



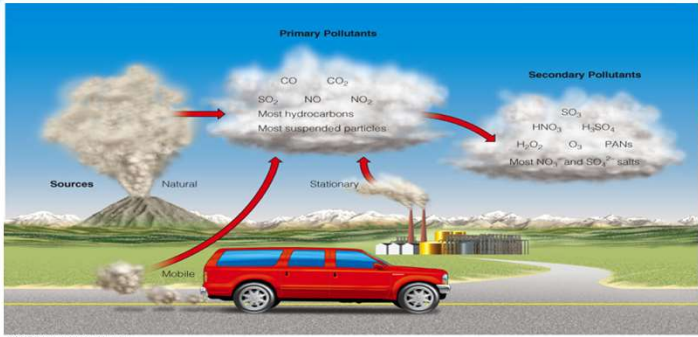
Primary Pollutants

- Pollutants put directly into the air
- Causes of Primary Pollutants – factories, cars, wind and soil, volcanoes, forest fires, pollen, decaying plants, salt particles from the sea, and refrigerants.

2008 Primary Air Pollutants:
Emissions By Type
Does not include TPM or CO emissions from International (non-Canadian) operations.

| Pollutant Type | Percentage |
|---------------------------------------|------------|
| Sulphur dioxide (SO ₂) | 1.3% |
| Oxides of Nitrogen (NO _x) | 26.3% |
| Volatile organic compounds (VOCs) | 17.5% |
| Carbon monoxide (CO) | 22.9% |
| Total particulate matter (TPM) | 32.0% |

AIR POLLUTION




The diagram illustrates the process of air pollution. On the left, a hand holds a globe. In the center, a landscape shows three sources of pollution: a volcano (Natural), a red SUV (Mobile), and a factory (Stationary). Red arrows point from these sources to a cloud labeled 'Primary Pollutants'. This cloud lists: CO, CO₂, SO₂, NO, NO₂, Most hydrocarbons, and Most suspended particles. Another red arrow points from the primary pollutants cloud to a second cloud labeled 'Secondary Pollutants'. This cloud lists: SO₃, HNO₃, H₂SO₄, H₂O₂, O₃, PANs, and Most NO₃⁻ and SO₄²⁻ salts. A small copyright notice '© 2007 Thomson Higher Education' is visible at the bottom left of the diagram.

Figure 19-3

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


Major Primary Pollutants: CO₂





The image shows a circular, silver carbon monoxide alarm with the text 'CARBON MONOXIDE ALARM' and a small red indicator light.

- Carbon oxides:**
 - Carbon monoxide (CO) is a highly toxic gas that forms during the incomplete combustion of carbon-containing materials.
 - 93% of carbon dioxide (CO₂) in the troposphere occurs as a result of the **carbon cycle**.
 - 7%** of CO₂ in the troposphere occurs as a result of human activities (**mostly burning fossil fuels**).
 - It is not regulated as a pollutant under the U.S. Clean Air Act.

Major Primary Pollutants: NO_x



- **Nitrogen oxides**
 - Nitrogen oxide (NO_x) forms when nitrogen and oxygen gas in air react at the high-combustion temperatures in automobile engines and coal-burning plants. NO_x can also form from lightning and certain soil bacteria.

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Major Primary Pollutants: SO_2




- **Sulfur dioxide (SO_2):**
 - About one-third of SO_2 in the troposphere occurs naturally through the sulfur cycle.
 - Two-thirds come from human sources, mostly combustion ($\text{S} + \text{O}_2 \rightarrow \text{SO}_2$) of sulfur-containing coal and from oil refining and smelting of sulfide ores.





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Major Primary Pollutants: SPM




- **Suspended particulate matter (SPM):**
 - Consists of a variety of solid particles and liquid droplets small and light enough to remain suspended in the air.
 - The most harmful forms of SPM are fine particles (**PM-10**, with an average diameter < 10 micrometers) and ultrafine particles (**PM-2.5**).
 - According to the EPA, SPM is responsible for about 60,000 premature deaths a year in the U.S.

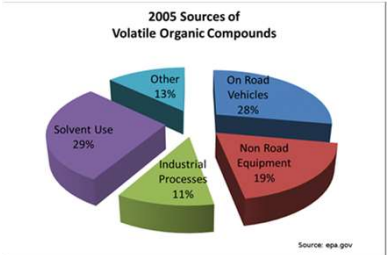


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Major Primary Pollutants: VOCs



- **Volatile organic compounds (VOCs):**
 - Most are hydrocarbons emitted by the leaves of many plants and methane.
 - About two thirds of global methane emissions comes from human sources.
 - Other VOCs include industrial solvents such as trichlorethylene (TCE), benzene, and vinyl chloride.
 - Long-term exposure to benzene can cause **cancer, blood disorders, and immune system damage.**



| Source | Percentage |
|----------------------|------------|
| Solvent Use | 29% |
| On Road Vehicles | 28% |
| Non Road Equipment | 19% |
| Industrial Processes | 11% |
| Other | 13% |

Source: epa.gov

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Major Primary Pollutants: Rn

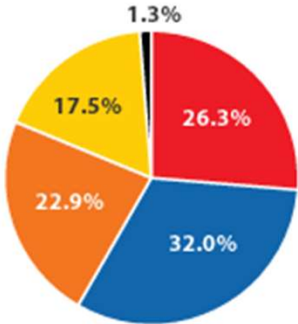
- **Radon (Rn):**
 - Is a **naturally** occurring radioactive gas found in some types of soil and rock.
 - It can seep into homes (**basements**) and buildings sitting above such deposits.



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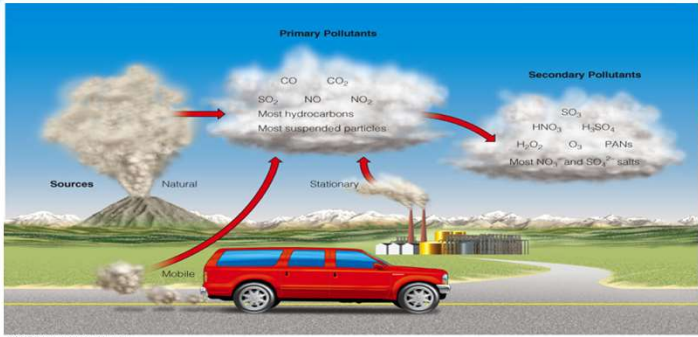
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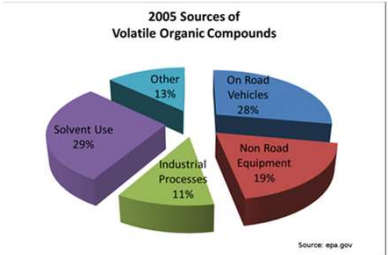


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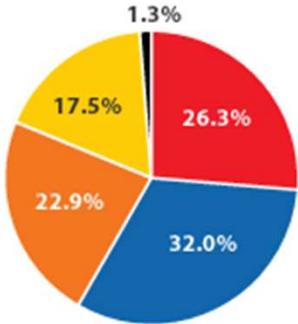
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