A study on characterization, emission and deposition of black carbon over Indo-Gangetic Basin

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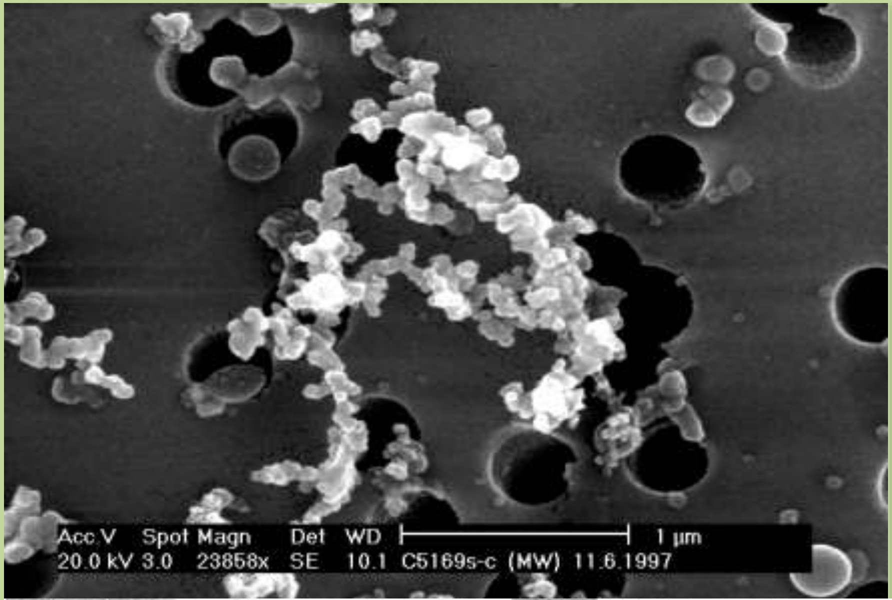
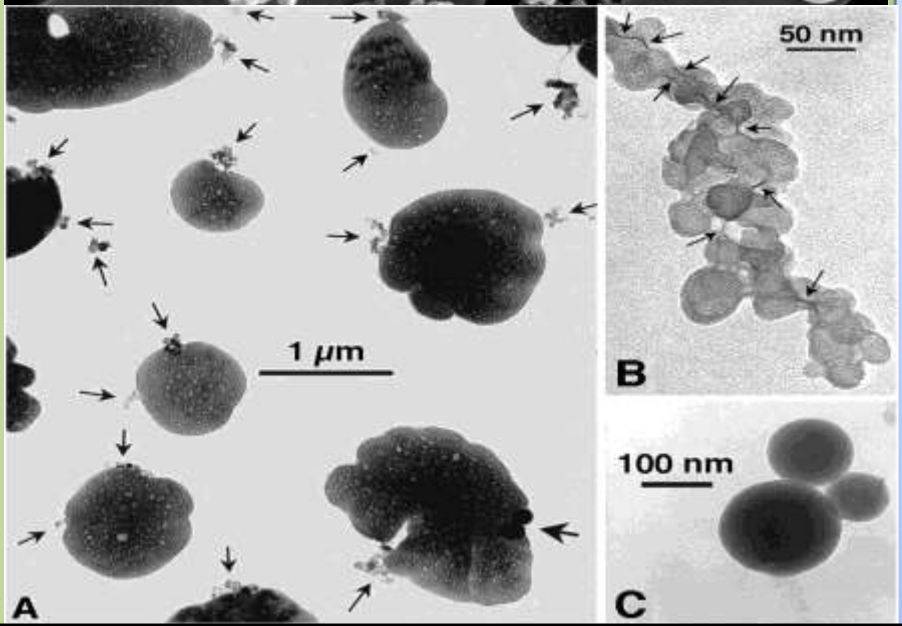
Introduction

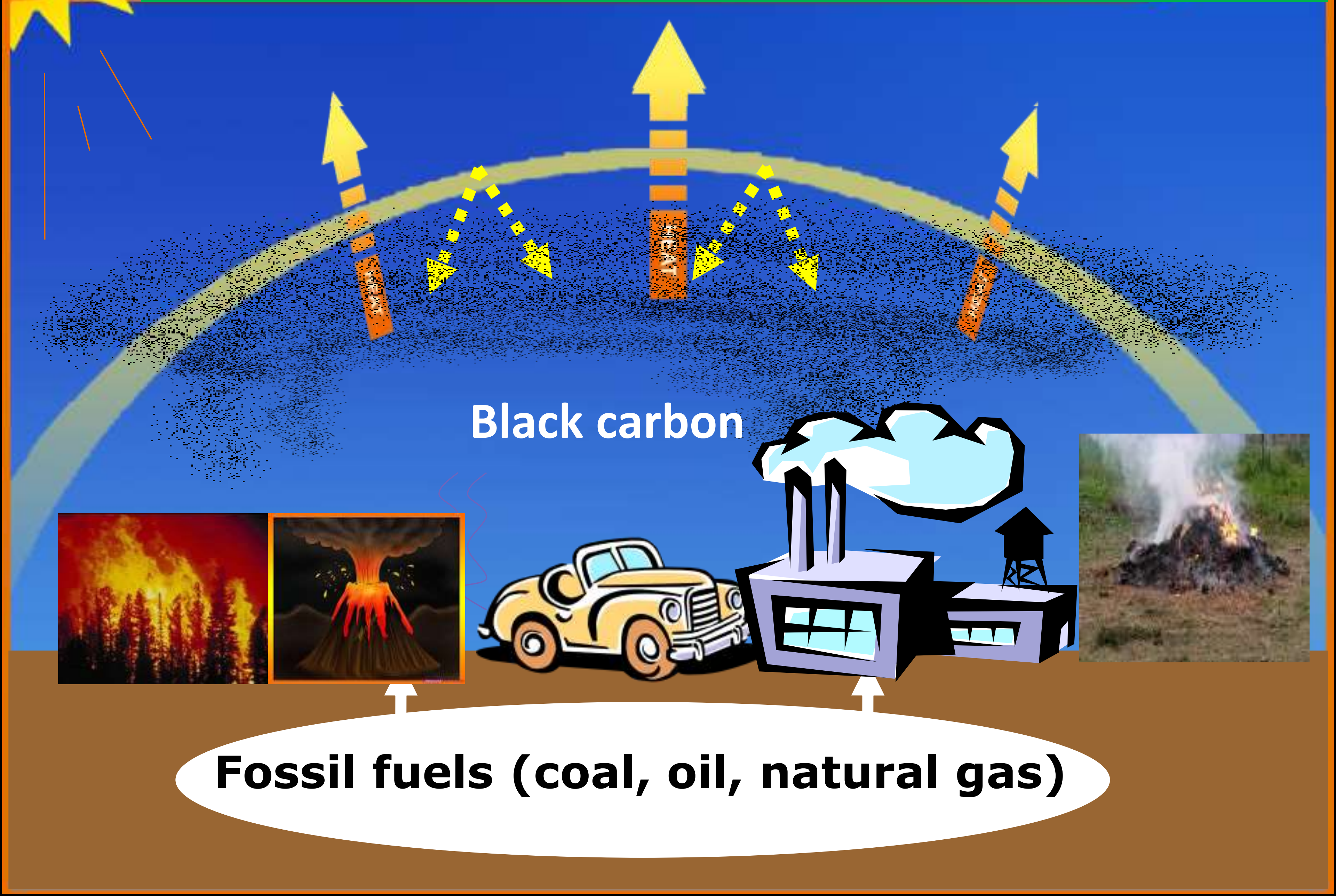


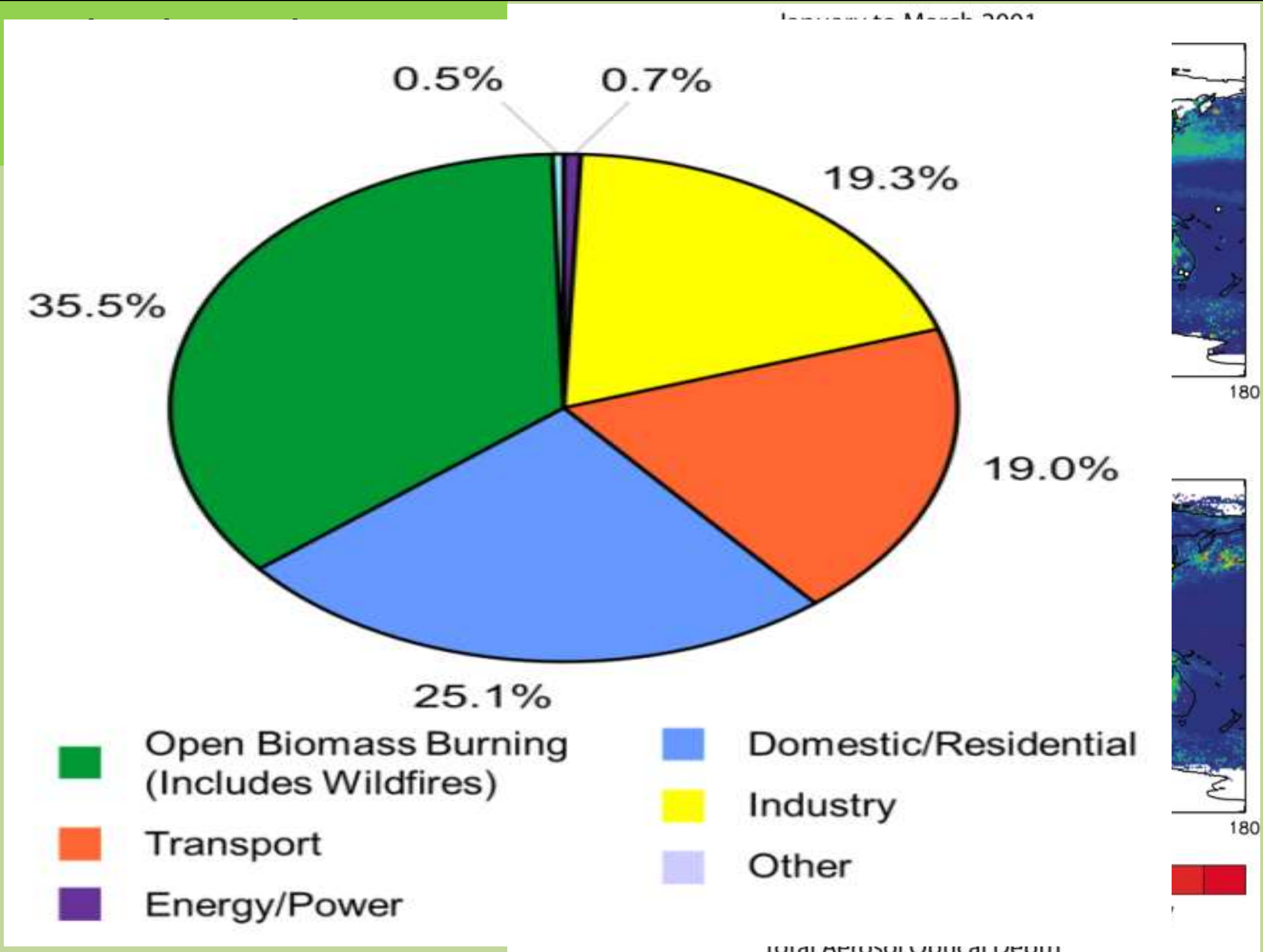


Black Carbon:

- is the main light-absorbing component in fossil fuel emissions
- consists almost exclusively of carbon („elemental carbon“)
- can only be formed in flames (including those in automobile engines)
- can be determined with reasonable reliability with combustion analyzers
- has optical absorption properties that vary over at least an order of magnitude, depending on size, mixing state, etc.
- shows little spectral dependence of absorption properties ⇒ „black“

Sources of black carbon





0.5%
0.7%
19.3%
35.5%
19.0%
25.1%
Open Biomass Burning (Includes Wildfires)
Transport
Energy/Power
Domestic/Residential
Industry
Other
180
180

Effect of black carbon

Climate

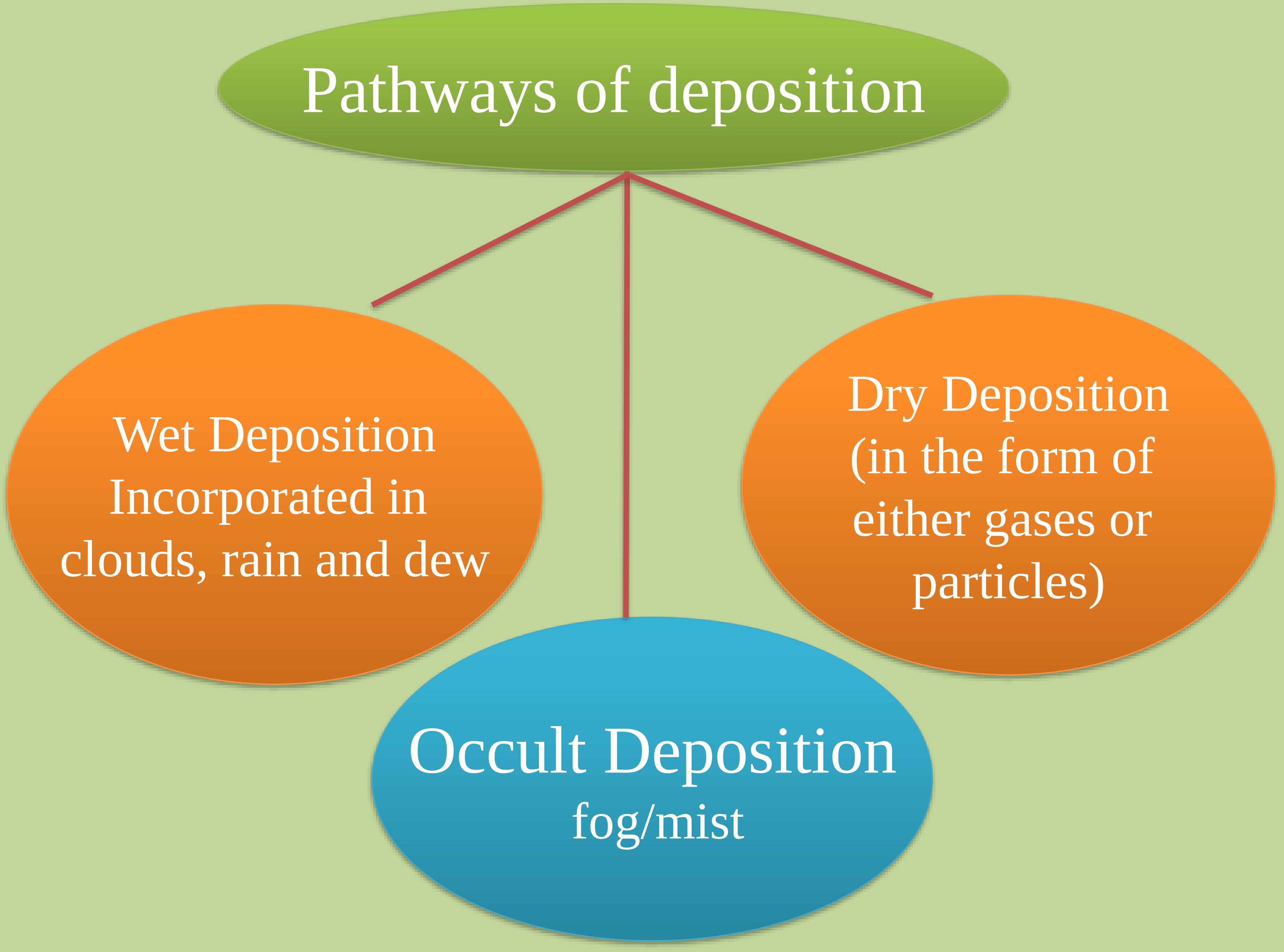
Direct
- radiative forcing by absorbing solar energy

Indirect
- by acting as CCN and IN, changing cloud properties, reducing precipitation, influencing hydrological cycle, increasing reflectivity of clouds

Human health

Short-term
- acute problems like asthma, bronchitis

Long-term
- Chronic blockage of respiratory track, lead to heart attack, cardiovascular disease


Pathways of deposition
Wet Deposition Incorporated in clouds, rain and dew
Dry Deposition (in the form of either gases or particles)
Occult Deposition
fog/mist

Dry Deposition

Aerodynamic transfer of trace gases black carbon and aerosol from the air to the surface and the gravitational settling of particles. Process comprises two stages, atmospheric transport and uptake at the surface.

Flux (F) = Vd × C

Characterized by a deposition velocity,

Vd = F/[S]

Vd is also related to resistance: Vd = 1/R
or Vd = 1/(Ra+Rb+RC)
Where, Ra = Aerodynamic resistance, Rb = Quasilaminar resistance and Rc = surface resistance

Importance and need of dry deposition of black carbon

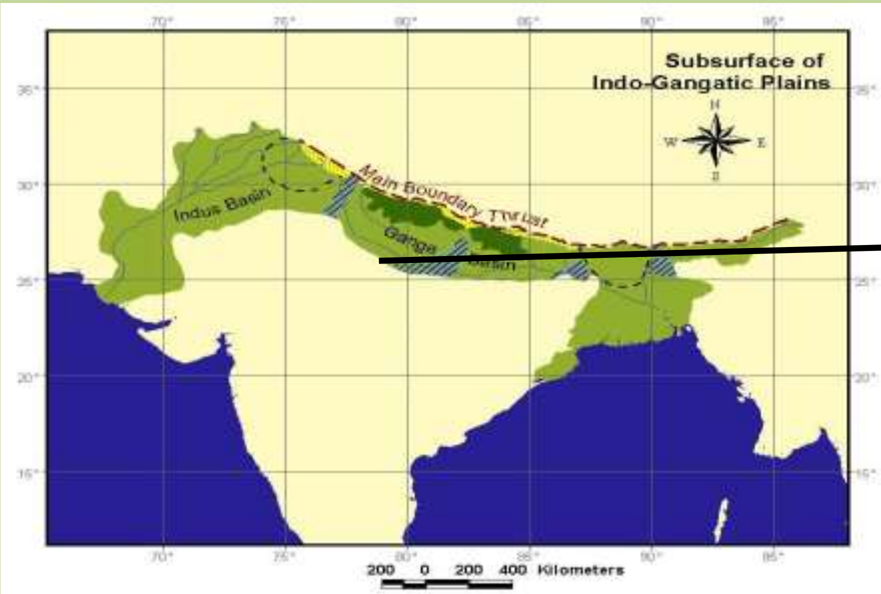
- to specify the rate at which atmosphere is being depleted and to determine the rate of delivery of materials to the underlying surface.

- Many researchers have reported deposition amounts of insoluble particulate matter and their elemental composition on natural surfaces there is no information on the specific amount of BC particles deposited on natural surface.

Objectives

- To determine the mass concentration of black carbon.
- To see the variation pattern and estimate the dry deposition flux of black carbon and
- To estimate the radiative forcing.

Methodology: Site selection



Measurement of mass concentration of black carbon

- Black carbon mass concentration measurements has been carried out by using the new seven channels Aethalometer (Model AE33; Magee Scientific USA).

- Aethalometer used continuous filtrations through quartz filter and estimates optical absorption using principle of transmission (Hansen et al., 1984).

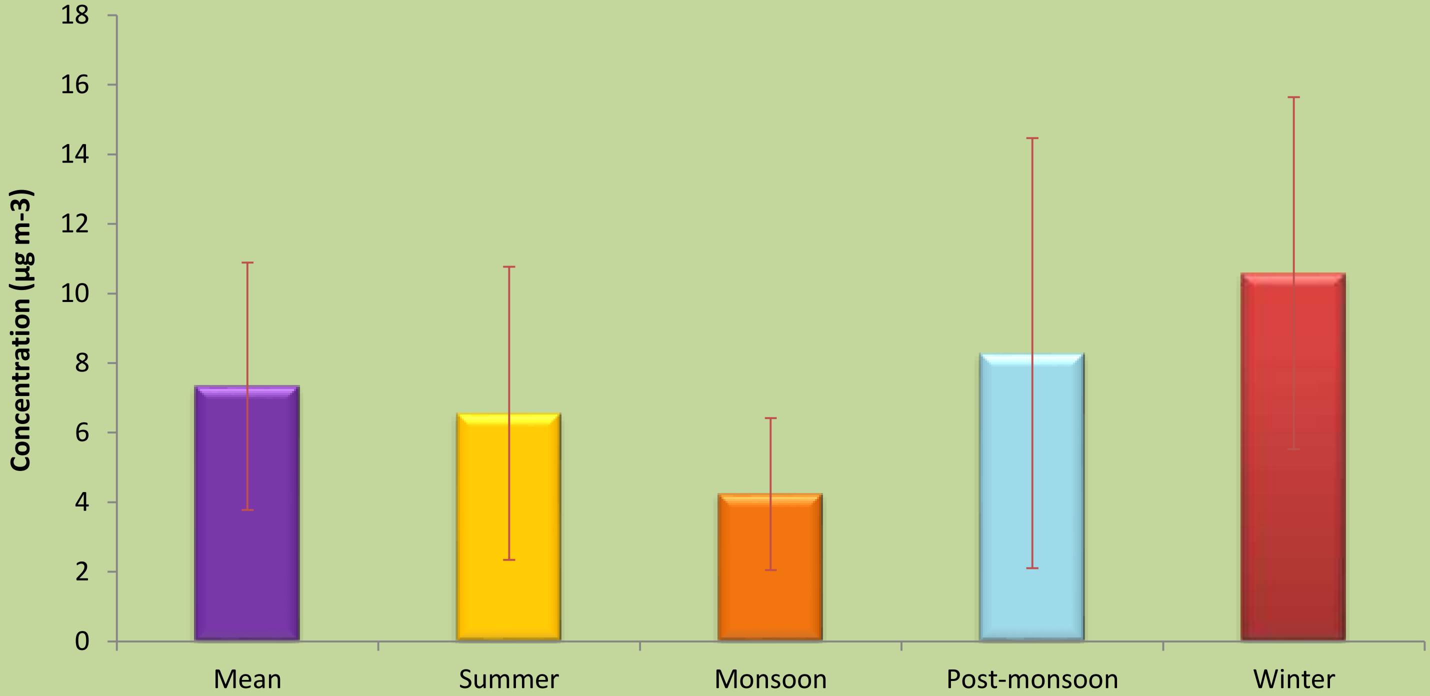
- Black carbon are collected on the filter continuously by drawing air through the filter tape at a flow rate of 2 LPM and estimate concentration of soot particles every minute following an optical attenuation technique.

Sampling

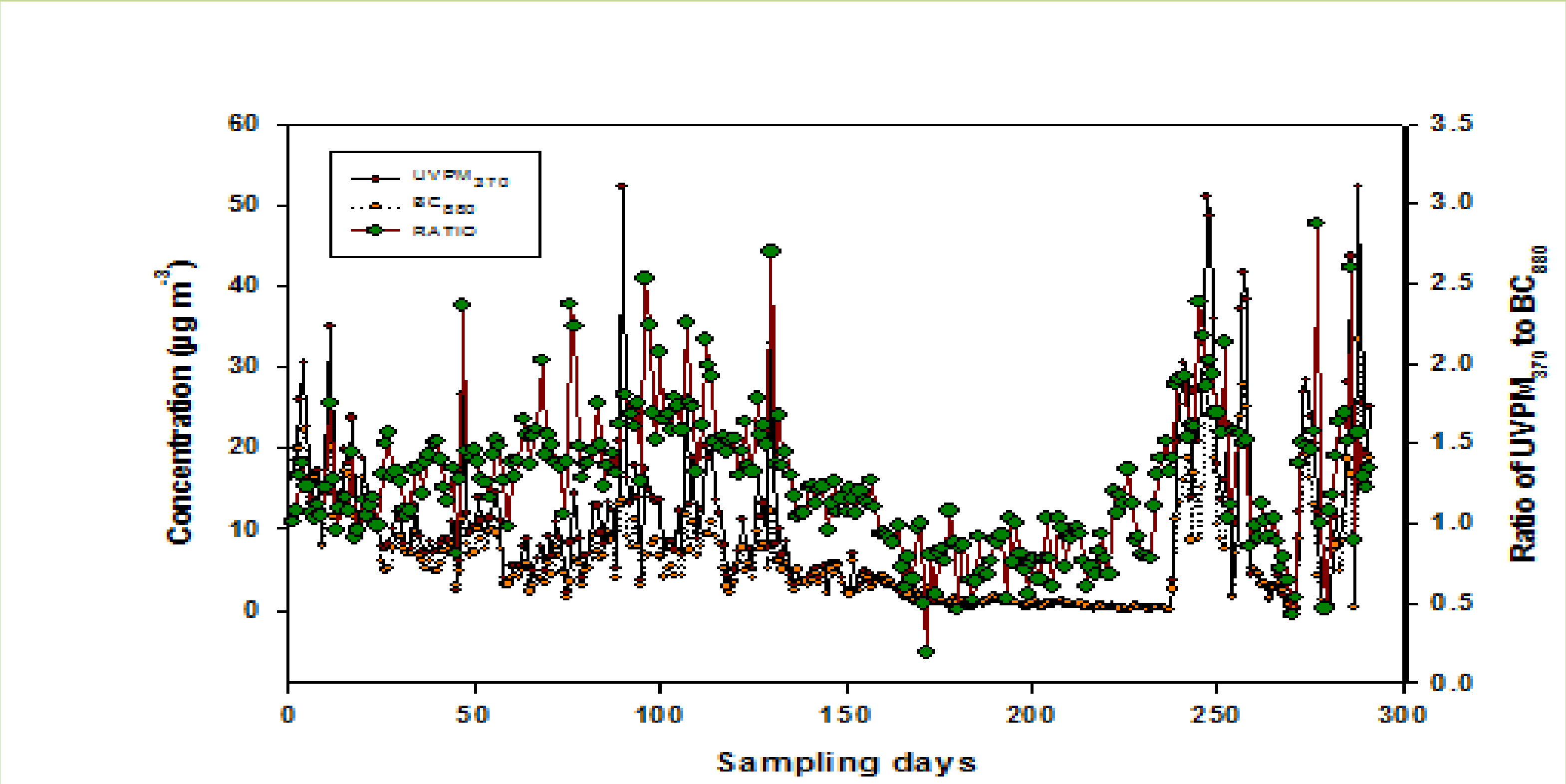
- The dry deposition of BC on natural surface has been determined using inferential method by multiplying the concentration of black carbon at Dayalbagh, Agra, India with reported dry deposition velocity (0.2 cm s^{-1})

- Radiative forcing were calculated using OPAC and SBDART model.

Results



The average mass concentration of BC was found to be 5.3 µg m^{-3} ranged from (0.05-66 µg m^{-3}) during the entire study period.



- The absorption coefficient is found to be higher during November followed by December month. This could be taken as another indication of the relative dominance of fossil fuel emissions during winter season.

- The mean ratio of BC at 370 nm to that at 880 nm ($R_{370/880}$) was 1.3 throughout the study period.

- The higher seasonal ratio of BC at 370 nm to that at 880 nm ($R_{370/880}$) have been shown in post-monsoon (1.6) and winter (1.4) while lowest in monsoon (0.9) seasons.

Dry deposition of BC

- The dry deposition flux of black carbon was found to be 0.9 mg m^{-2} d^{-1}.
- It varies from 0.09 to 11.4 mg m^{-2} d^{-1}.
- The dry deposition flux was found to be highest in winter and lowest in monsoon probably due to high concentration and low boundary layer.

Radiative forcing (W m^{-2}) during the study period

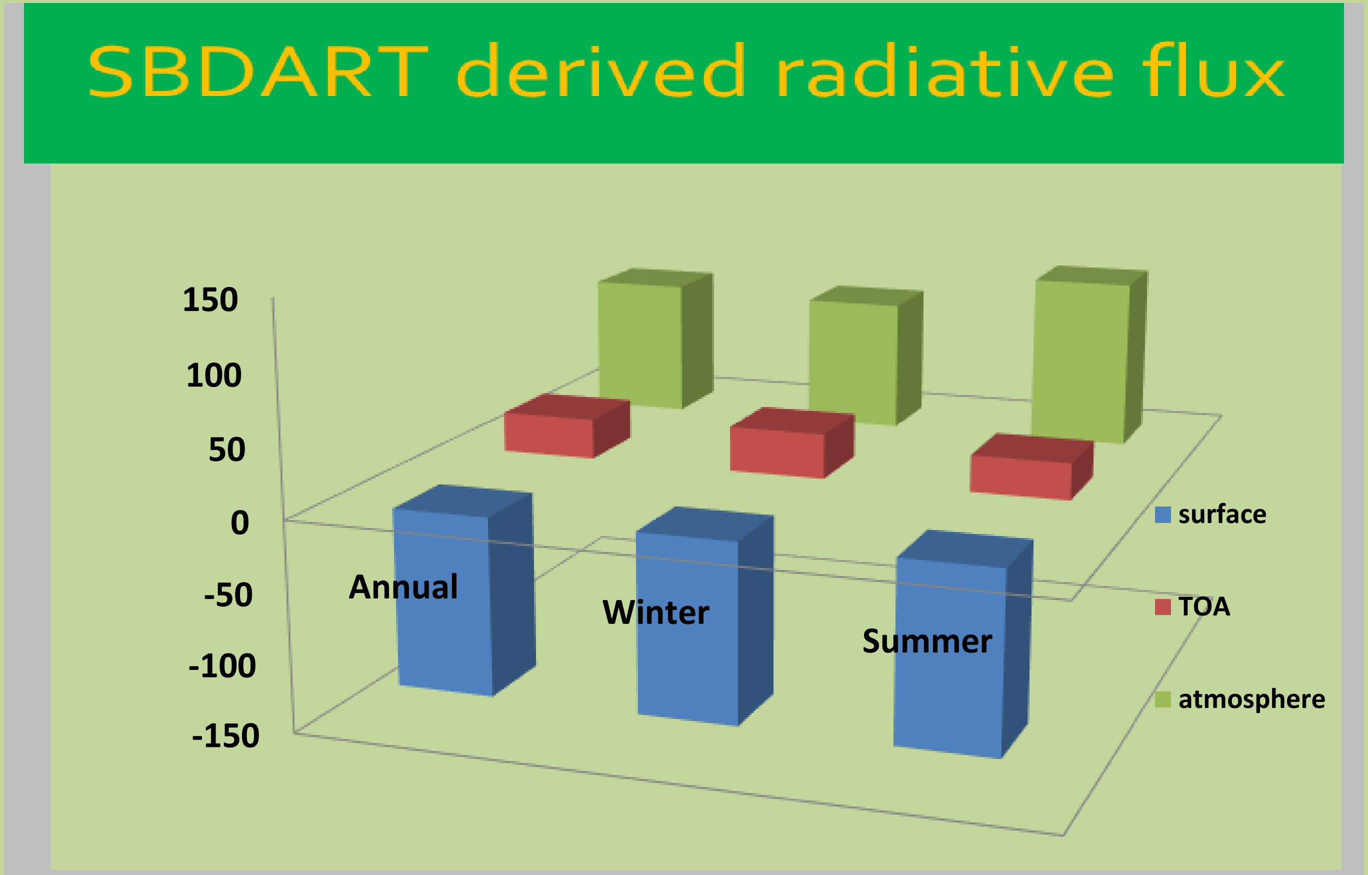


Fig. - Radiative forcing (W m^{-2}) during the study period at Agra region over Indo-Gangetic plain.

The mean estimated radiative forcing at 0.55 µm is -14 W m^{-2} at top of atmosphere while, at the surface net radiative forcing is -137 W m^{-2} and 123 W m^{-2} at the atmosphere.

Acknowledgement

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