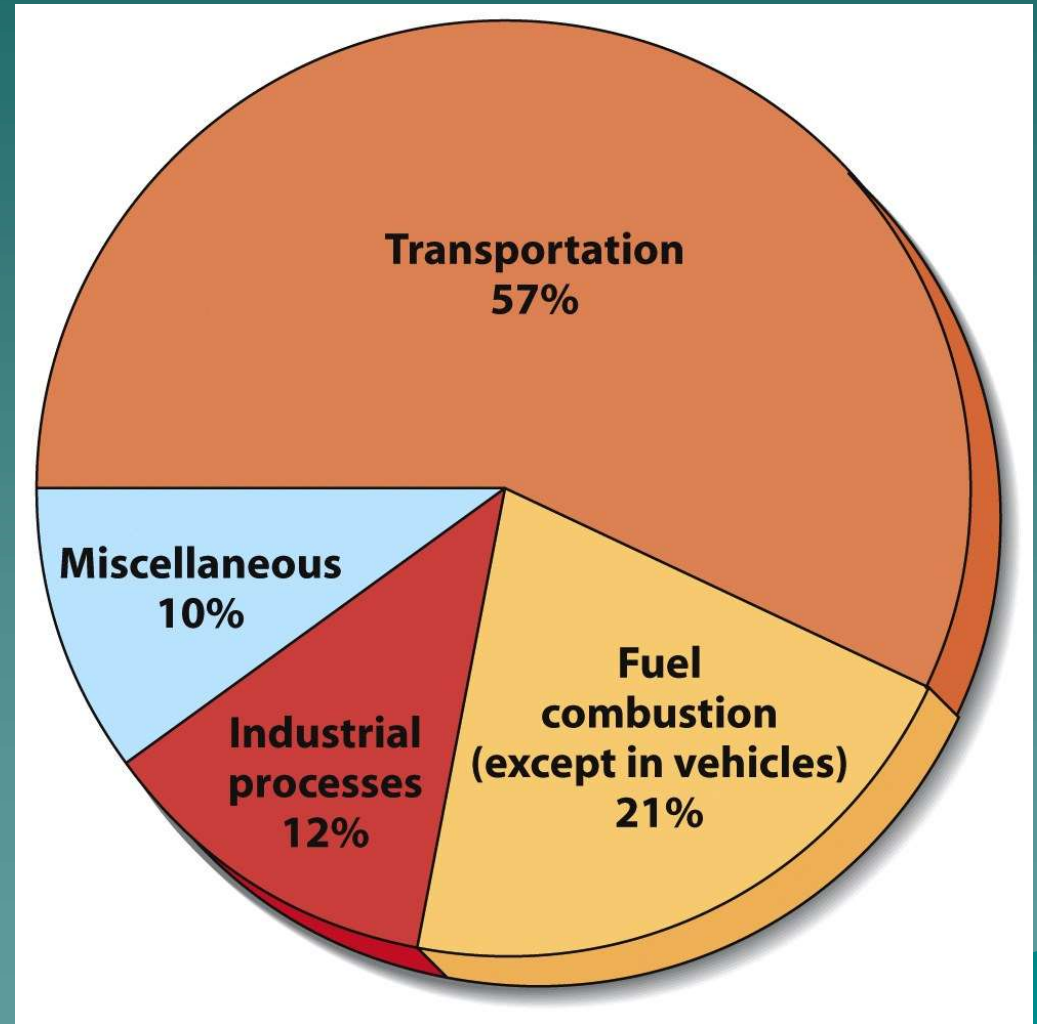
- Diverse group of organic compounds that contain only hydrogen and carbon (ex: CH₄-methane)
 - Some are related to photochemical smog and greenhouse gases
- 
- A stylized, layered mountain range graphic in shades of teal and blue, located in the bottom right corner of the slide.

Ozone

- o Tropospheric Ozone
 - Man- made pollutant in the lower atmosphere
 - Secondary air pollutant
 - Component of photochemical smog
- o Stratospheric Ozone
 - Essential component that screens out UV radiation in the upper atmosphere
 - Man- made pollutants (ex: CFCs) can destroy it

Sources of Outdoor Air Pollution

- Two main sources
 - Transportation
 - Industry
- Intentional forest fires is also high

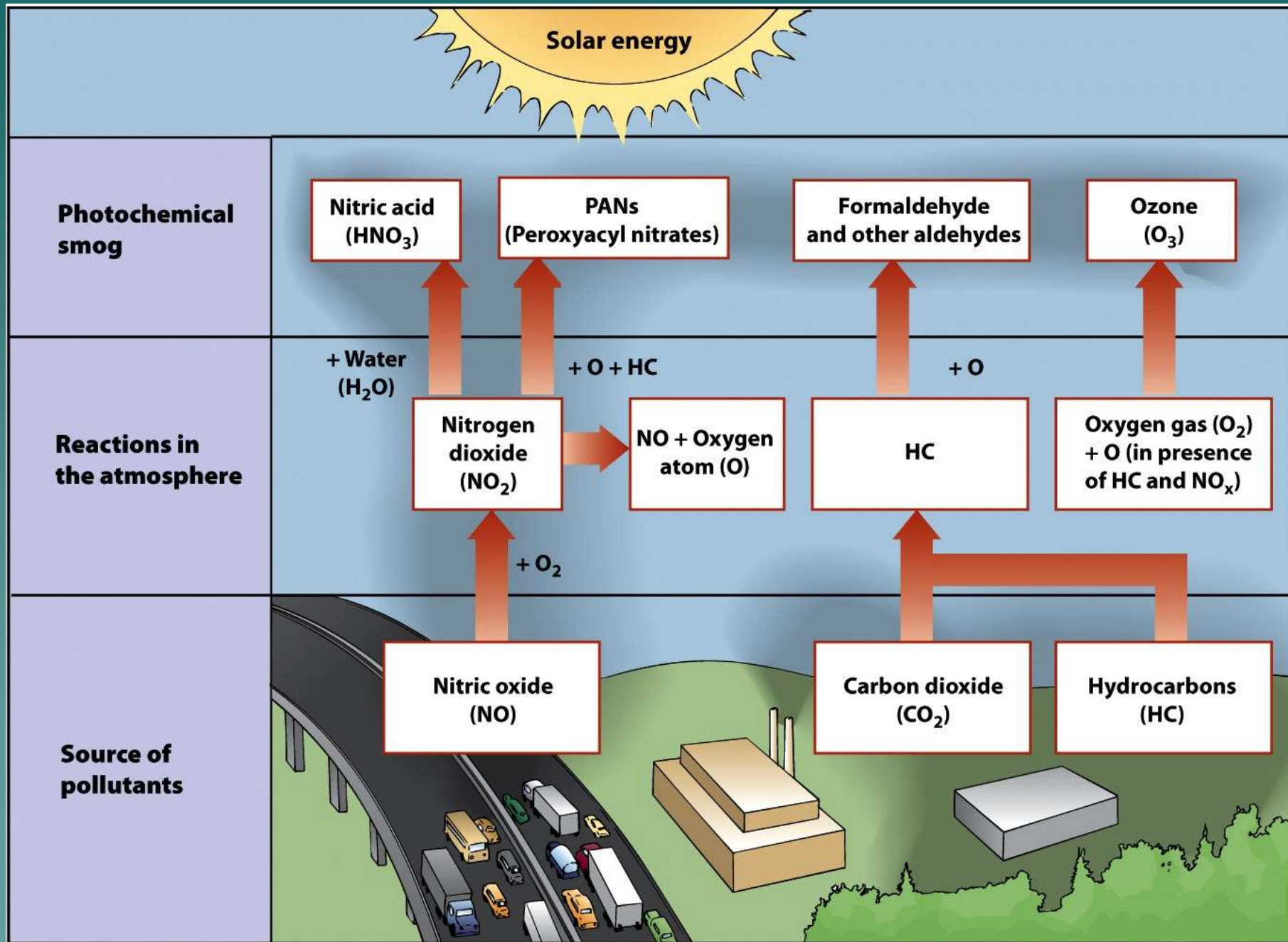


Urban Air Pollution

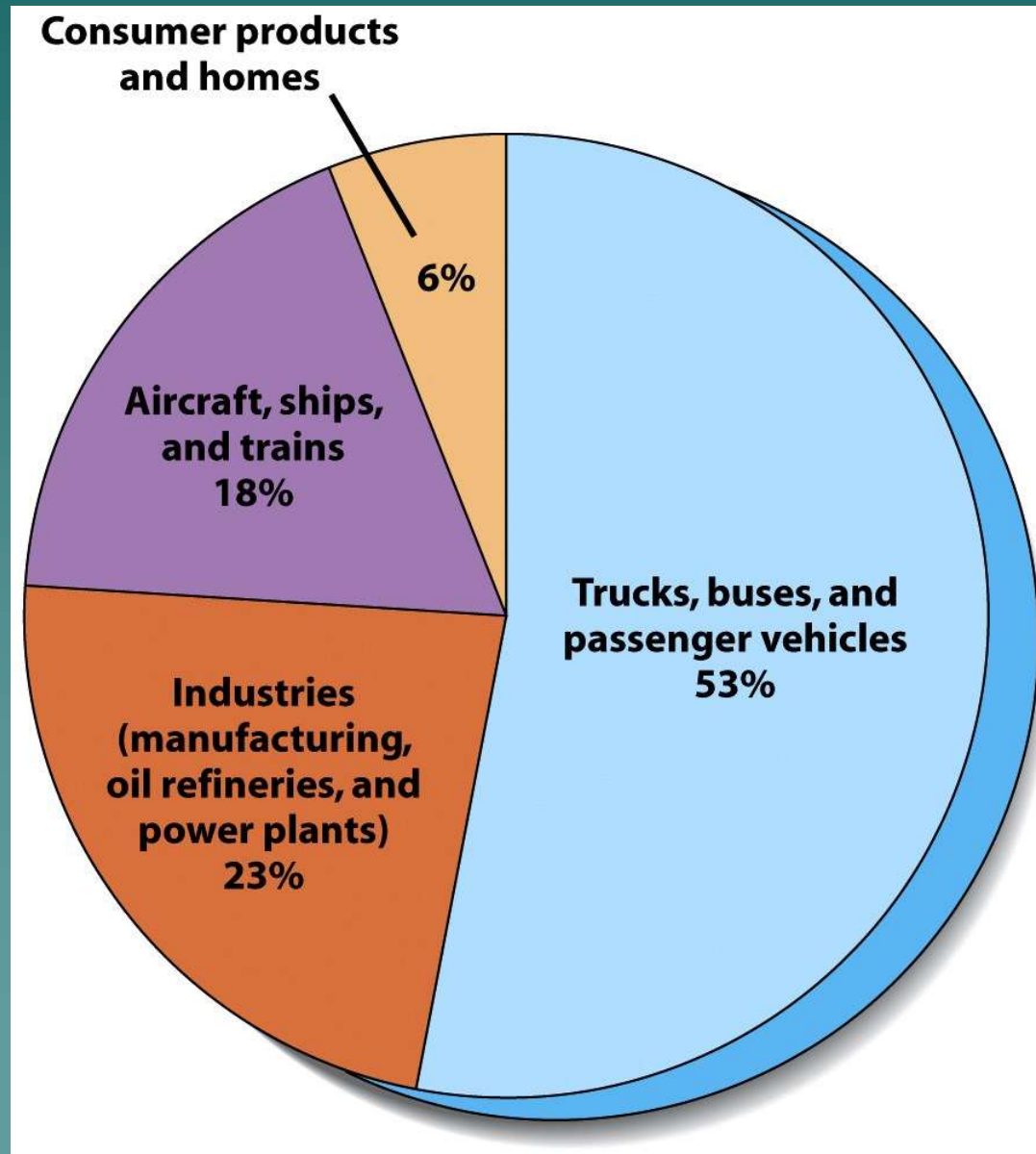
- Photochemical Smog (ex: Los Angeles below)
 - Brownish-orange haze formed by chemical reactions involving sunlight, nitrogen oxide, and hydrocarbons



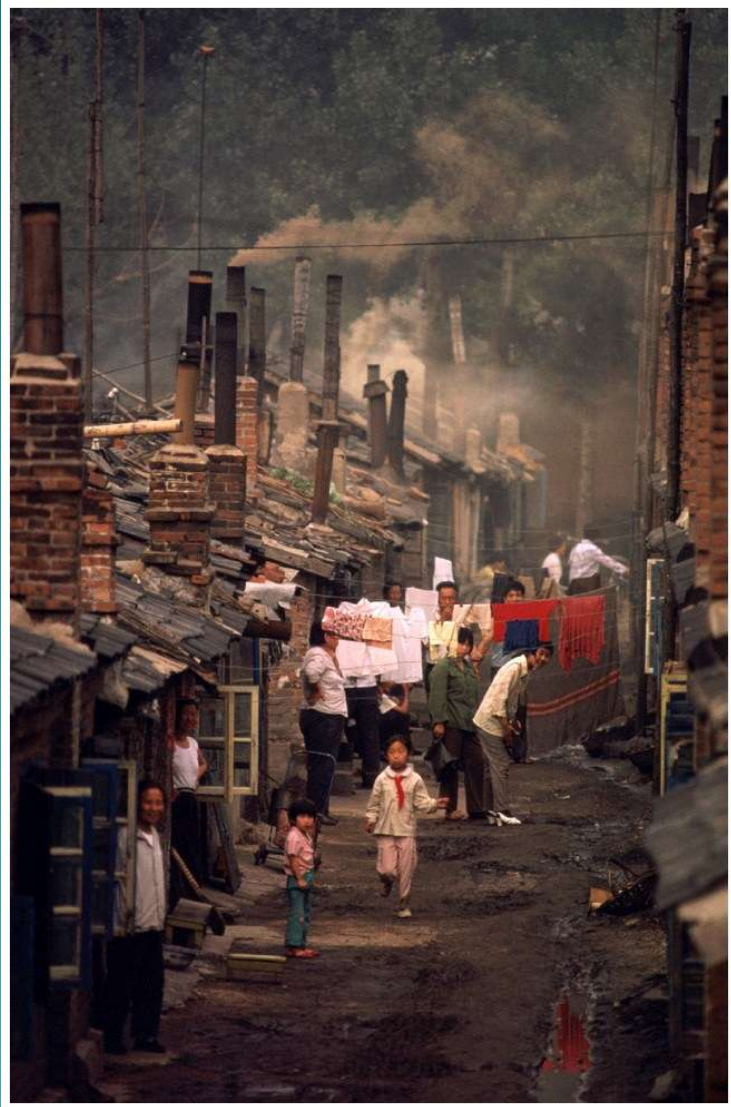
Formation of Photochemical Smog



Sources of Smog in Los Angeles



Case-In-Point Air Pollution in Beijing and Mexico City



- Beijing (left)
- Mexico City (above)


Effects of Air Pollution

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

Table 20.2 Health Effects of Several Major Air Pollutants

<i>Pollutant</i>	<i>Source</i>	<i>Effects</i>
Particulate	Industries, electric power plants, motor vehicles, construction, agriculture	Aggravates respiratory illnesses; long-term exposure may cause increased incidence of chronic conditions such as bronchitis; linked to heart disease; suppresses immune system; some particles, such as heavy metals and organic chemicals, may cause cancer or other tissue damage
Nitrogen oxides	Motor vehicles, industries, heavily fertilized farmland	Irritate respiratory tract; aggravate respiratory conditions such as asthma and chronic bronchitis
Sulfur oxides	Electric power plants and other industries	Irritate respiratory tract; same effects as particulates
Carbon monoxide	Motor vehicles, industries, fireplaces	Reduces blood's ability to transport oxygen; headache and fatigue at lower levels; mental impairment or death at high levels
Ozone	Formed in atmosphere (secondary air pollutant)	Irritates eyes; irritates respiratory tract; produces chest discomfort; aggravates respiratory conditions such as asthma and chronic bronchitis

Health Effects of Air Pollution

- o Sulfur Dioxide and Particulate material
 - Irritate respiratory tract and impair ability of lungs to exchange gases
 - o Nitrogen Dioxides
 - Causes airway restriction
 - o Carbon monoxide
 - Binds with iron in blood hemoglobin
 - Causes headache, fatigue, drowsiness, death
 - o Ozone
 - Causes burning eyes, coughing, and chest discomfort
- 
- A stylized, dark teal silhouette of a mountain range is positioned in the bottom right corner of the slide, partially overlapping the text area.

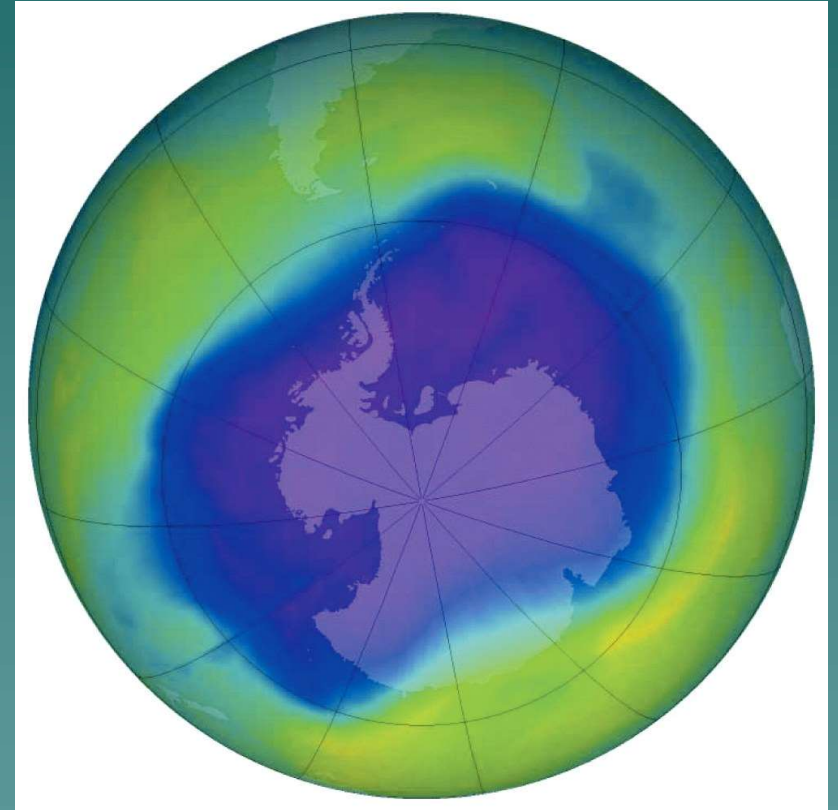
Children and Air Pollution

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



Ozone Depletion in Stratosphere

- Ozone thinning/hole
 - First identified in 1985 over Antarctica
- Caused by
 - human-produced bromine and chlorine containing chemicals
 - Ex: CFCs



Ozone Depletion in Stratosphere

- Hole over Antarctica requires two conditions:
 - Sunlight just returning to polar region
 - Circumpolar vortex- a mass of cold air that circulates around the southern polar region
 - Isolates it from the warmer air in the rest of the planet
- Polar stratospheric clouds form
 - Enables Cl and Br to destroy ozone

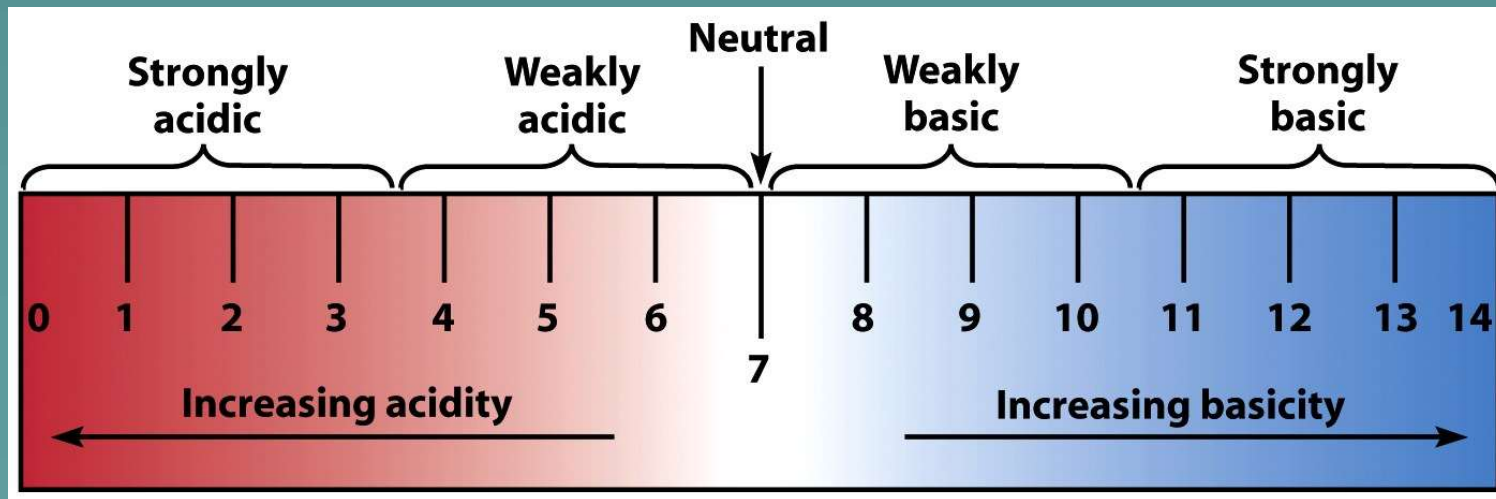
Effects of Ozone Depletion

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

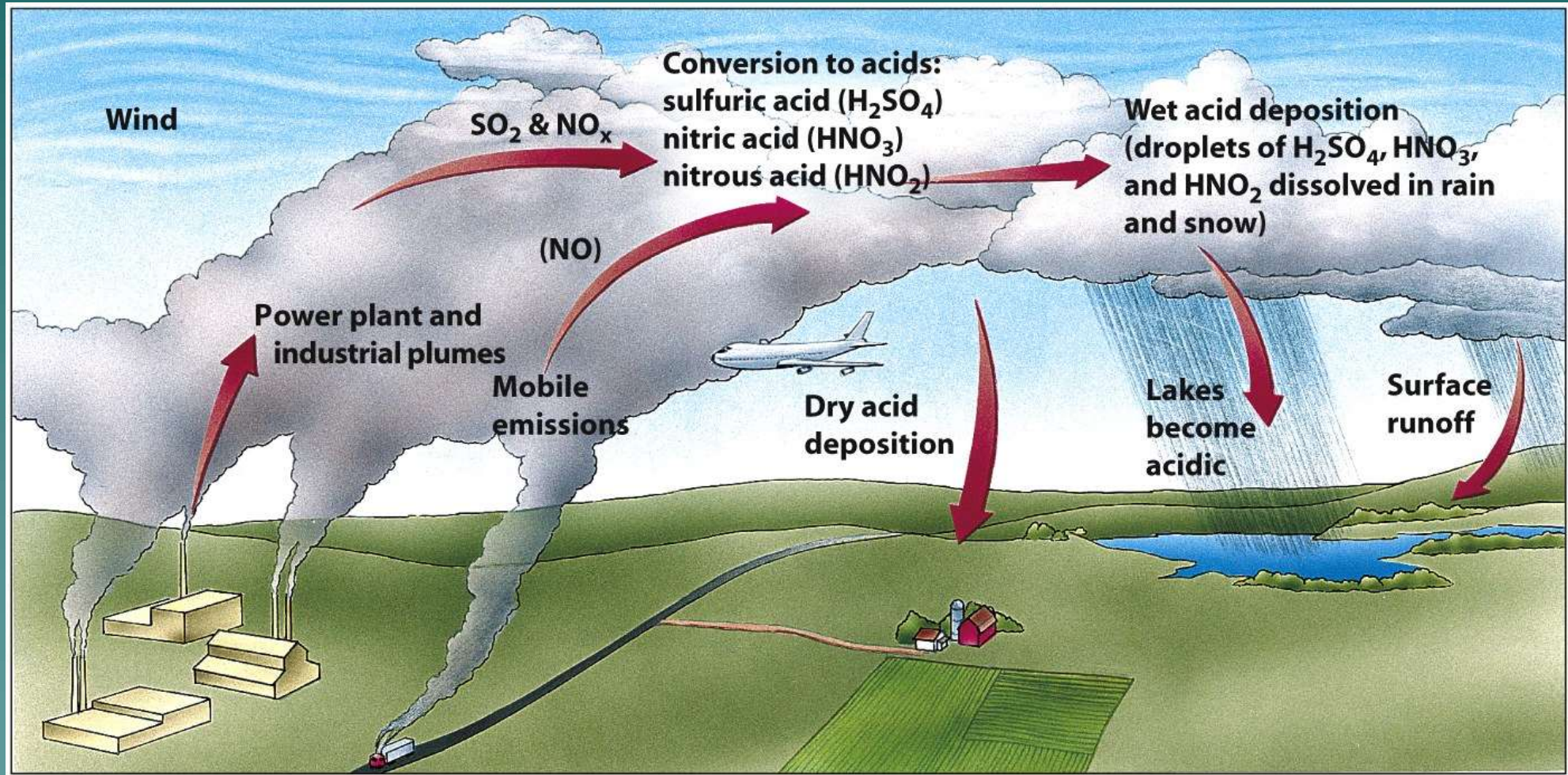


Acid Deposition

- o Sulfur dioxide and nitrogen dioxide emissions react with water vapor in the atmosphere and form acids that return to the surface as either dry or wet deposition
- o pH scale



How Acid Deposition Develops

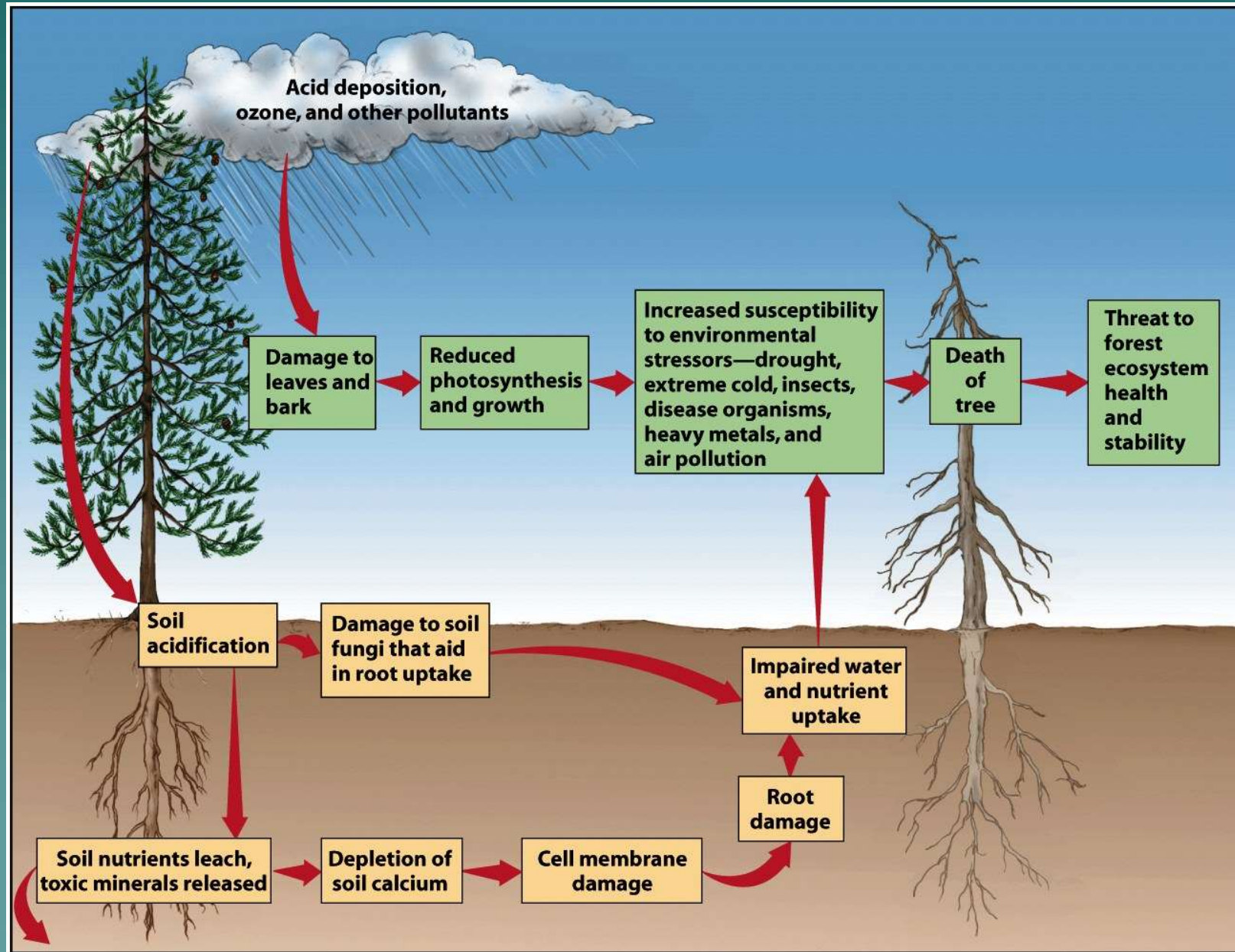


Effects of Acid Deposition

- 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

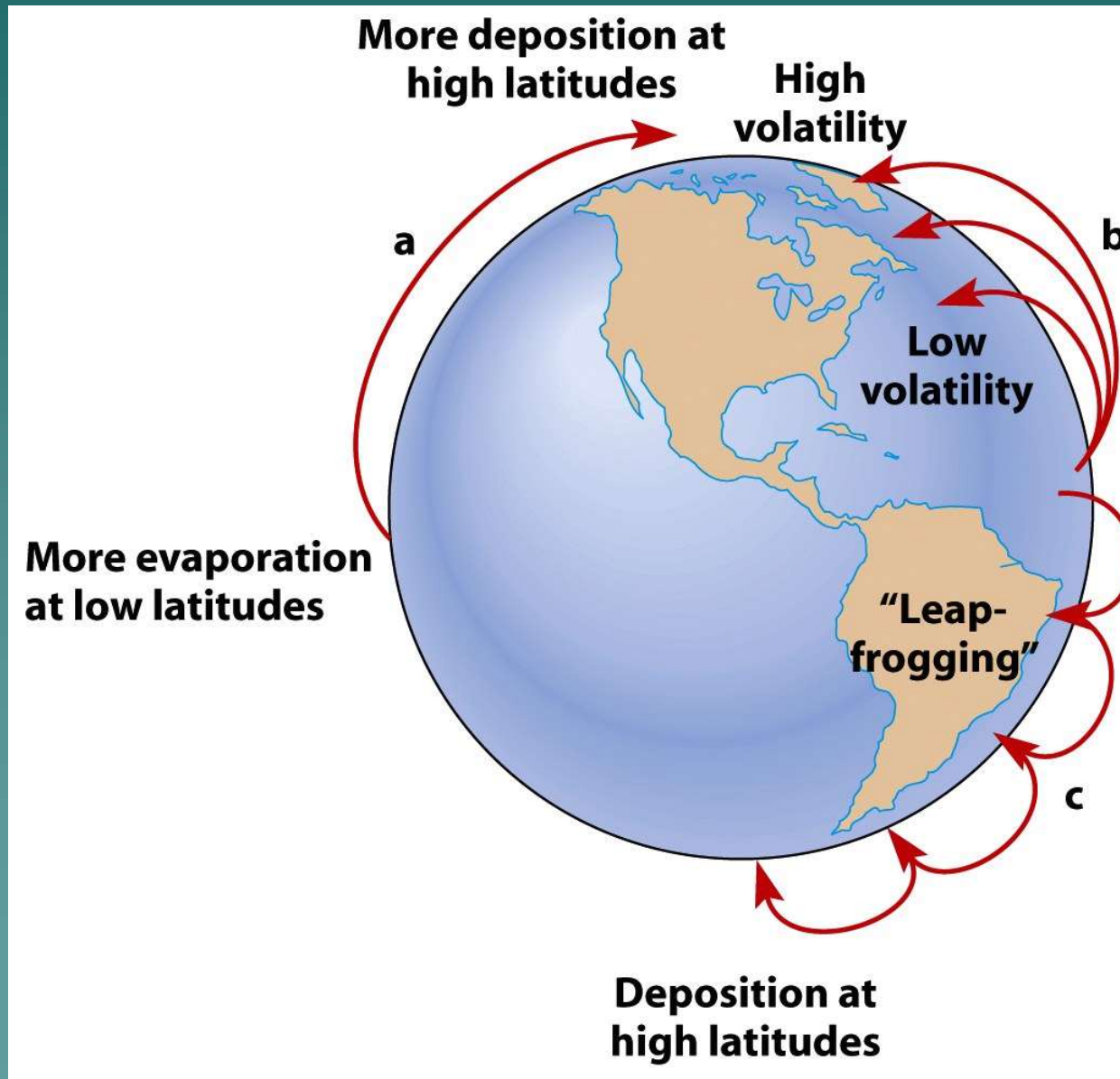


Air Pollution Around the World



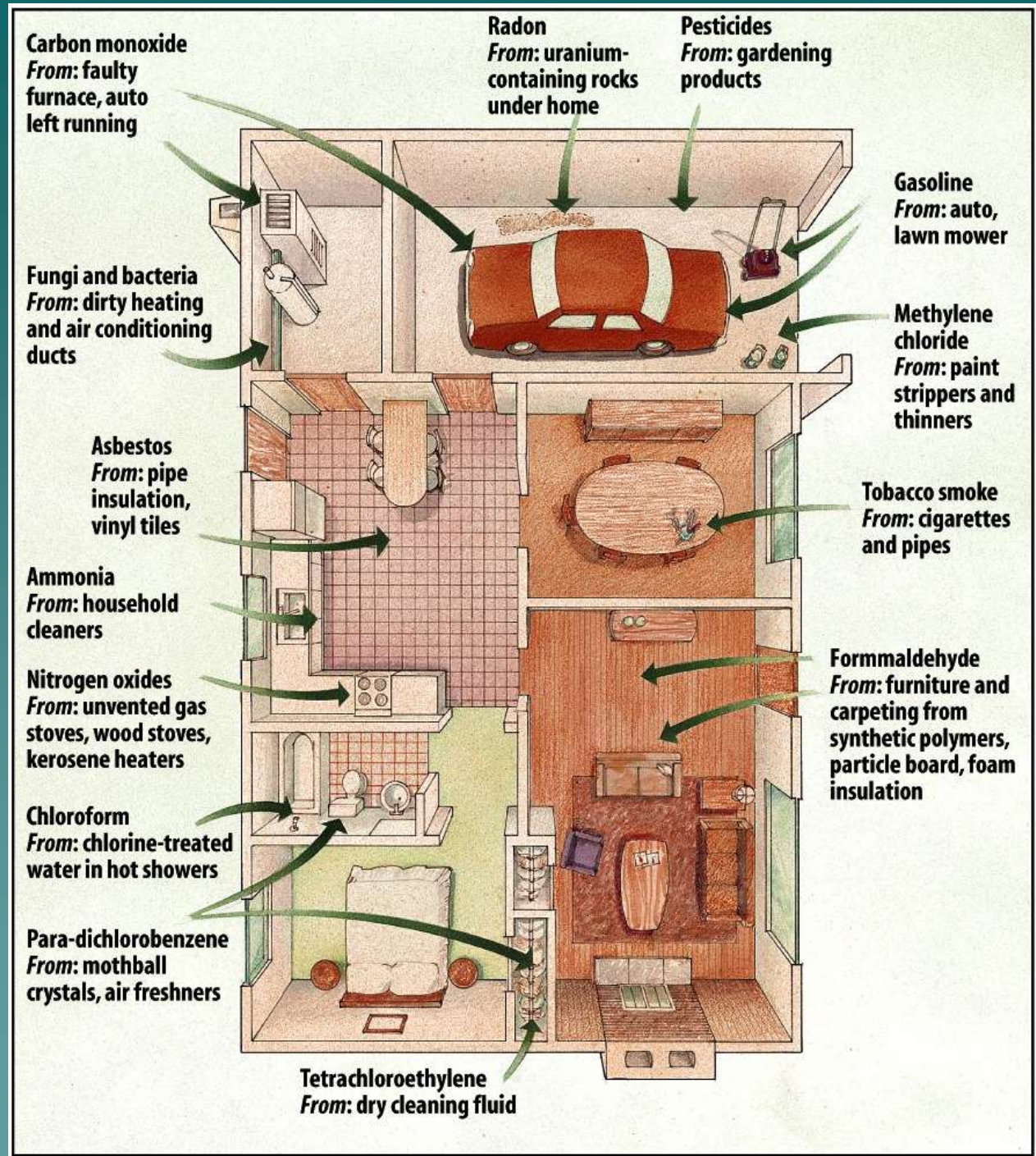
- Air quality is deteriorating rapidly in developing countries
- Shenyang, China
 - Residents only see sunlight a few weeks each year
- Developing countries have older cars
 - Still use leaded gasoline
- 5 worst cities in world
 - Beijing, China; Mexico City, Mexico; Shanghai, China; Tehran, Iran; and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

Long Distance Transport of Air Pollutants



Indoor Air Pollution

- Pollutants can be 5-100X greater than outdoors
- Most common:
 - Radon, cigarette smoke, carbon monoxide, nitrogen dioxide, formaldehyde, pesticides, lead, cleaning solvents, ozone, and asbestos



Indoor Air Pollution - Radon

