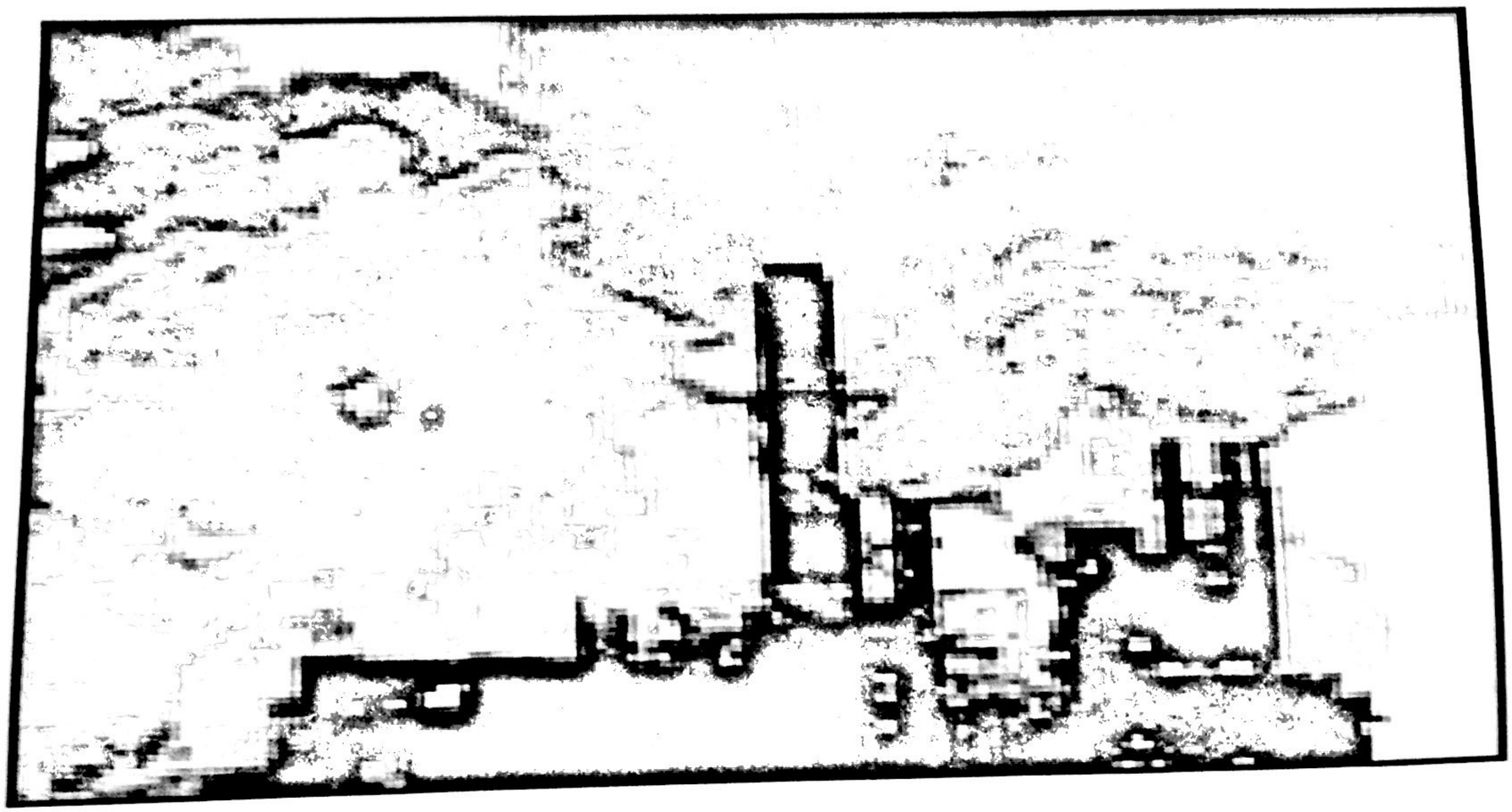
Air pollution

Introduction

- Unlimited and free access to clean air of acceptable quality is a fundamental human necessity and right.
- The lung is a critical interface between the environment and the human body.
- An average person takes about 10 million breaths a year, and toxic substances in air can easily reach the lung and other organs where they can produce harmful effects.

- Clean air is considered to be a basic requirement of human health and well-being. However, air pollution continues to pose a significant threat to health worldwide.
- According to a WHO assessment of the burden of disease due to air pollution, more than 2 million premature deaths each year can be attributed to the effects of urban outdoor air pollution and indoor air pollution
- More than half of this disease burden is borne by the populations of developing countries .

- There are an estimated 85,000 chemicals commonly used in modern industrial and nonindustrial applications,
- Many of them are airborne toxicants.



DEFINING AIR POLLUTION

- *Air pollution:*

  The presence of contaminants or pollutant substances in the air that interfere with human health or welfare, or produce other harmful environmental effects

  (United States Environmental Protection Agency, 2007)

- **Air pollutants are airborne particles and gasses that occur in concentrations that endanger the heath and well-being of organisms or disrupt the orderly functioning of the environment.**

Air Pollution is a Big Killer

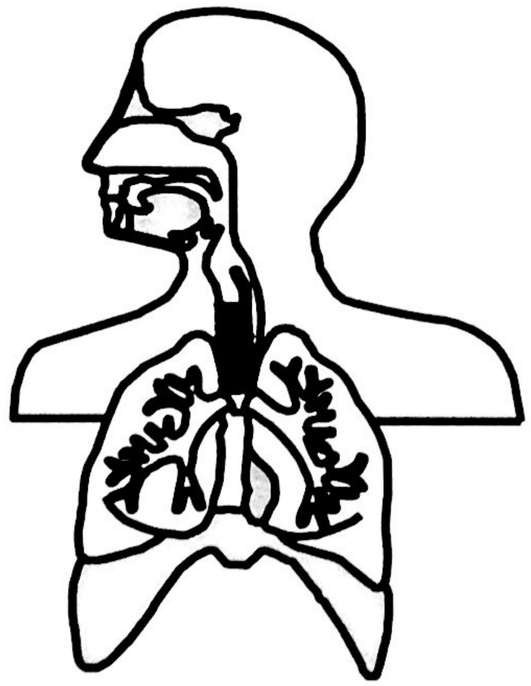
- Each year, air pollution prematurely kills about 3 million people, mostly from indoor air pollution in developing countries.
  - In the U.S., the EPA estimates that annual deaths related to indoor and outdoor air pollution range from 150,000 to 350,000.
  - According to the EPA, each year more than 125,000 Americans get cancer from breathing diesel fumes.

Impacts of Air Pollution

Acid Rain

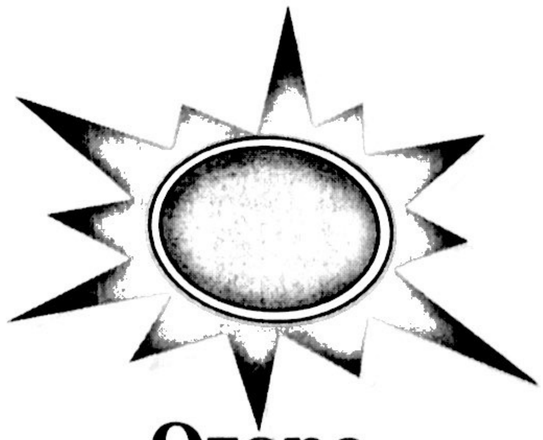
Visibility and Ecosystem

Water Quality

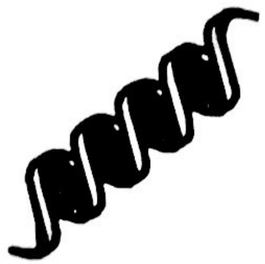


Human Health

Climate Change



Ozone Depletion



Air Toxics

AIR POLLUTION AND THE INDUSTRIAL REVOLUTION

- During most of the nineteenth century, coal was the principal fuel, although some oil was used for steam generation late in the century.
- The predominant air pollution problem of the nineteenth century was smoke and ash from the burning of coal or oil in the boiler furnaces of stationary power plants, and in home heating fireplaces and furnaces.
- Smoke and ash abatement in Great Britain was considered to be a health agency responsibility and was confirmed by the first Public Health Act of 1848 and the later ones of 1866 and 1875.

- During this period, the most significant change was the rapid increase in the number of automobiles from almost none at the turn of the century to millions by 1925

Annual Motor Vehicle Sales in the United States[a]

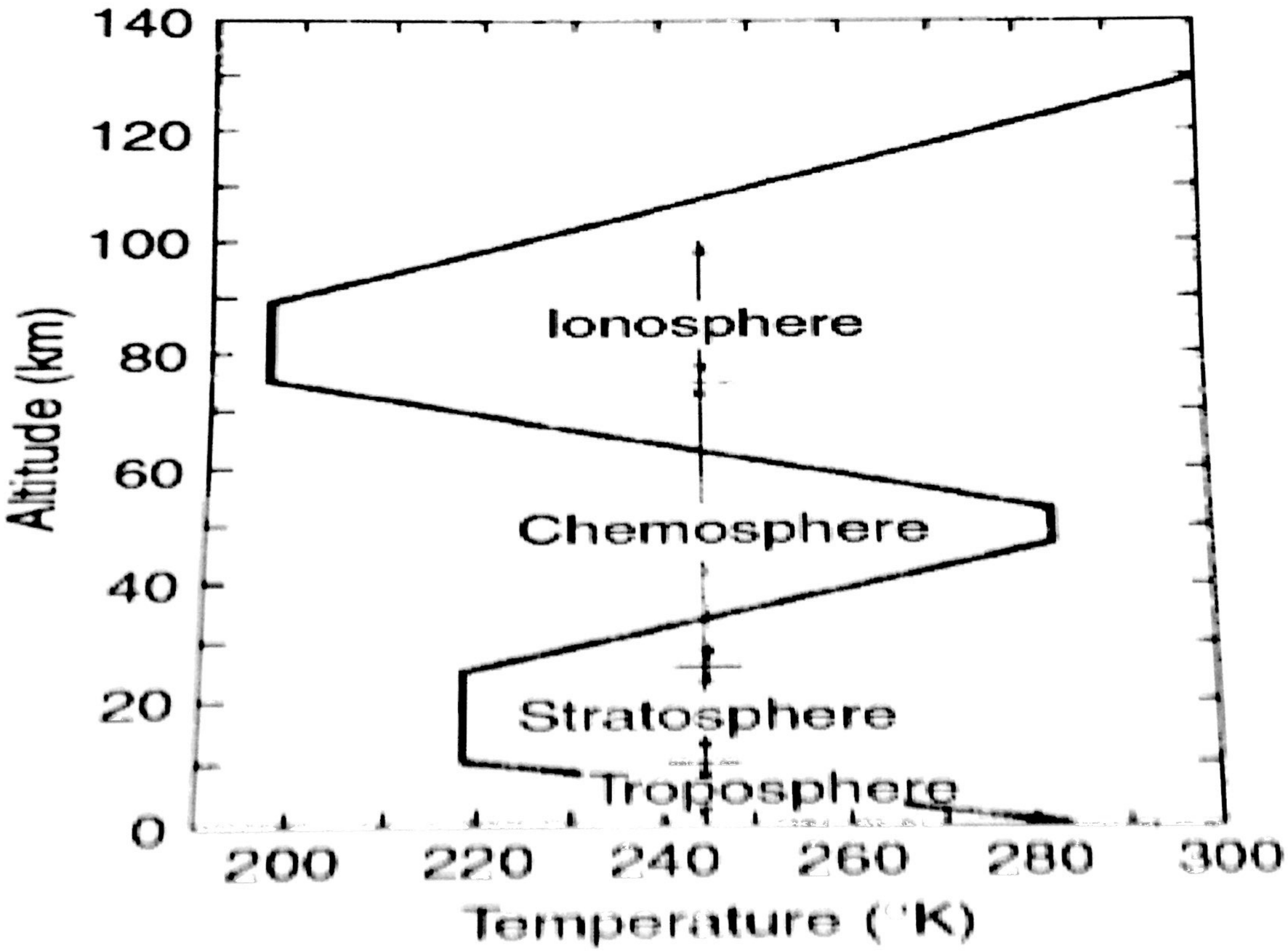
Year	Total	Year	Total
1900	4192	1945	725 215
1905	25 000	1950	8 003 056
1910	187 000	1955	9 169 292
1915	969 930	1960	7 869 221
1920	2 227 347	1965	11 057 366
1925	4 265 830	1970	8 239 257
1930	3 362 820	1975	8 985 012
1935	3 971 241	1980	8 067 309
1940	4 472 286	1985	11 045 784
		1990	9 295 732

[a] Data include foreign and domestic sales for trucks, buses, and automobiles.

1925-1950

- A major technological change was the building of natural gas pipelines, and where this occurred, there was rapid displacement of coal and oil as home heating fuels with dramatic improvement in air quality; witness the much publicized decrease in black smoke .
- During this period, no significant national air pollution legislation or regulations were adopted anywhere in the world. However, the first state air pollution law in the United States was adopted by California in 1947.

The regions of the atmosphere.



- The **ionosphere** and **chemosphere** are of interest to, air pollution scientists primarily because of their absorption and scattering of solar energy, which influence the amount and spectral distribution of solar energy and cosmic rays reaching the stratosphere and troposphere.

- The **stratosphere** is of interest to air pollution scientists because global transport of pollution, particularly the debris of aboveground atomic bomb tests and volcanic eruptions, occurs in this region and because absorption and scattering of solar energy also occur there.

- The lower portion of this region contains the stratospheric ozone layer, which absorbs harmful ultraviolet (UV) solar radiation. Global change scientists are interested in modifications of this layer by long-term accumulation of chlorofluorocarbons (CFCs) and other gases released at the earth's surface or by high-altitude aircraft.

Composition of unpolluted tropospheric air

The Gaseous Composition of Unpolluted Air (Dry Basis)

	ppm (vol.)	$\mu g\, m^{-3}$
Nitrogen	780 000	8.95×10^8
Oxygen	209 400	2.74×10^8
Water	—	—
Argon	9300	1.52×10^7
Carbon dioxide	315	5.67×10^5
Neon	18	1.49×10^4
Helium	5.2	8.50×10^2
Methane	1.0–1.2	$6.56–7.87 \times 10^2$
Krypton	1.0	3.43×10^3
Nitrous oxide	0.5	9.00×10^2
Hydrogen	0.5	4.13×10^1
Xenon	0.08	4.29×10^2
Organic vapors	*ca.* 0.02	—

- The real atmosphere is more than a dry mixture of permanent gases. It has other **constituents—vapor of both water and organic liquids**, and **particulate matter (PM)** held in suspension.

Natural Sources:

- **volcano** emits particulate matter. Pollutant gases such as SO_2, H_2S, and methane are also emitted.
- **Accidental fires in forests**. emits large quantities of pollutants in the form of smoke, unburned hydrocarbons, carbon monoxide, carbon dioxide, oxides of nitrogen, and ash.
- **Dust storms** entrain large amounts of particulate matter result mainly in visibility reduction.
- **The oceans** of the world are an important natural source of pollutant material. It continually emitting aerosols to the atmosphere, in the form of salt particles, which are corrosive to metals and paints.
- **The trees** and other plant life are the major source of hydrocarbons on the planet.

Anthropogenic (human made)
Industrial Sources

- Industrial sources are stationary, and each emits relatively consistent qualities and quantities of pollutants.
- A great deal of industrial pollution comes from manufacturing products from raw materials

Personal Sources

The energy release and air pollution emissions from personal sources in the United States are greater than those from industry

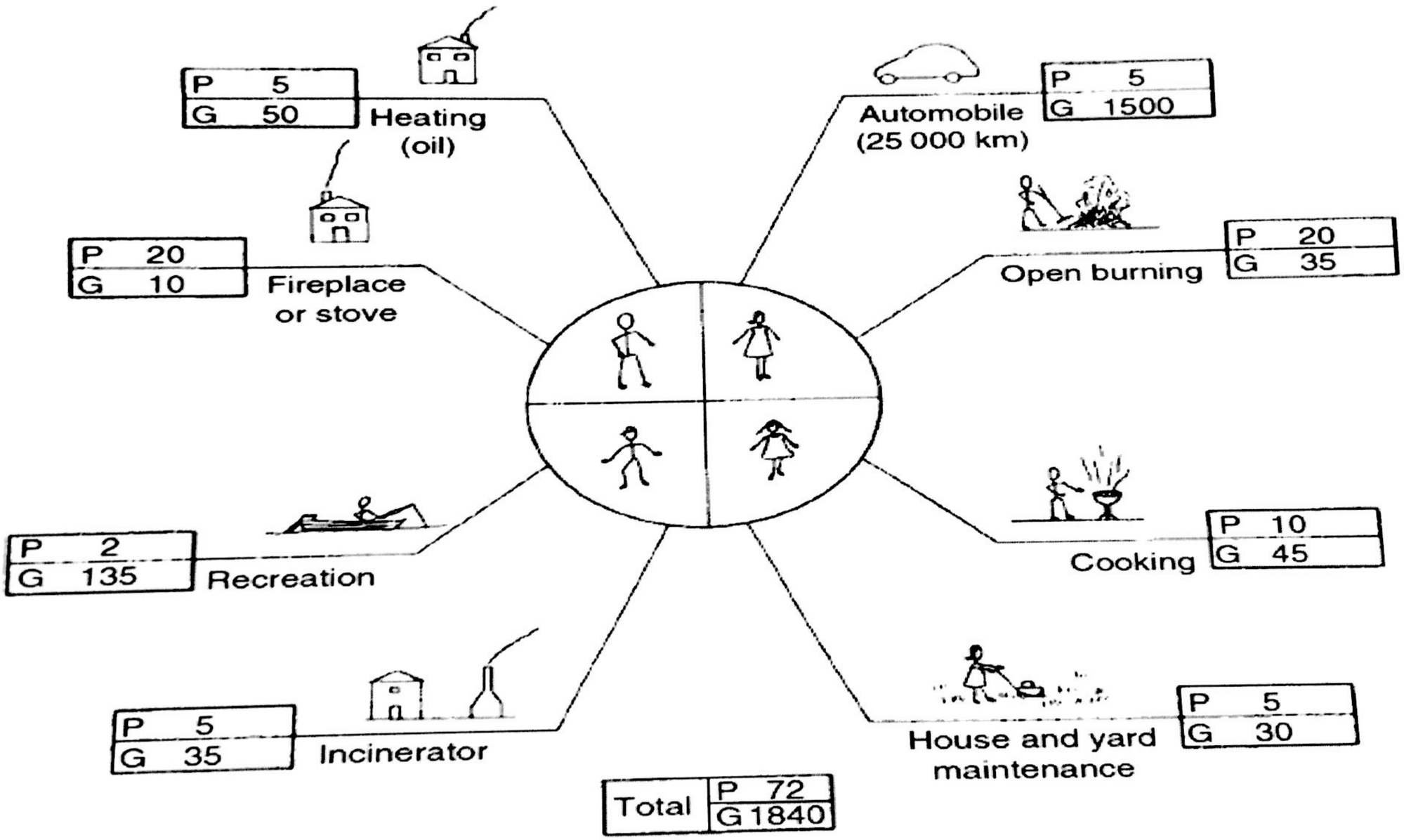


Fig. 10.4. Estimated personal emissions from US family of four persons. P, particulate matter in kilograms per year; G, gases in kilograms per year.

Classification of Air pollutants

- Pollutants can be grouped into two categories:

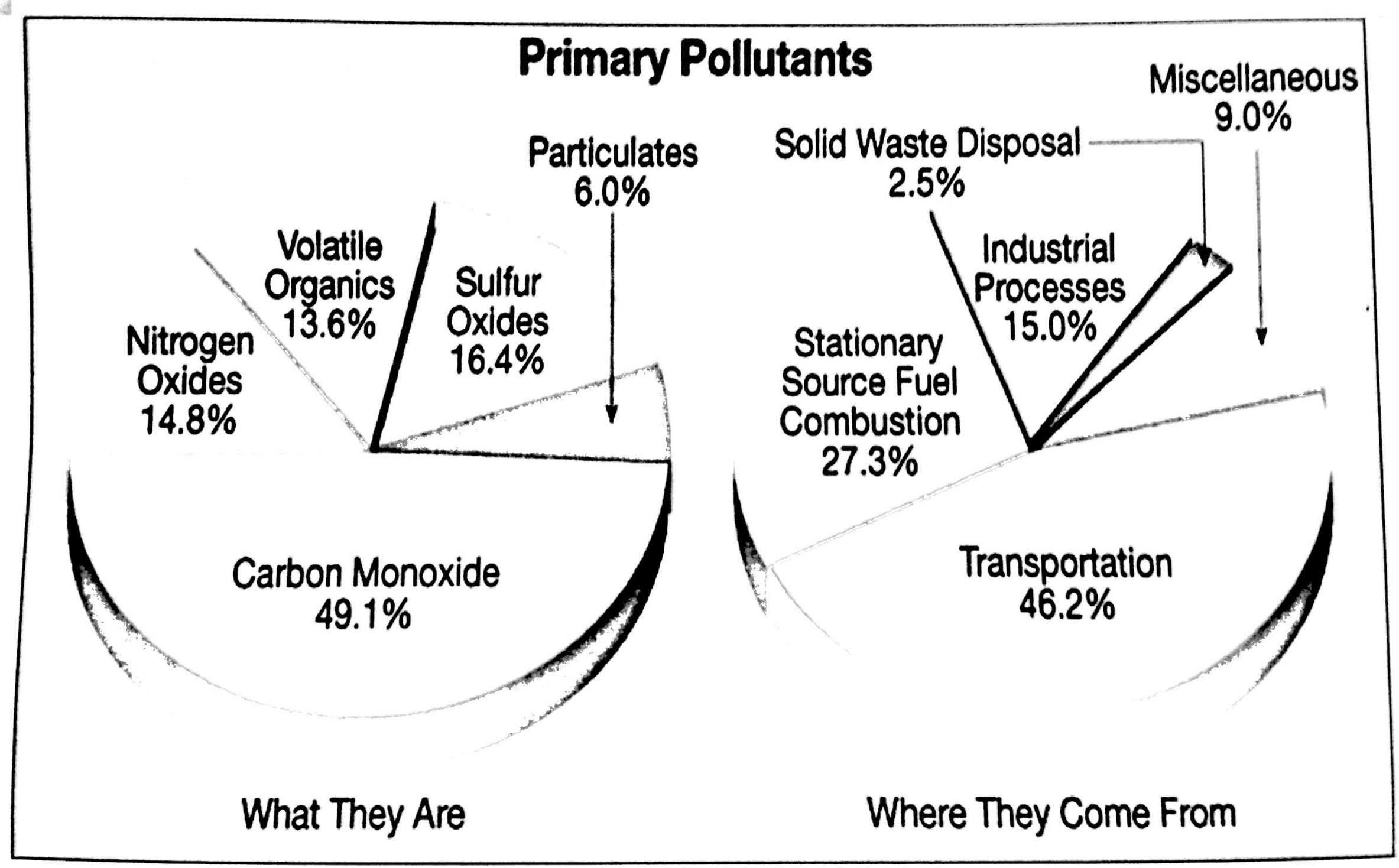
(1) **primary pollutants, which are emitted directly from ,** identifiable sources,

(2) **secondary pollutants, which are produced in the ,** atmosphere when certain chemical reactions take place among primary pollutants.

Primary air pollutants

Primary air pollutants are those that are emitted into the atmosphere from a source such as a factory chimney or exhaust pipe, or through suspension of contaminated dusts by the wind.
Account for most problems:

- Primary air pollutants include:
  - Carbon monoxide (58%)
  - Nitrogen oxides (15%)
  - Sulfur oxides (13%)
  - Volatile organic compounds VOCs (11%)
  - Particulates (3%)


Primary Pollutants
Particulates 6.0%
Volatile Organics 13.6%
Sulfur Oxides 16.4%
Nitrogen Oxides 14.8%
Carbon Monoxide 49.1%
What They Are
Solid Waste Disposal 2.5%
Miscellaneous 9.0%
Industrial Processes 15.0%
Stationary Source Fuel Combustion 27.3%
Transportation 46.2%
Where They Come From

1.Sulfur dioxide:

- the main source of sulfur dioxide is the combustion of fuels containing sulfur.
- Fossil fuels, most notably coal and oil, contain varying amounts of sulfur according to their source but typically between 1% and 5%. On combustion, the sulfur in the fuel is converted almost quantitatively to sulfur dioxide.
- Nowadays in developed countries, much of the sulfur is removed from motor fuels in the refining process prior to emission.
- In less developed countries, however, unabated burning of coal and the use of fuel oils and automotive diesel with a higher sulfur content are major sources of sulfur dioxide.

2. Oxides of nitrogen

- Nitrogen in fuels is converted to oxides of nitrogen in the combustion process.
- there is a further process in which atmospheric nitrogen and oxygen are combined during high-temperature combustion to form oxides of nitrogen.

3.Carbon monoxide

- Colorless, Odorless, and extremely toxic
- CO gets locked on hemoglobin in blood 250 x faster than O2, leading to hypoxia.
- formed during the incomplete combustion of carbon-containing fuels.
- Complete combustion leads to the formation of carbon dioxide, most combustion systems involve some fuel-rich regions in which a proportion of carbon is oxidized only to carbon monoxide.