

# Introduction to Air Pollution & Climate Change

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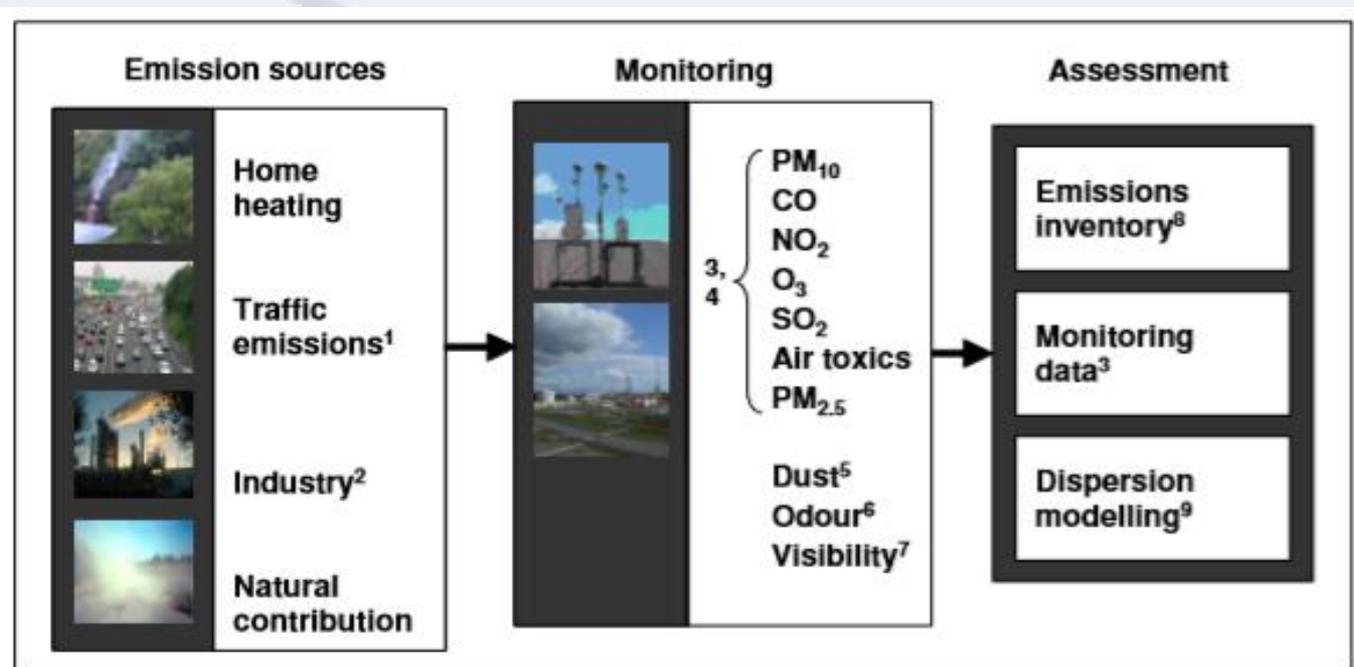
# What is Ambient Air Quality?

- ❖ Physical and chemical measure of pollutant concentrations in the ambient atmosphere to which the general population is exposed to.
- ❖ Condition or state of air we breathe.



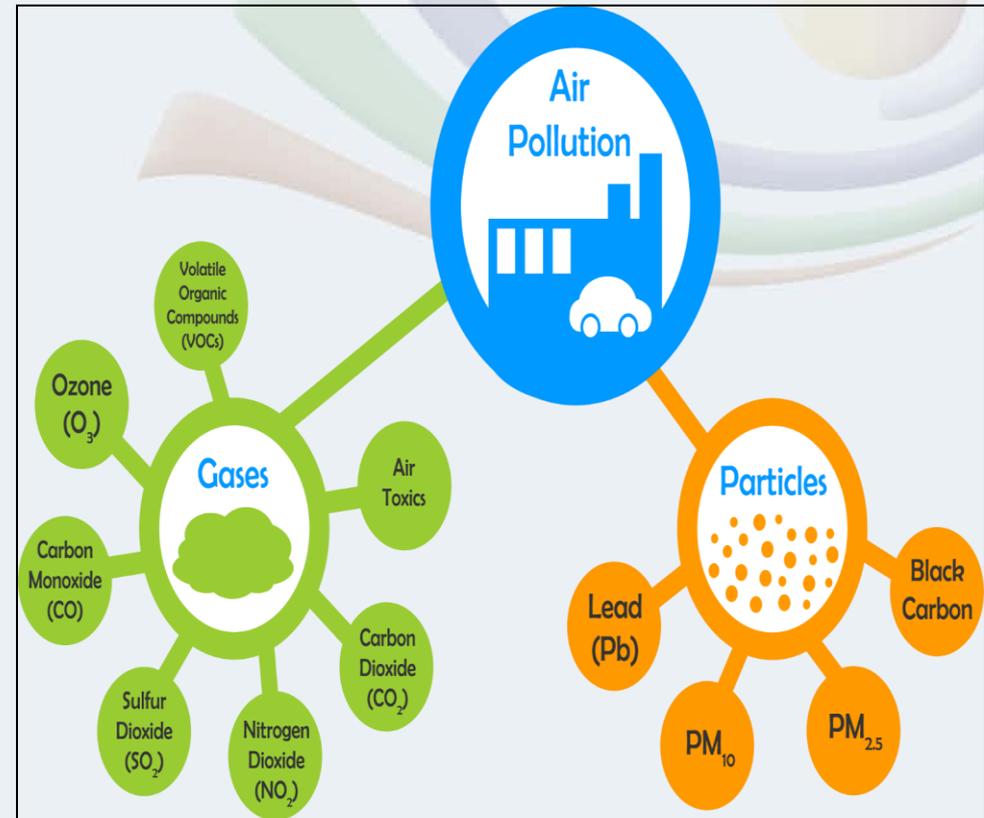
# What are Air Pollutants?

Air pollutants are substances that are present in the air at **concentrations** that are above their normal **background levels** which can have a harmful effect on humans, animals and plants and the environment.



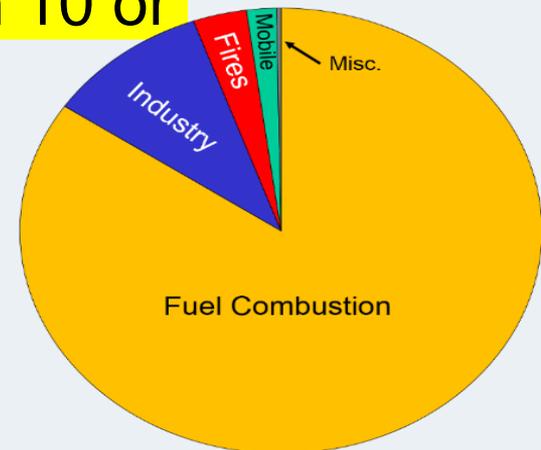
# Criteria air pollutants

- Particulate Matter (PM)
- Sulphur Dioxide (SO<sub>2</sub>)
- Nitrogen Oxide (NO<sub>2</sub>)
- Ozone (O<sub>3</sub>)
- Carbon Monoxide (CO)
- Benzene (C<sub>6</sub>H<sub>6</sub>)
- Lead (Pb)



# Sulphur dioxide (SO<sub>2</sub>)

- SO<sub>2</sub> is a gas which has a nasty sharp smell.
- Reacts easily with other substances to form harmful compounds such as H<sub>2</sub>SO<sub>4</sub>.
- About 99% of the SO<sub>2</sub> in air comes from human sources.
- Causes coughing, wheezing and shortness of breath.
- The effects of SO<sub>2</sub> are felt very quickly and most people would feel the worst symptoms in 10 or 15 minutes after breathing it in.

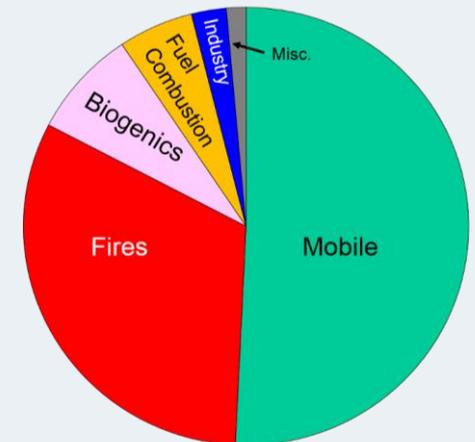


# Oxides of nitrogen (NO<sub>x</sub>)

- NO<sub>x</sub> is produced from the reaction of nitrogen and oxygen gases in the air during combustion, especially at high temperatures.
- NO<sub>x</sub> gases react to form smog and acid rain as well as being central to the formation of fine particles (PM) and ground level ozone.
- **Nitrogen dioxide (NO<sub>2</sub>)** is an irritant gas, which at high concentrations causes inflammation of the airways.
- Long term exposure can decrease lung function, increase the risk of respiratory conditions and increases the response to allergens.

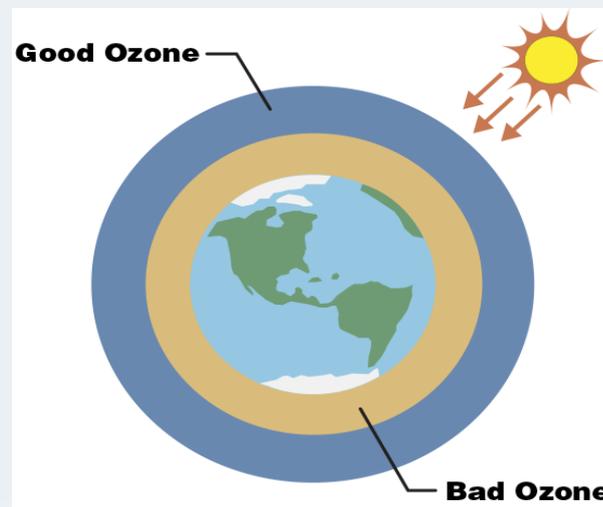
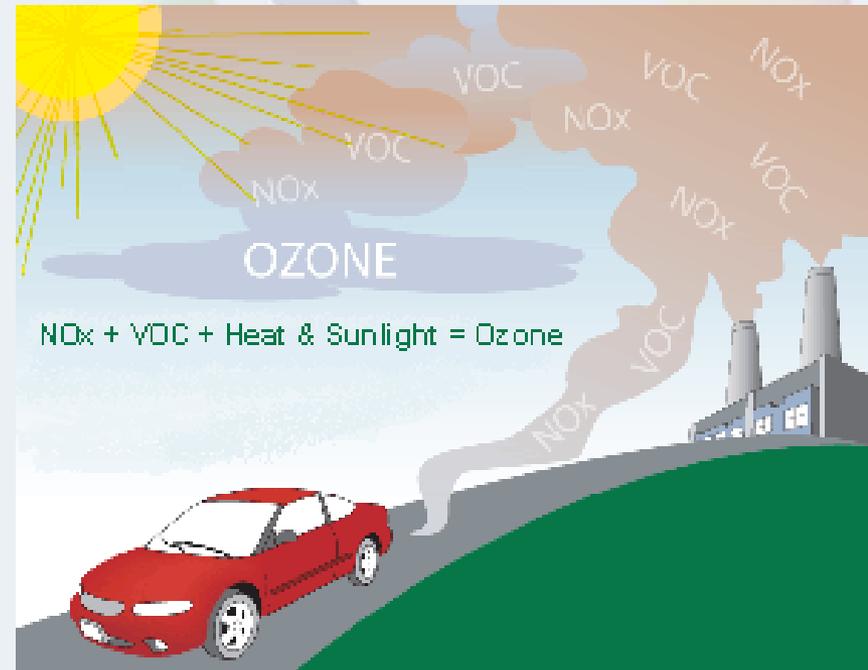
# Carbon monoxide (CO)

- CO is an indicator for traffic emissions and fuel combustion activities.
- Exposure to CO is a concern in the context of indoor air quality and is exacerbated by incomplete combustion and poor ventilation.
- Breathing CO can cause headache, dizziness, vomiting and nausea.
- Exposure to moderate and high levels of CO over long periods of time has also been linked with increased risk of heart disease.



# Ozone (O<sub>3</sub>)

- Ground-level O<sub>3</sub> is formed when VOCs and NO<sub>x</sub> react with the sun's ultraviolet rays.
- O<sub>3</sub> reaches its highest level during the afternoon and early evening hours.
- Causes a reduced resistance to infections.
- Increases fatigue.
- Promotes chest pain.
- Causes lung damage.

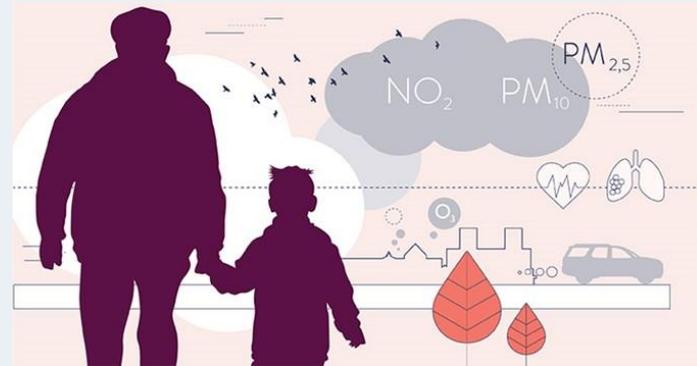


# Particulate matter (PM)

- PM<sub>10</sub> is particulate matter of 10 micrometres or less in diameter.
- PM<sub>2.5</sub> is particulate matter of 2.5 micrometres or less in diameter.
- PM is a complex mixture that may contain soot, smoke, metals, nitrates, sulphates, dust, water and tire rubber.
- PM<sub>2.5</sub> particles pose the greatest problems because they bypass the body's natural defences.
- Results in chronic bronchitis or chronic obstructive lung disease.
- Causes irregular heartbeat.
- Premature death in people with heart or lung disease.

# Health effects of air pollution

- Air pollution affects a number of different organs and systems.
- Immediate health problems
  - Cardiovascular and respiratory illness
  - Extra stress to heart and lungs
  - Damaged cells in the respiratory system
- Permanent health effects
  - Accelerated aging of the lungs.
  - Development of diseases such as asthma, bronchitis and possibly cancer.
  - Shortened life span.



# National Ambient Air Quality Standards

- The NAAQS are designed for the protection of the environment and human health.

Pollutant & Averaging Period	Standard	Annual Number of Permitted Exceedances
PM10 24h	75 $\mu\text{g m}^{-3}$	4
PM2.5 24h	40 $\mu\text{g m}^{-3}$	4
SO <sub>2</sub> 10 min	191 ppb	526
SO <sub>2</sub> 1h	134 ppb	88
SO <sub>2</sub> 24h	48 ppb	4
NO <sub>2</sub> 1h	106 ppb	88
O <sub>3</sub> 8h (Running)	61 ppb	11
CO 1h	26 ppm	88
CO 8h (Running)	8.7 ppm	11

Air pollution impacts health and the economy

Particulate matter affects more people than any other pollutant, and higher concentrations are known to cause increased mortality.

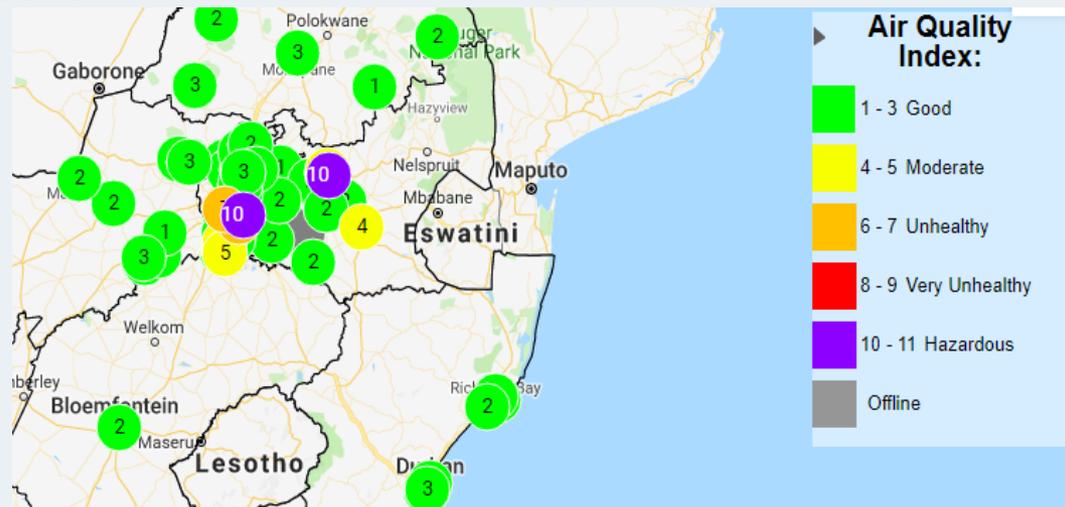
Annual Average PM2.5

Meets WHO Standard (<10  $\mu\text{g/m}^3$ )   
 Meets South African Standard (<20  $\mu\text{g/m}^3$ )   
 Doesn't Meet Either Standard (>20  $\mu\text{g/m}^3$ ) 

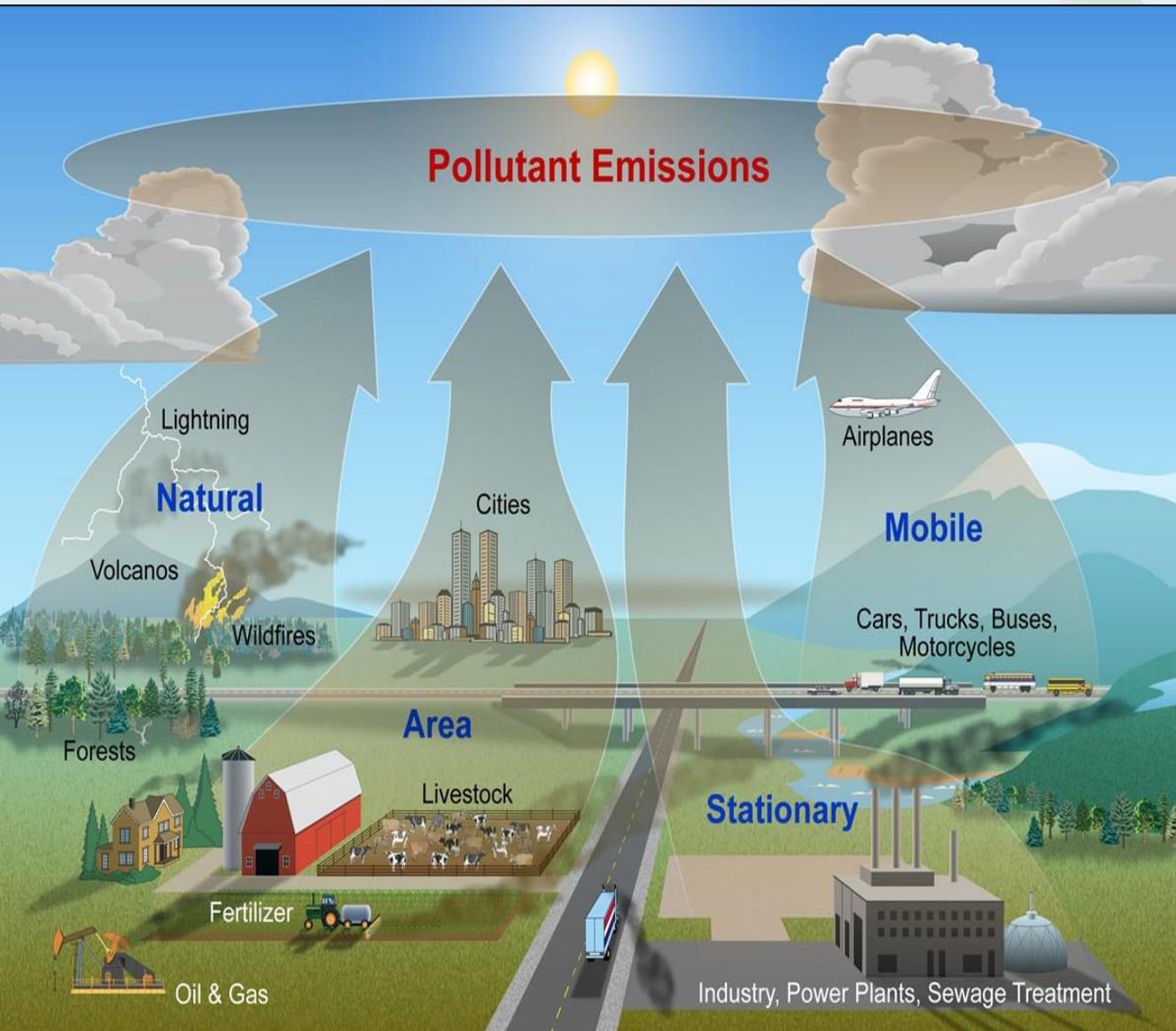


# What is Air Quality Monitoring

- Collection of air quality data that can be used to make informed decisions on how to best manage and improve the environment.
- Most common reasons for monitoring
  - ✓ Determines the level of contaminants to compare with the NAAQS
  - ✓ Obtains data for air quality modelling
  - ✓ Provides air quality information for policy or strategy development
  - ✓ Obtains experimental data
  - ✓ Conducts air quality research



# Sources of air pollution



## 4 main types of air pollution sources

- Mobile sources
- Stationary sources
- Area sources
- Natural sources

# Mobile sources

- An increase in privately owned vehicles resulted in an increase in fuel consumption.
- In urban areas, vehicle emissions may be responsible for
  - **90 to 95 percent of CO**
  - **60 to 70 percent of NOx within the atmosphere**
- Emissions associated with aircraft activities include
  - **CO<sub>2</sub>, PM, NOx, CO, SO<sub>2</sub> and VOCs**



# Area sources

- Informal settlements are dependent on domestic fuels such as coal, paraffin and wood for cooking and heating.
- The release of SO<sub>2</sub> is dependent on combustion and fuel characteristics
- Poor combustion conditions result in high emission rates, which in turn significantly affect neighbourhood air quality.
- Biomass burning is a significant source of gases and particulate matter emissions to the atmosphere.
- Veld fires adversely affect air quality due to the large concentrations of CO, VOCs, PM and other harmful chemicals present in the smoke.

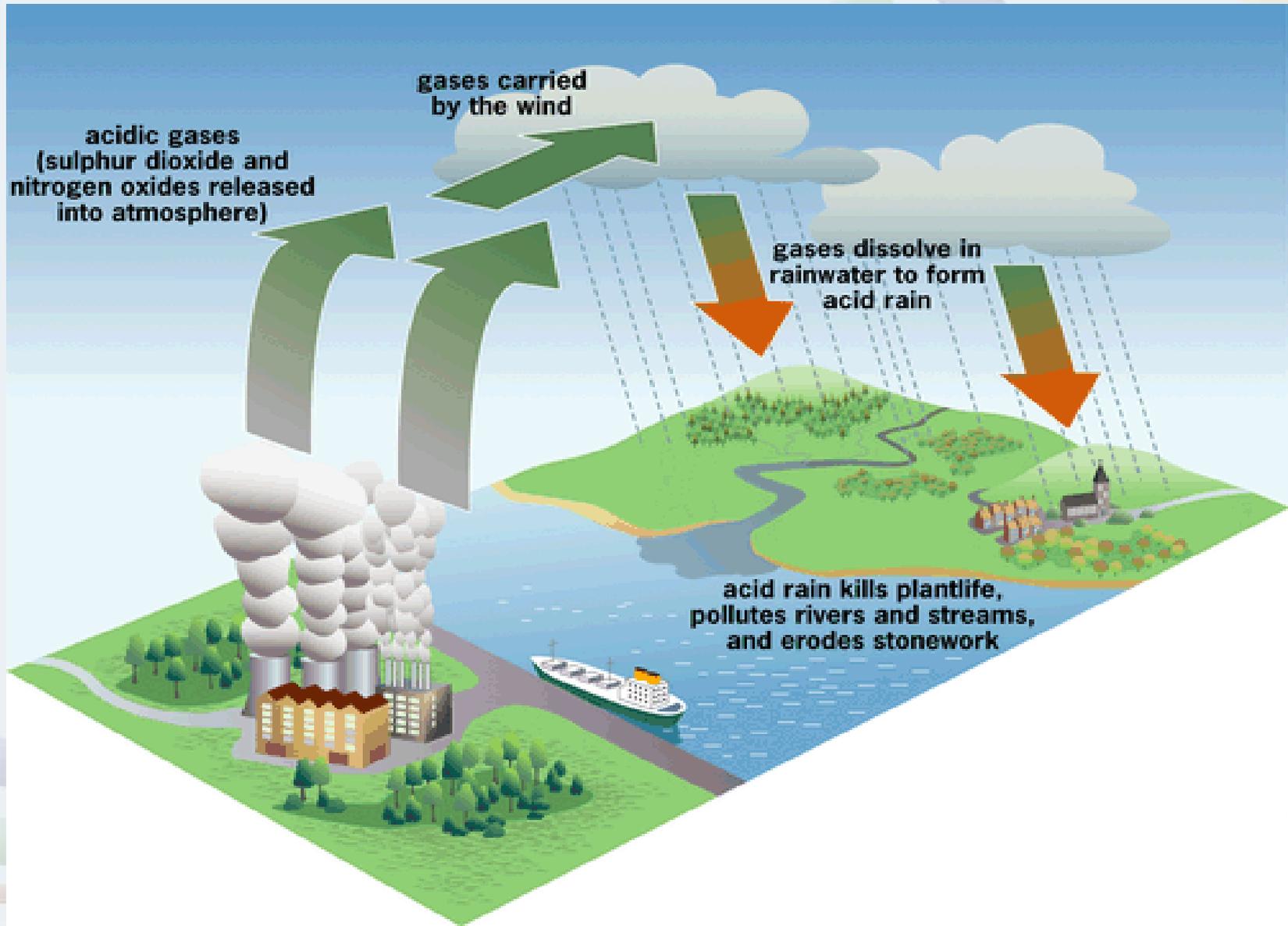


# Stationary sources

- Industries are a major consumer of energy and depend mainly on fossil fuels, especially coal.
- Coal mining operations are secondary impacts from coal-fired power stations.
- Industrial sector also include iron and steel, cement, pulp and paper, and oil refining.
- Industrial processes produce primary combustion particulates (PM10).
- **The negative environmental effects may be experienced long after industrial operations have ceased.**



# Environmental Impacts of Common Air Pollutants – Sulphur Dioxide



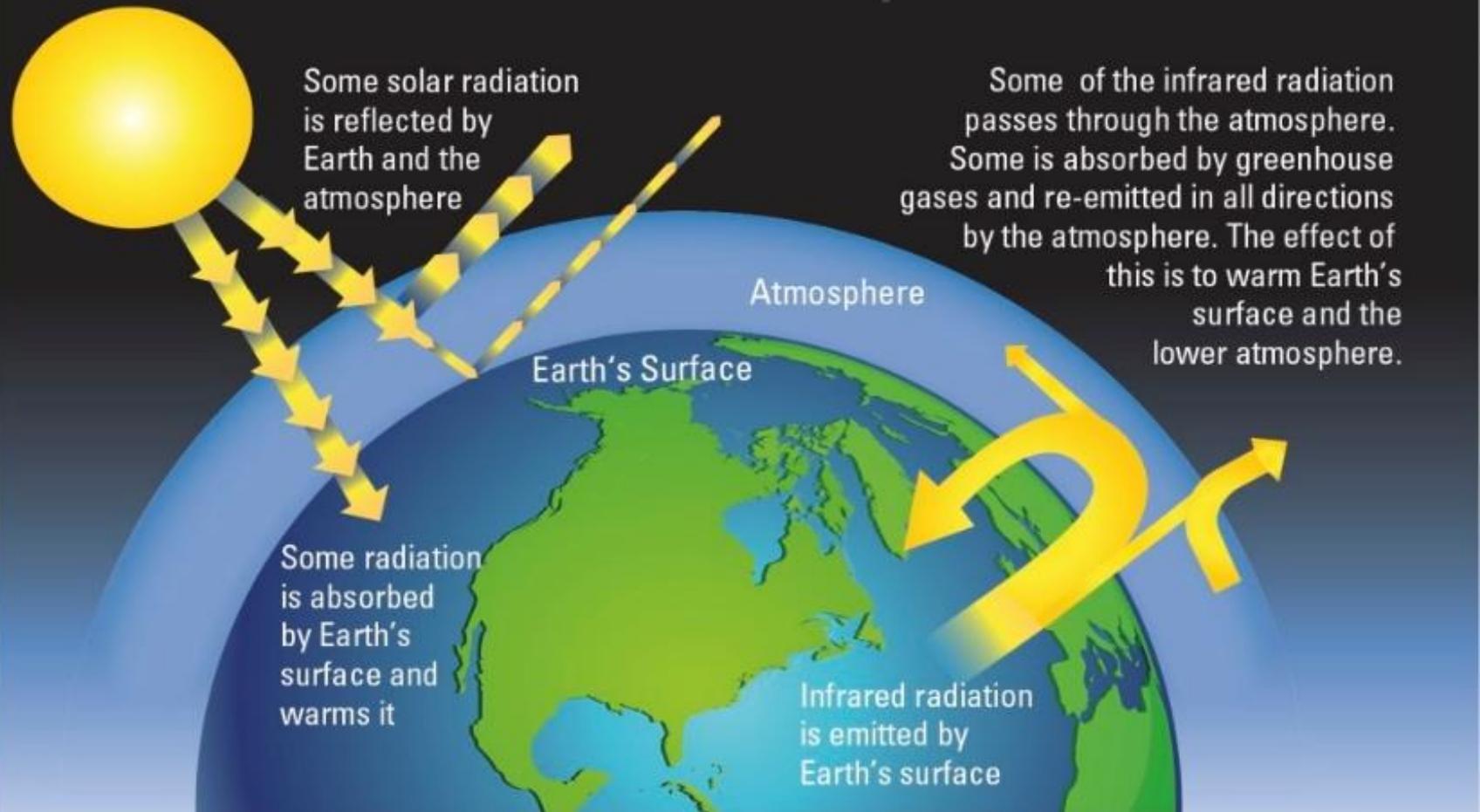
# Environmental Impacts of Common Air Pollutants – Nitrogen Oxides

Nitrogen oxides can create environmental health hazards when they react with sunlight and other chemicals to form smog. Nitrogen oxides and sulphur dioxide react with substances in the atmosphere to form acid rain.

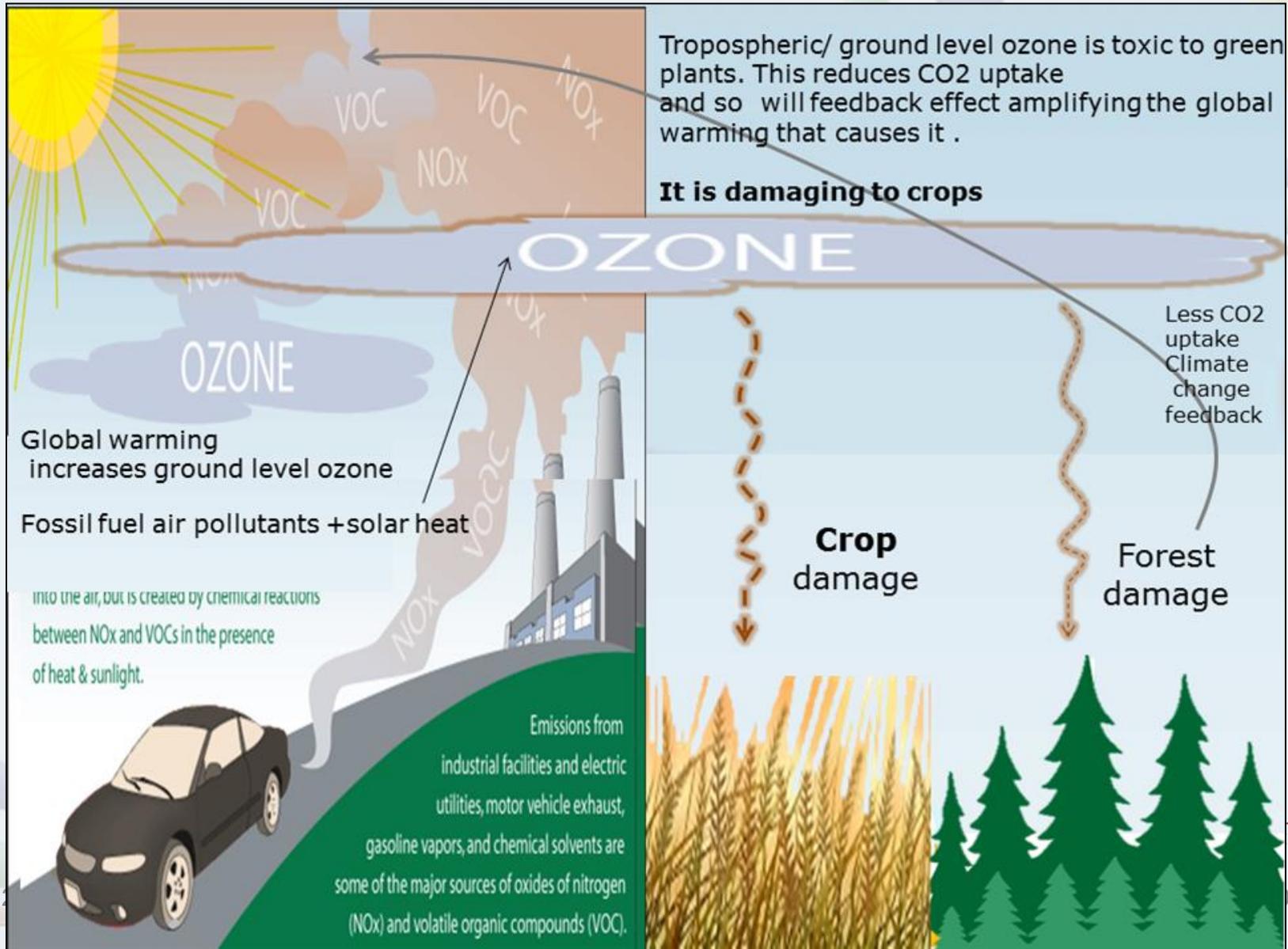


# Environmental Impacts of Common Air Pollutants – Carbon Monoxide

## THE GREENHOUSE EFFECT



# Environmental Impacts of Common Air Pollutants – Ozone



# Environmental Impacts of Common Air Pollutants – Particulate Matter

