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Source quantification of PM_{2.5} using $\delta^{13}\text{C}$ values along with corresponding organic carbon, elemental carbon, and select inorganic ions over two COALESCCE network locations

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Ratios of stable carbon isotopes reported as values of $\delta^{13}\text{C}$ ‰, are often used to provide information about the origin of aerosol particles because these stable carbon isotopes are conserved through time and change predictably during atmospheric processes. As part of the COALESCCE network ambient aerosol measurement campaign, PM_{2.5} samples were collected at two regionally representative sites during 2019 (Bhopal and Mysuru) in India with the objectives of identifying and estimating their potential sources at regional level and quantitatively estimating the anthropogenic impact on their carbon content by coupling the $\delta^{13}\text{C}$ values with their corresponding organic carbon (OC) and elemental carbon (EC) concentrations along with inorganic water soluble ion concentrations. The EC, OC, water soluble inorganic ions and $\delta^{13}\text{C}_{\text{TC}}$ values were determined using a variety of analyses.

At Bhopal, the average OC and EC concentrations were 9.5 and 2.4 $\mu\text{g}/\text{m}^3$, respectively, with an average $\delta^{13}\text{C}$ value of $-26.6 \pm 0.6\text{‰}$. At Mysuru, the average OC and EC concentrations were 4.5 and 1.0 $\mu\text{g}/\text{m}^3$, respectively, with an average $\delta^{13}\text{C}$ of $-26.2 \pm 0.6\text{‰}$. Notable differences were observed in the seasonality of the $\delta^{13}\text{C}$ values with slight increase ($-25.8 \pm 0.5\text{‰}$) during the winter (Jan, Feb) and a decrease ($-27.0 \pm 0.3\text{‰}$) during the monsoon (Jun, Jul, Aug, Sep) in Bhopal. Further, based on the MODIS derived fire spots and back trajectories, we infer that $\delta^{13}\text{C}$ values (-27.5 to -26.0‰) in Bhopal during post-monsoon season (Oct, Nov, Dec) were predominately associated with biomass burning. Further, the enrichment in both non-sea salt potassium and sulphate/nitrate was significantly higher than the other inorganic species, suggesting that biomass burning in Bhopal during post-monsoon was aged and less fresh and may have transported from the Indo-genetic plains during post harvesting periods. In contrast, $\delta^{13}\text{C}$ values at Mysuru did not exhibit pronounced seasonality and ranged between -25.3 to -26.7‰ during all of 2019, suggesting the influence of proximal sources.

Finally, we use the $\delta^{13}\text{C}$ values with priors in a Bayesian mixing model MixSIAR to resolve the TC at

both sampling locations into fossil fuel combustion and non-fossil fuel combustion carbon. We find that in Bhopal fossil fuel combustion accounted for $53.6 \pm 12.2\%$ of the TC, whereas, in Mysuru, it accounted for $60.4 \pm 6.3\%$ of the TC.