NCAP-COALESCE

CarbOnaceous AerosoL Emissions, Source apportionment & ClimatE impacts

Understanding scientific complexities related to carbonaceous aerosols focussing on issues underlying their origin and fate, and their role as drivers of regional climate change over India.

Research BRIEFS

Tracing the predominant sources of carbon in PM2.5 using δ13C values together with OC/EC and select inorganic ions over two COALESCE locations

Author List : Kajal Yadav[1], Ramya Sunder Raman[1*], Ankur Bhardwaj[1], Debajyoti Paul[2], Tarun Gupta[3], Deeksha Shukla[1], S.V. Laxmi Prasad[4], Prabhavathi Venkatesh[5]

[1]Department of Earth and Environmental Sciences, Indian Institute of Science Education and Research Bhopal, Bhopal 462066, India, [2]Department of Earth Sciences, Indian Institute of Technology Kanpur, Kanpur 208016, India, [3]Department of Civil Engineering, Indian Institute of Technology Kanpur, Kanpur 208016, India, [4]Department of Environmental Engineering, Sri Jayachamarajendra College of Engineering Mysuru 570006, India, [5]Department of Chemical Engineering, Indian Insitutue of Technology Madras, Madras 600036, India

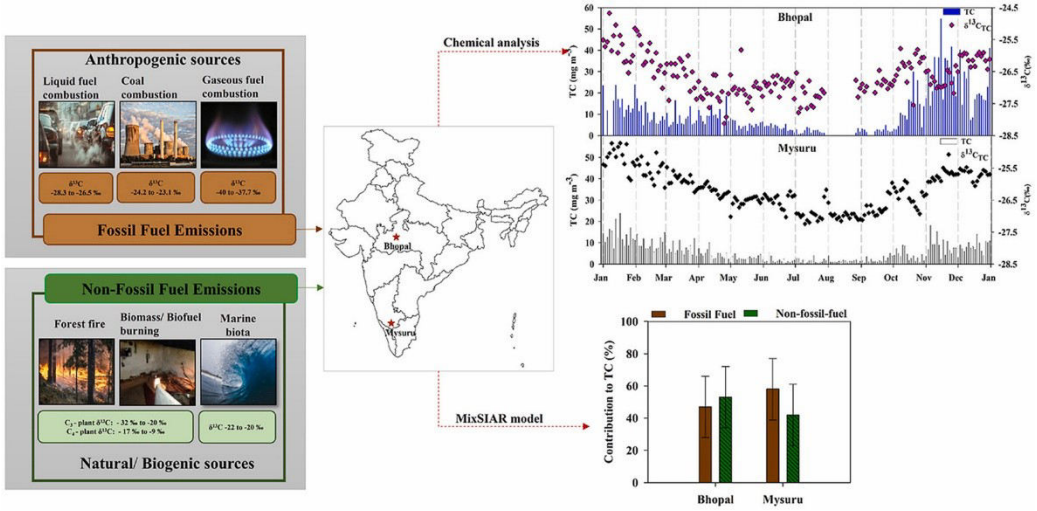

Figure. Times series of TC (μg m^{-3}) and δ^{13}C values (‰) in $PM_{2.5}$ at Bhopal and at Mysuru

Key highlights:

- At Mysuru, narrow δ^{13}C range suggests few TC sources, likely traffc emissions.
- Low δ^{13}C values during monsoon at Bhopal and Mysuru likely due to SOC formation.
- At Bhopal, fresh biomass burning/vehicular exhaust TC important during pre-monsoon.
- At Bhopal, regional aged biomass burning important TC source during post-monsoon.
- MixSIAR quantifed fossil fuel TC at Mysuru (62%) exceeded that at Bhopal (47%).

Summary of your Research:

As part of the COALESCE (Carbonaceous Aerosol Emissions, Source apportionment and Climate Impacts) campaign the present study investigated total carbon (TC) sources at two regional sites (Bhopal and Mysuru) in India during 2019. To achieve this, ambient PM2.5 was collected at these sites and utilized organic carbon (OC), elemental carbon (EC) and water-soluble inorganic ions together with δ^{13}C values. The annual average δ13C values (− 26.2 ± 0.6‰) at Mysuru and Bhopal (− 26.6 ± 0.6‰) were comparable.

However, at Mysuru, except during winter, day-to-day variability was much lower (narrow range of −26.8 to −26.0‰) than that at Bhopal (range: −28.1 to −24.7‰), suggesting that TC was contributed by few sources, likely dominated by vehicular emissions. Seasonal average $\delta^{13}C$ values at Bhopal increased slightly (− 25.8 ± 0.5‰) during the winter (Jan–Feb) and decreased (− 27.0 ± 0.3‰) during the monsoon (Jun–Sep) season compared to the annual average.

MODIS derived fire spots and back trajectories, inferred that the δ13C values (−27.5 to −26.0‰) in Bhopal during the post-monsoon were indicative of dominant biomass burning contributions. δ13C values were input to a Bayesian model–MixSIAR to demonstrate the usefulness of such models in apportioning TC. In its simplest implementation, the model separated TC sources into fossil fuel emissions and non-fossil fuel sources . Fossil fuel combustion emissions accounted for 47 ± 19% (Bhopal) and 62 ± 22% (Mysuru) of the TC.

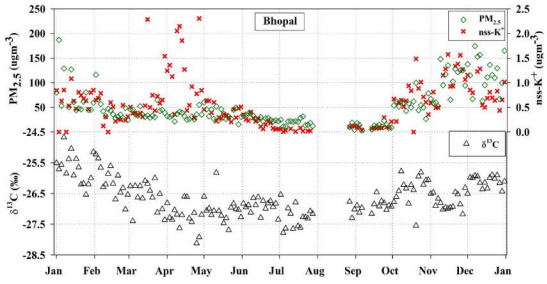

Figure. Temporal variability of PM2.5, nss-K+ (a biomass burning marker) and their co-variability with δ13C values during 2019 at Bhopal.

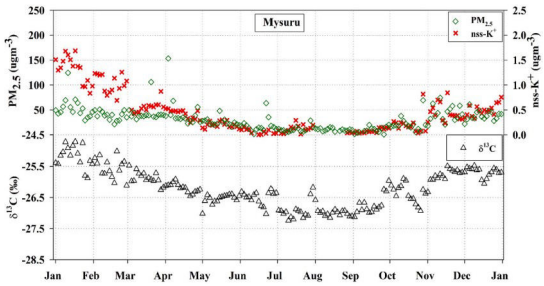

Figure. Temporal variability of PM2.5, nss-K+ (a biomass burning marker) and their co-variability with δ13C values during 2019 at Mysuru..

Take away/conclusion :

- Striking seasonal patterns in δ13C values were observed at both the sites, with the highest value observed during the winter season and the lowest during the monsoon season. Different δ13C values indicate different chemical composition of carbonaceous aerosols and/or rather different sources of aerosol carbon origin during the year.
- The δ13C values (average − 26.6 ± 0.6%) in Bhopal were predominantly influenced by biomass burning and fossil fuel combustion sources. Together with the back-trajectories and MODIS fire count, findings suggest that the PM2.5 composition is strongly affected by anthropogenic activities, including agricultural residue burning and liquid fuel combustion in this region. In contrast, δ13C values observed in Mysuru suggest the consistent influence of liquid fuel emissions, signifying the dominance of proximal sources in influencing TC concentrations.
- MixSIAR resolved the TC using $\delta^{13}C$ values into two source categories: fossil fuel combustion emissions and non-fossil fuel sources. The model results reveal that in Bhopal fossil fuel combustion accounted for 47 ± 19% of the TC, whereas, in Mysuru, it accounted for 62 ± 22% of the TC.

Research Article citation

Yadav, K., Raman, R. S., Bhardwaj, A., Paul, D., Gupta, T., Shukla, D., Prasad, S. V. L., Lokesh, K. S., & Venkatesh, P. (2022). Tracing the predominant sources of carbon in PM2. 5 using δ13C values together with OC/EC and select inorganic ions over two COALESCE locations. Chemosphere, 308, 136420..

Link:
https://doi.org/https://doi.org/10.1016/j.envpol.2019.113077

National Co-ordinator

(NCAP-COALESCE Project)
Interdisciplinary Programme in Climate Studies

Indian Institute of Technology, Bombay
Powai, Mumbai-400076, India

Phone: 91-22-2576-5141

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