Sources of Indoor and outdoor Air Pollution

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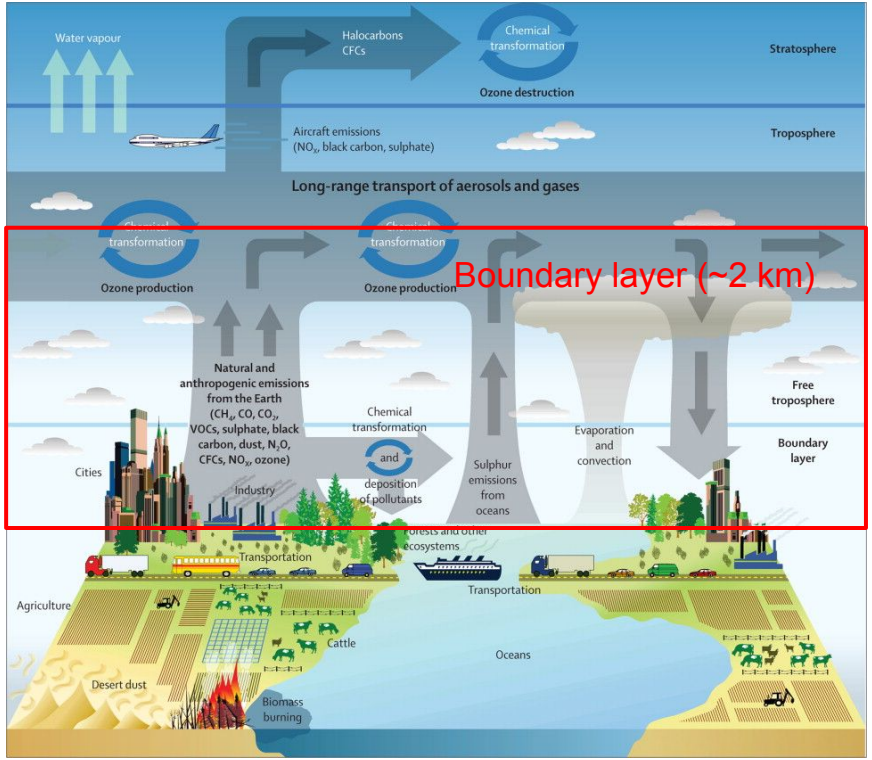
Outline

- What is air pollution
- Types of air pollution
  - Indoor air pollution
  - Outdoor air pollution
- Sources of air pollution
- Seasonal dynamics of air pollution source

What is Air Pollution?

The release of hazardous materials into the atmosphere in the form of gases, chemicals, particulate matter, or biological material is known as air pollution.



The main layer where human activities take place, and the emission, transmission and transformation of pollutants occur in this layer.

Some of the major sources of air pollution in the boundary layer include:

- domestic fires,
- vehicular traffic,
- waste burning,
- industrial activities and
- growing oil and mining industries

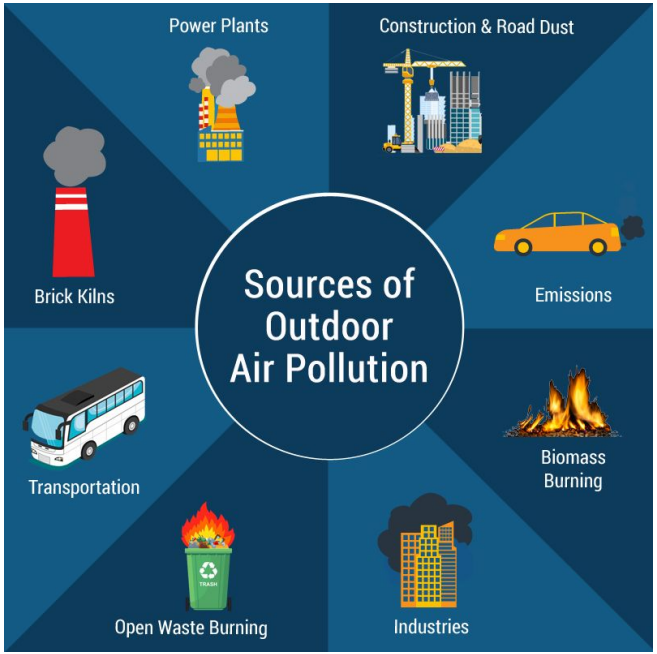
What is Air Pollution?

- According to WHO, air pollution in Africa is far from being well characterized, although it is suspected to be responsible for negative health outcomes and over a million deaths.

- Air pollution is a major concern for Africa because it has also one of the fastest growing urban populations in the world, especially in West Africa (Knippertz et al. 2015).

Types of Air Pollution

- Indoor Air Pollution
- Outdoor Air Pollution



Outdoor air pollution is also known as Ambient air pollution.

- Indoor air pollution is also known as household air pollution. It means contamination of air inside houses, buildings and work areas.

Indoor Air Pollution

According to the World Health Organisation, indoor pollution, also referred to as home pollution, cost an estimated 86 million healthy life years in 2019. Women in low- and middle-income countries bore most of this burden. Local food vendors in the community.

Indoor Air Pollution from cook stoves (wood or charcoal)

The major pollutants released include;

- Carbon monoxide,
- Nitrogen dioxide
- Particulates matter
- VOCs

(b)

(c)

Indoor pollution from Wood-burning Oven

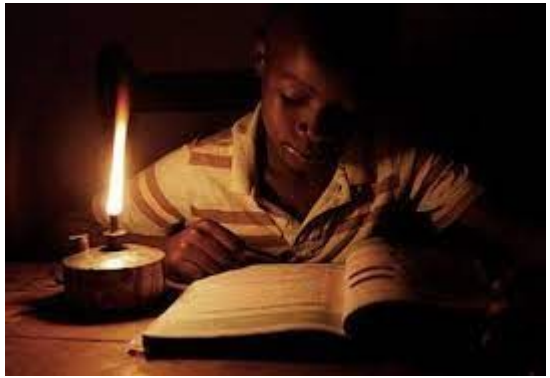
Emissions from wood-burning oven into the indoor environment :

During starting, stoking, and reloading operations, or emitted continuously due to leak or crack in oven.

Indoor Pollution From Tobacco Smoking

Indoor Air Pollution

- Unvented kerosene stove and lamps
- Unvented kerosene heaters
- Combustion gases and particulates also come from chimneys



Indoor Pollution Source: Wood Stove

When a wood stove fails to be well-maintained and ventilated, it can release harmful compounds such as

- Carbon monoxide,
- Nitrogen dioxide,
- Particulate matter, and
- VOCs.

Studies have shown that children living in homes heated with wood stoves have a significant increase in respiratory symptoms.

Indoor Pollution Source: Building Material

Building materials, home improvement products, and textiles used in the home can pose health risks. For example, formaldehyde volatilizes from pressed wood products made using adhesives that contain urea-formaldehyde (UF) resins. Pressed wood products made for indoor use include

- Particleboard (used as subflooring and shelving and in cabinetry and furniture),
- Hardwood plywood paneling (used for decorative wall covering and used in cabinets and furniture),

Indoor Pollution Source: Abestos

Asbestos is most commonly found in older homes

Pipe and furnace insulation materials,

- Asbestos shingles,
- Millboard,
- Textured paints and other coating materials,
- Floor tiles, and
- Ceiling tiles and panels.

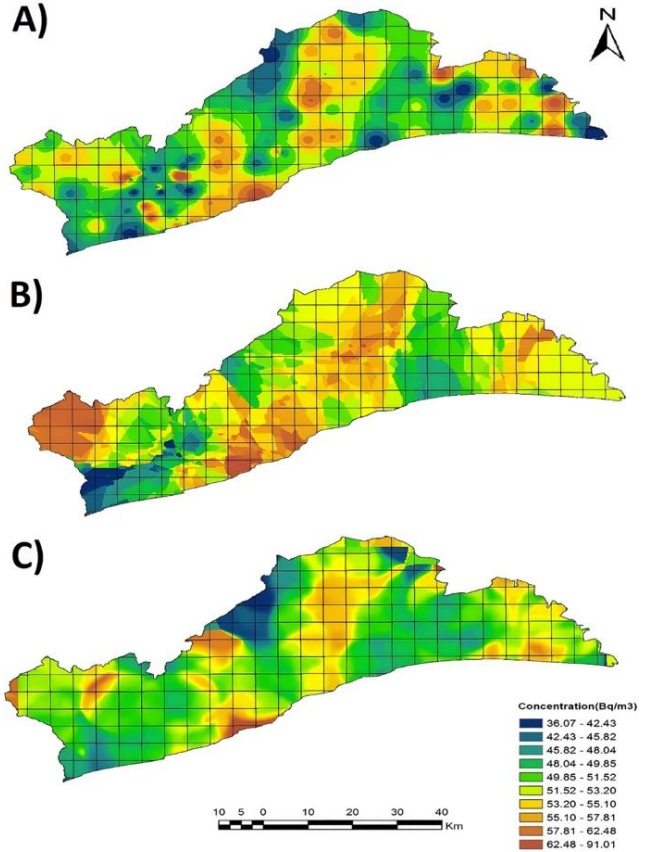
Elevated concentrations of airborne asbestos can occur after asbestos-containing materials are disturbed.

Exposure to these fibers has been associated with

- Lung cancer,
- Asbestosis, and
- Mesothelioma

Indoor Pollution Source: Radon

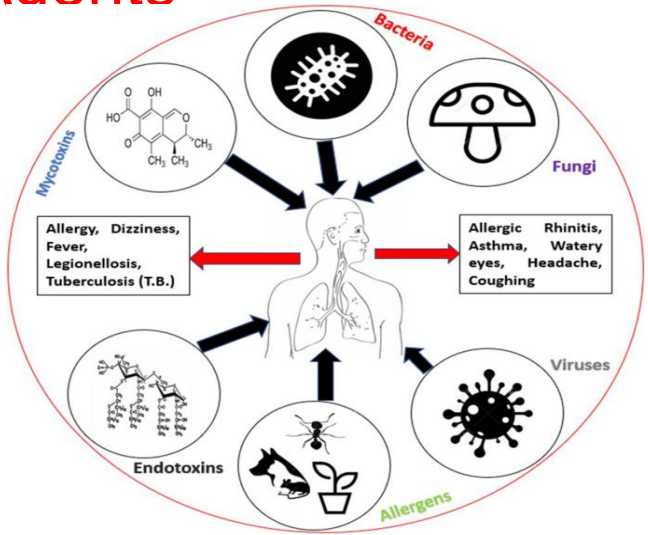
- The most common source of indoor radon is uranium in the soil or rock on which homes are built.
- Various types of cement, gravels, rocks, sands, clay bricks and tiles contain radon
- The also anthropogenic sources
- Radon gas enters homes through
  - Dirt floors, Cracks in concrete walls and floors,
  - Floor drains, and Sumps.
- Exposure to radon becomes a concern when trapped in buildings and concentrations increase indoors.
- Radon causes thousands of preventable lung cancer and deaths each year globally.
- For persons that smoke and have high home radon levels, the risk of developing lung cancer is relatively high.



Greater Accra had concentrations ranging 58.7 ±2.6–92.0±5.2 Bq m−3 .

Indoor Pollution Source: Biological Agents

- Sources of indoor biologic pollutants include plants, people, and animals.
- Building materials and/or conditions that support the growth
- It is important not to overlooks these potential sources of biologic pollutants. Contaminated central air handling systems can become breeding grounds for
  - Mold,
  - Mildew
- Other sources of biological contaminants/agents include:
  - Animal dander, saliva, urine,
  - Bacteria,
  - Cockroaches,
  - House dust mites,
- Some biological contaminants trigger allergic reactions, including
  - Allergic rhinitis,
  - Hypersensitivity pneumonitis, and
  - Some types of asthma.



Kumar et al., 2021

Indoor Pollution Source: Biological Agents(Pet Dander)

Pet Dander

- Pet dander comprised of microscopic flakes of skin shed by household pets, meaning that hairless breeds can cause symptoms like:
  - coughing,
  - Sneezing,
  - watery eyes, and
  - chest tightness.

- It is an acute irritant that can make some indoor environments vexing for allergy sufferers.

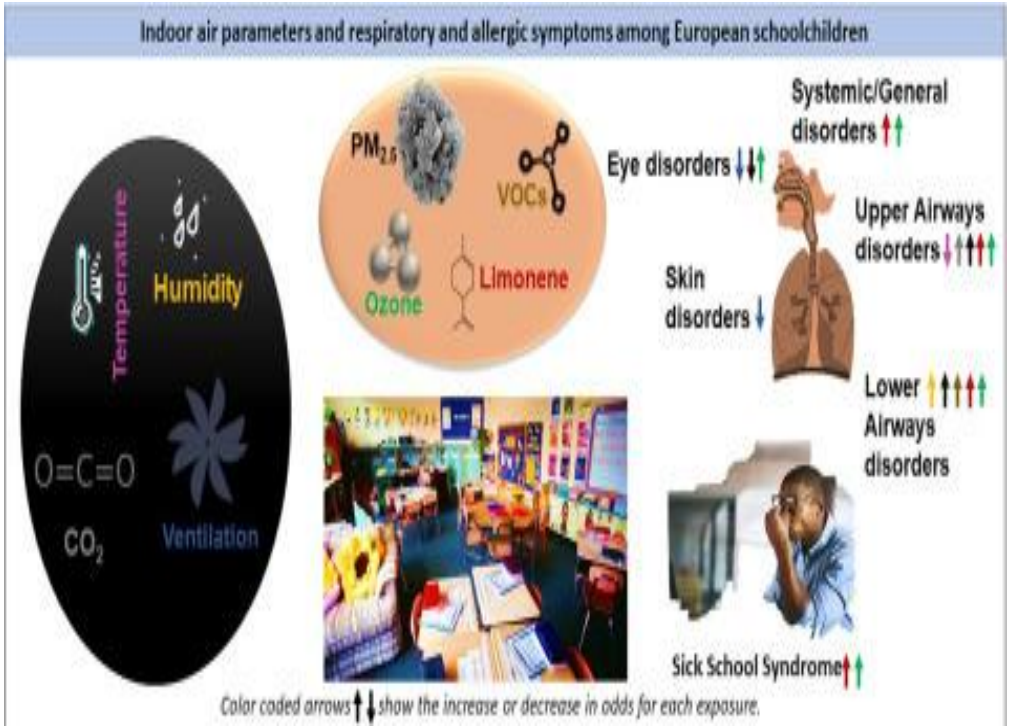
Indoor Pollution Source: Symptoms of Biological Air Pollution

Infectious illnesses, such as influenza, measles, and chickenpox are transmitted through the air.

Molds and mildews release disease-causing toxins.

Symptoms of health problems caused by biological pollutants include (US Environmental Protection Agency 2012)

- Coughing,
- Digestive problems,
- Dizziness,
- Fever,
- Lethargy,
- Shortness of breath,
- Sneezing, and
- Watery eyes.



Baloch et al., 2020

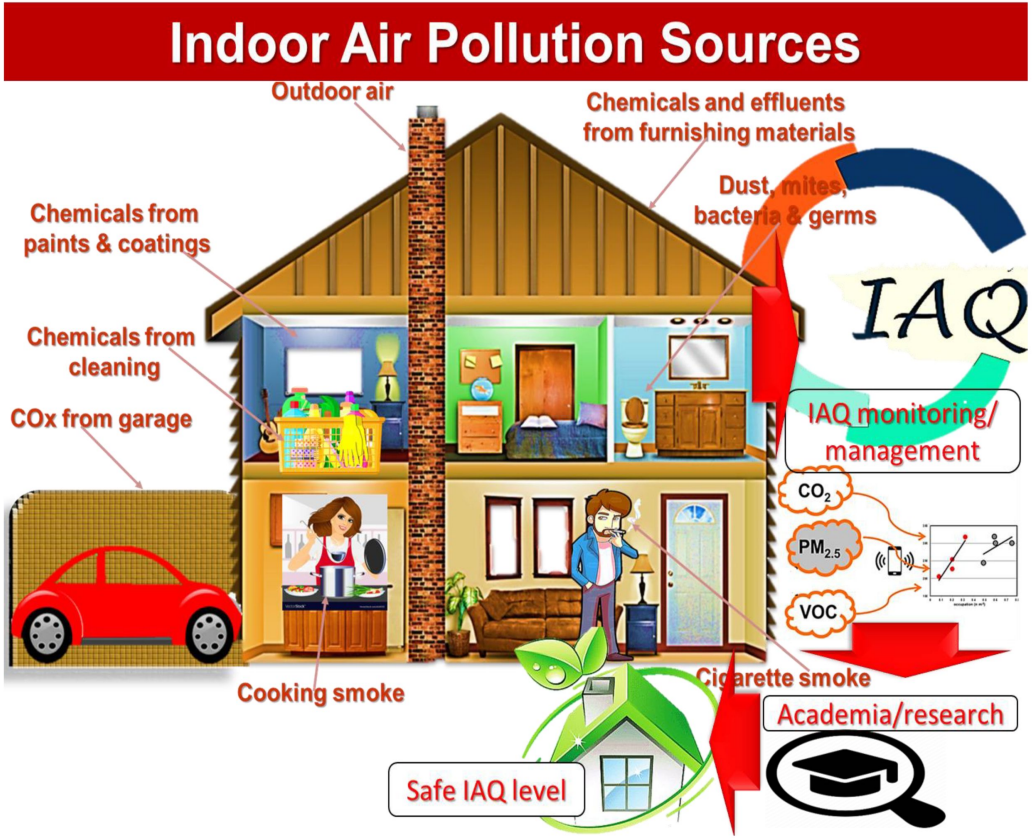
Indoor Pollution Source: Other Household Products

Household Products

Many day-to-day products present in almost every home can cause indoor air pollution. These include:

- Cleaning agents and disinfectants
- Paints
- Glues and solvents
- Personal care products
- Air fresheners
- Candles

These products may emit volatile organic compounds (VOCs), which can cause issues such as eye, nose or throat irritation, headaches, nausea, organ damage, and even cancer in some extreme cases.



Kausar et al., 2023

Outdoor Air Pollution

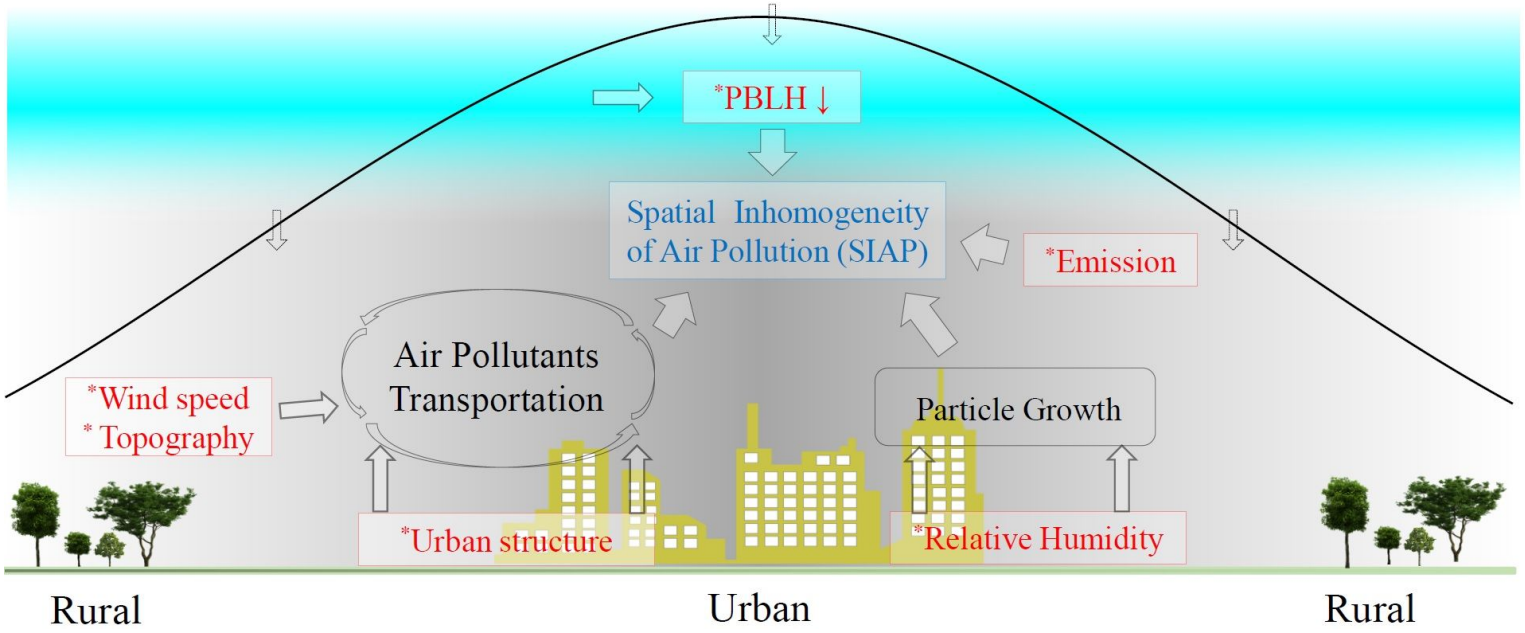
Outdoor air pollution is also known as Ambient air pollution. This pollution is caused by emissions from cars, trucks, industries, construction sites, landfill sites and many more activities. These emitted pollutants are harmful to our health.

Major outdoor pollutant includes;

- Carbon monoxide (CO)
- Nitrogen dioxide (NO_2)
- Sulfur dioxide (SO_2)
- Particulate Matter (PM10 and PM2.5)
- Agricultural Chemicals
- Dust and Soil Particles
- Biomass Burning Emissions

Do you think these pollutants differ from one place to the other??

Outdoor Air Pollution: Urban and Rural setting



Differences in surface characteristics between Urban and Rural settlement greatly influences vulnerability of humans to the impacts of air pollution. Also, the source of air pollution

Outdoor Air Pollutants

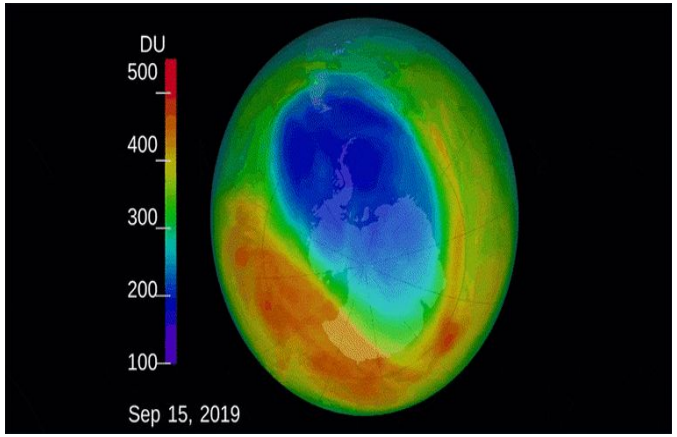
Nitrogen Oxides (NO_x)

- Nitrogen oxides, including nitric oxide (NO) and nitrogen dioxide (NO_2), are produced primarily by vehicle emissions and industrial processes. They contribute to the formation of ground-level ozone and can lead to respiratory issues.

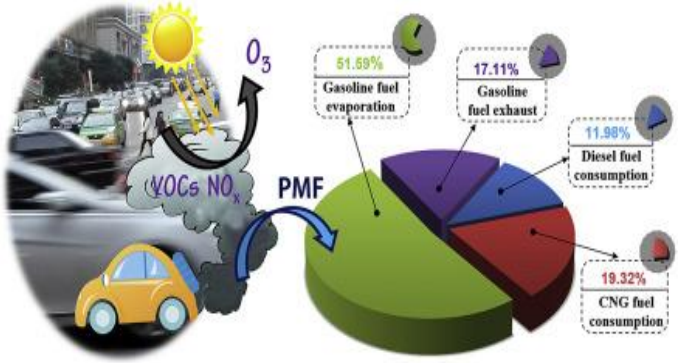
Outdoor Air Pollutants

Ozone (O_3)

- A secondary pollutant formed when nitrogen oxides and VOCs react in the presence of sunlight. Ground-level ozone can irritate the respiratory system and worsen pre-existing health conditions.



The Positive Matrix Factorization (PMF) receptor model is used for identification of source contributions to O_3.



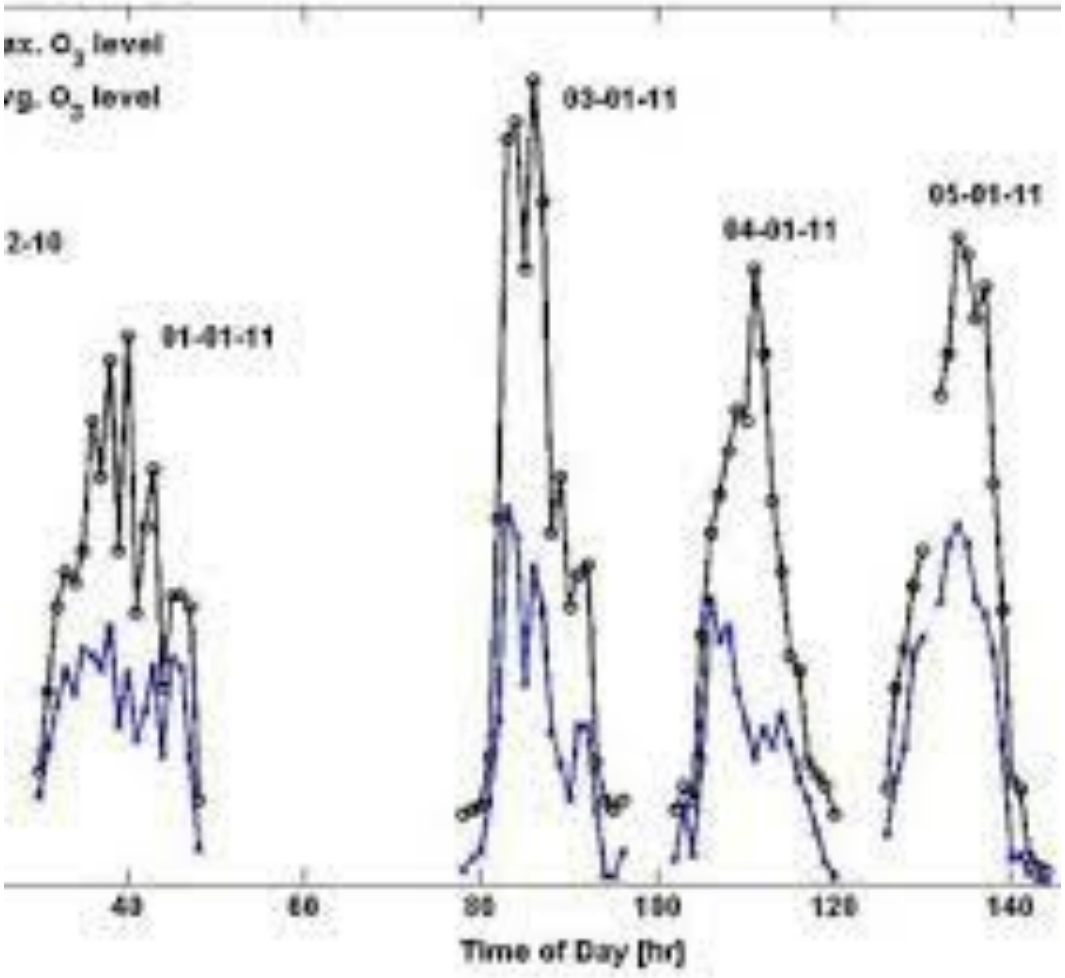
Contribution to Ozone

Gasoline > Compressed Natural gas (CNG) > Diesel

High ozone level in Urban centers

Accra

Kumasi

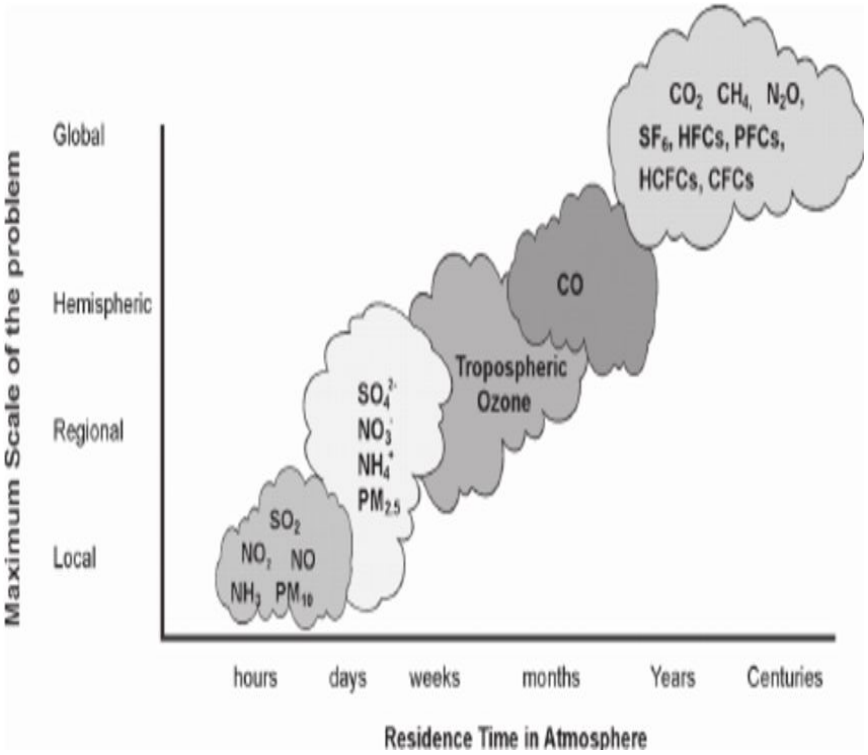


High Ozone level b/n 4 - 6 PM
Temperature and RH have strong impact on PBL Ozone level.

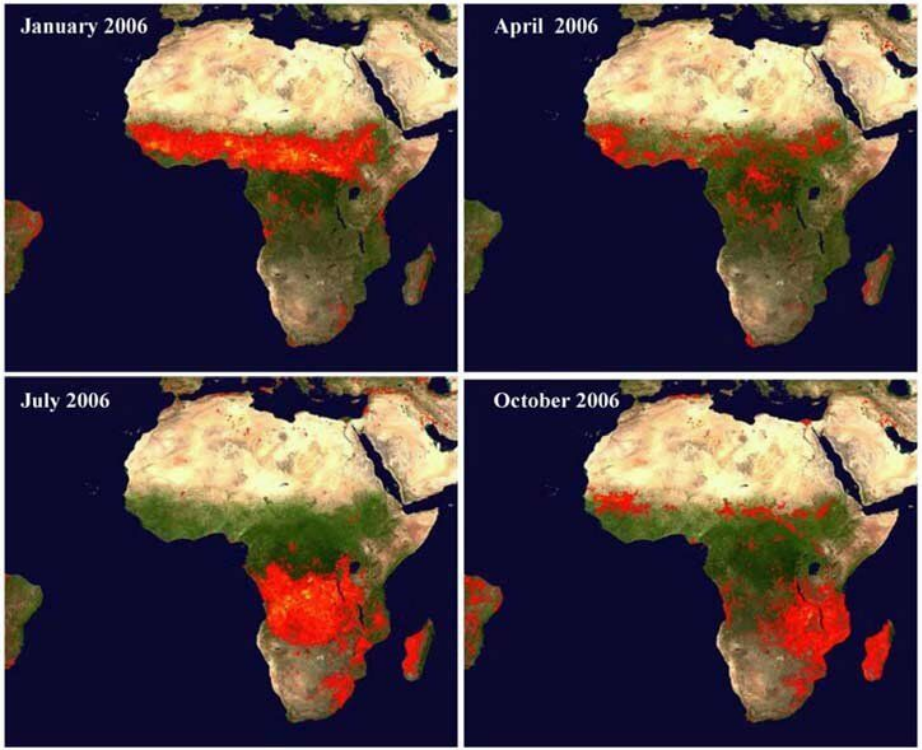
(Quansah, Amekudzi and Preko 2012)

Spatial Distribution and Resident time of Pollutant

- **Local and Regional Variability:** Pollutant distribution varies by location, impacting urban and rural areas differently.
- **Residence Time in the Environment:** The longevity of pollutants in air influences their long-term effects.
- **Transport and Dispersion Mechanisms**: Pollutant sources can be point, area, mobile and natural. After release, they are then dispersed.
- **Ecosystem and Human Health Impacts:** Pollutant distribution affects wildlife, vegetation, water quality, and human health near pollution sources.



Seasonal Variability of PM2.5



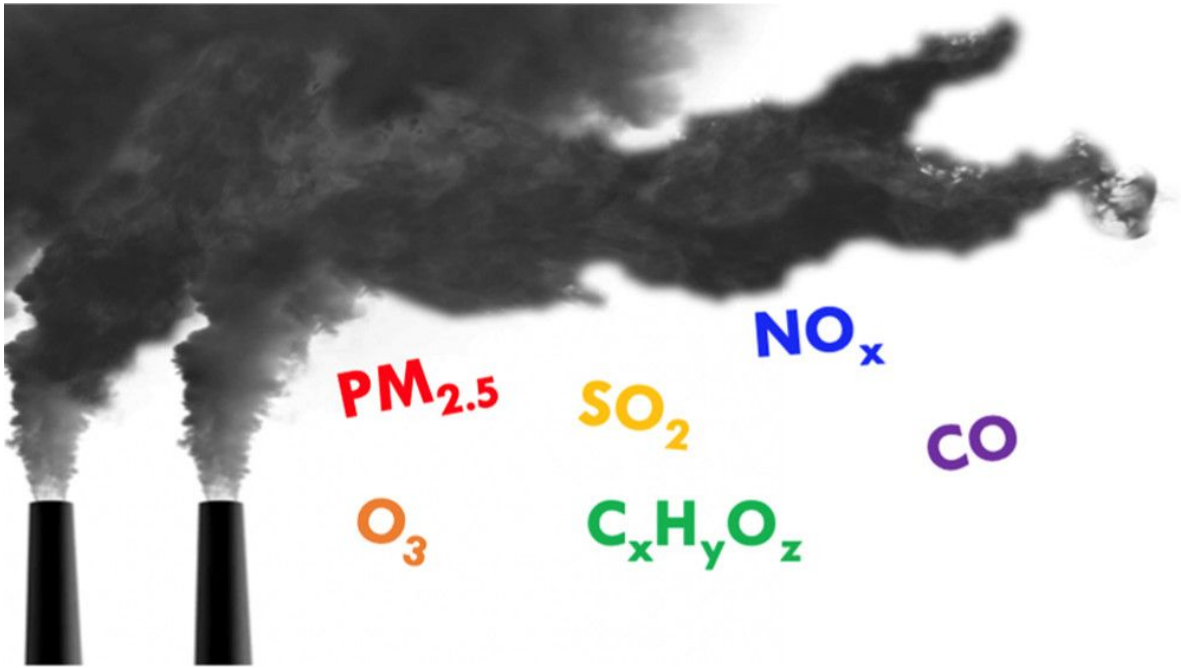
- High burning of biomass in Africa usually occur during the dry-season. Especially in West Africa.
- This usually occurs prior to land preparation toward plating (Between January and March)
-

MODIS fire retrievals showing the seasonality of biomass burning over the African continent during 2006.

Dispersion of Pollutant from the City Center

Dispersion is the spread and movement of pollutants. Pollution dispersion depends on

- wind speed and direction,
- plume rise, and
- atmospheric turbulence

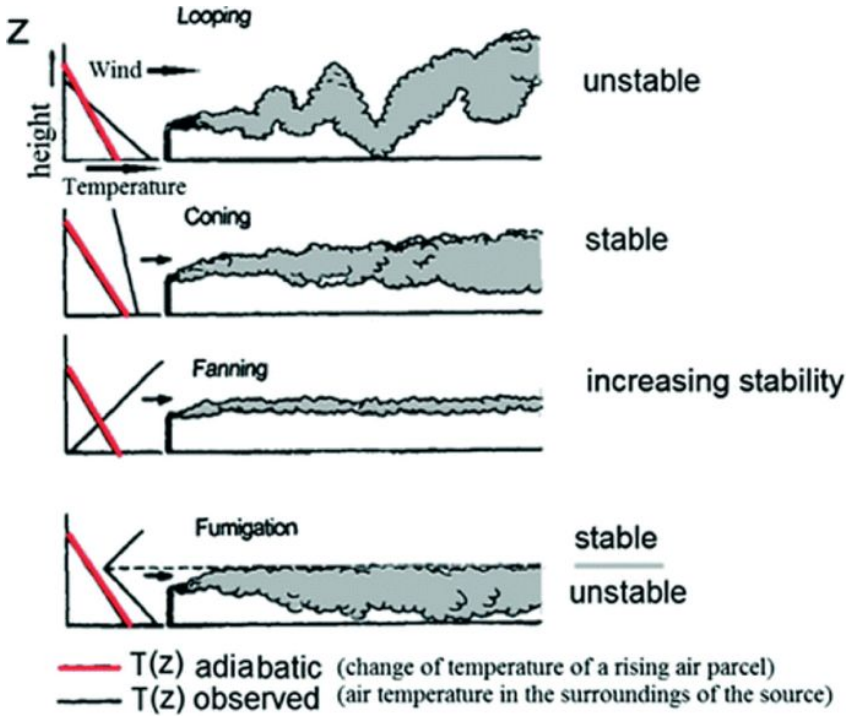


Dispersion of Pollutant from the City Center

Pollutant dispersal strongly depend on atmospheric temperature, the wind speed and the direction of movement.

Based on these factors there are different types of dispersal which include;

- Looping plumes
- Coning
- Fanning
- Fumigation



What types of gases can be emitted from this source?

Thank You

CLEAN AIR FUND

UNIVERSITY OF LEEDS