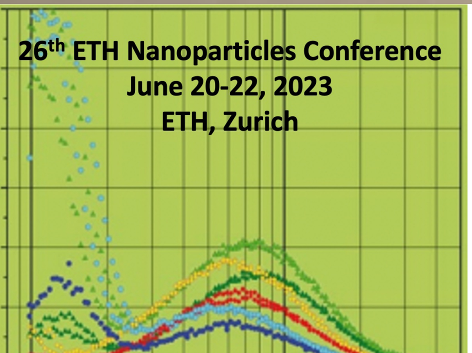
Aerosol optical properties measured from two heterogenous mix of Indian vehicular fleets



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- Carbonaceous aerosols consist of light absorbing BC or EC (near-IR region) and light scattering OC with a fraction of it that absorbs light, BrC (near-UV spectrum) ***(Laskin et. al., 2015)***

- On-road transportation sector have a net warming impact on climate over all time scales and are detrimental to air quality ***(IPCC, 2021)***

- Vehicle tailpipe emissions profiles of diesel and gasoline are distinctly different: net radiative effect depends on type of fuel used ***(Huang et. al., 2020)***

- **In this study, we are examining the optical properties of aerosols emitted from real-world vehicular fleets in India**

On-road vehicles queued up at Mulund Toll Plaza, Mumbai

Study area

Twin-site (roadside/background) measurements

LBS Road

95% LDV + 5% HDDV fleet

Traffic volume: 2878 ± 541 veh.hr^{-1}

Fuel composition: 44% gasoline, 30% diesel, 22% CNG, 4% electric

%super-emitter: 12% ± 2%

Mulund-Thane Toll Plaza

90% LDV + 10% HDDV fleet

Traffic volume: 4633 ± 709 veh.hr^{-1}

Fuel composition: 34% gasoline, 48% diesel, 16% CNG, 2% electric

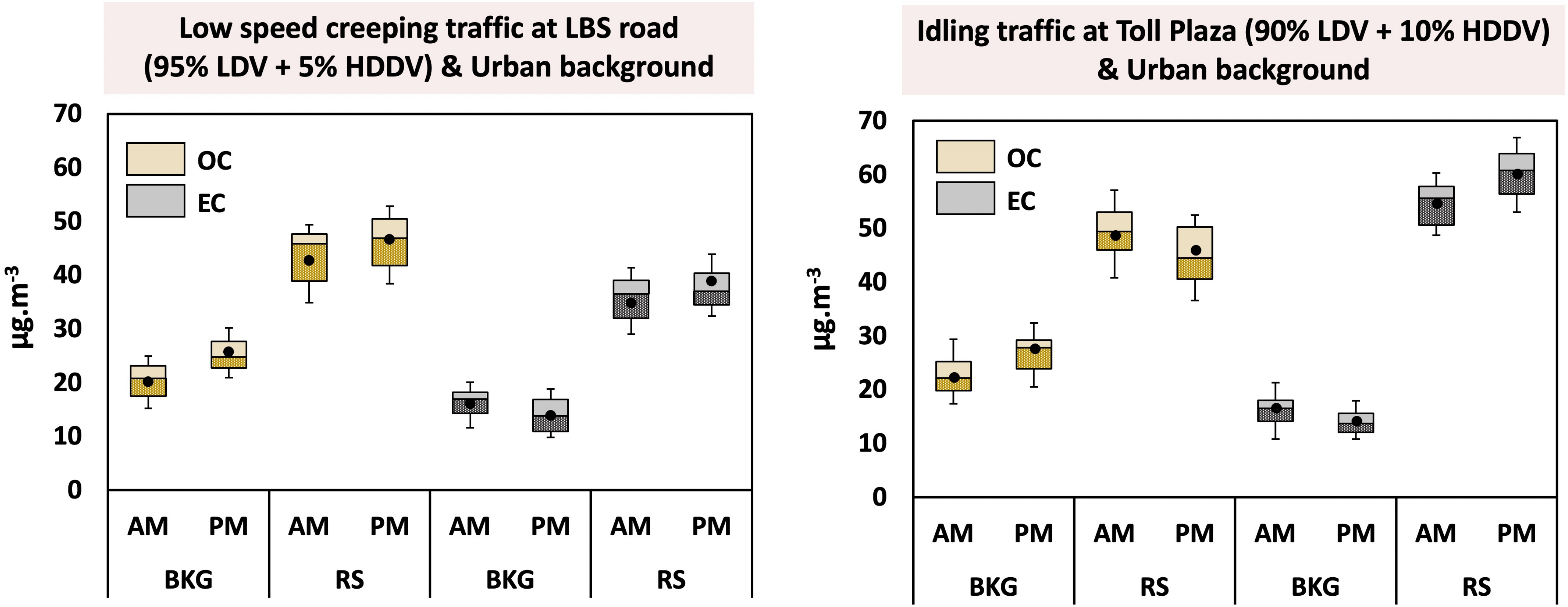
%super-emitter: 18% ± 4%

Background: ESED Terrace, IIT Bombay

LDV: Light-duty vehicles

HDDV: Heavy-duty diesel vehicles

Carbonaceous aerosols profile



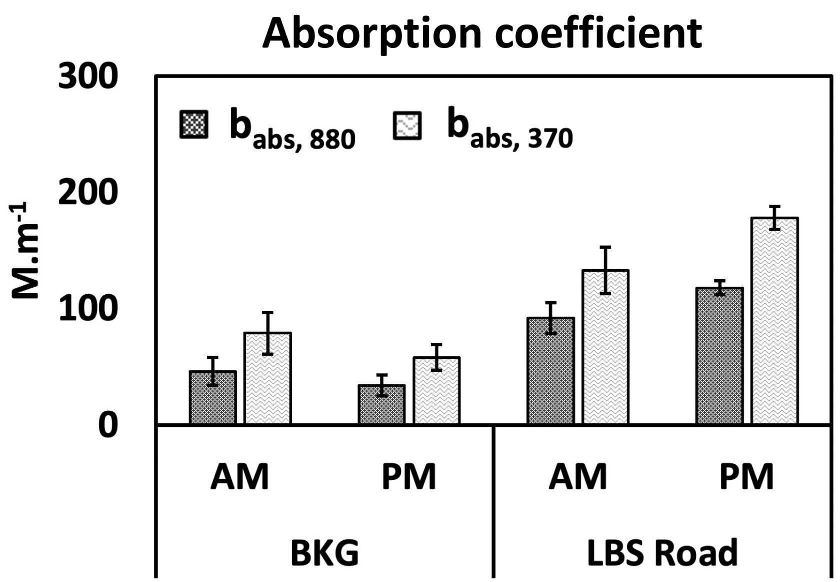
BKG: Background

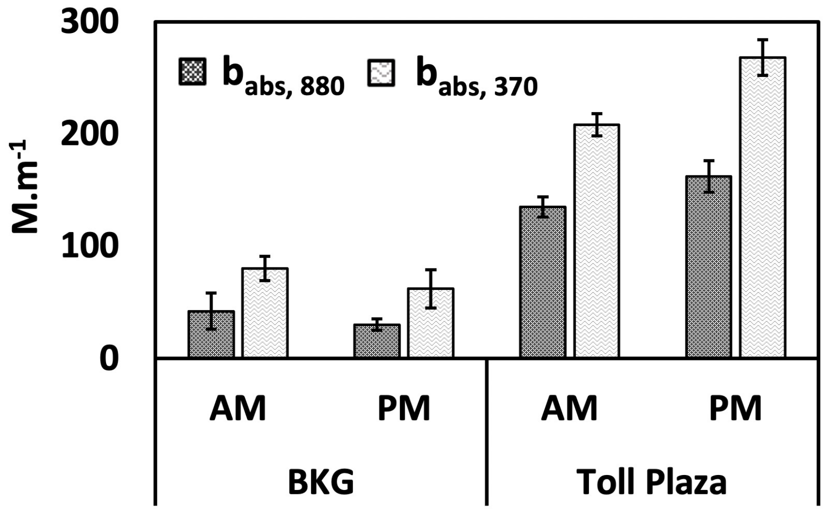
RS: Roadside

AM: 07:00 to 11:59 am
PM: 12:00 to 17:00 pm

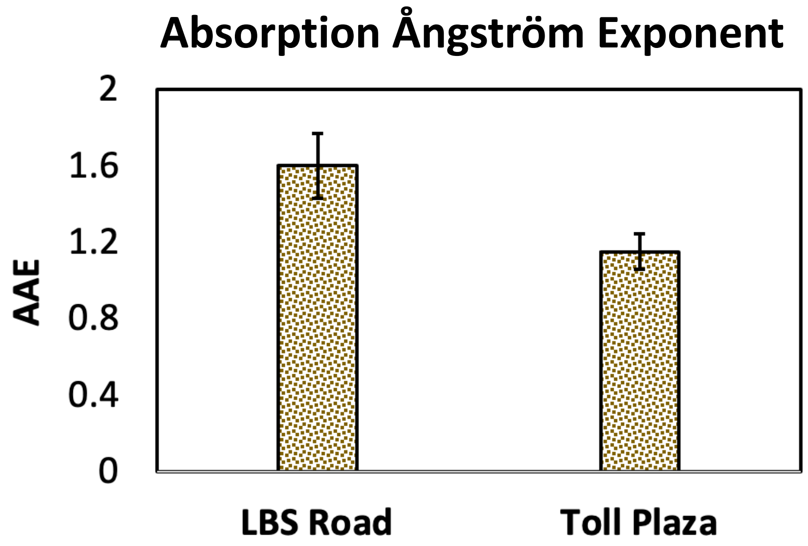
- ❑ Higher traffic volume and HDDV fraction led to >> (OC +EC)/$PM_{2.5}$ and >> EC at Toll plaza
- ❑ Lower volatile OC and Soot-EC increased by 1.5 and 2.1 times at Toll plaza driven by higher %HDDVs and %SE
- ❑ Similar to findings from our road-tunnel studies: >>OC in LDV fleet (at Freeway Tunnel); >>EC in 20% HDDV fleet (at Kamshet Tunnel)

Absorption properties of measured aerosols



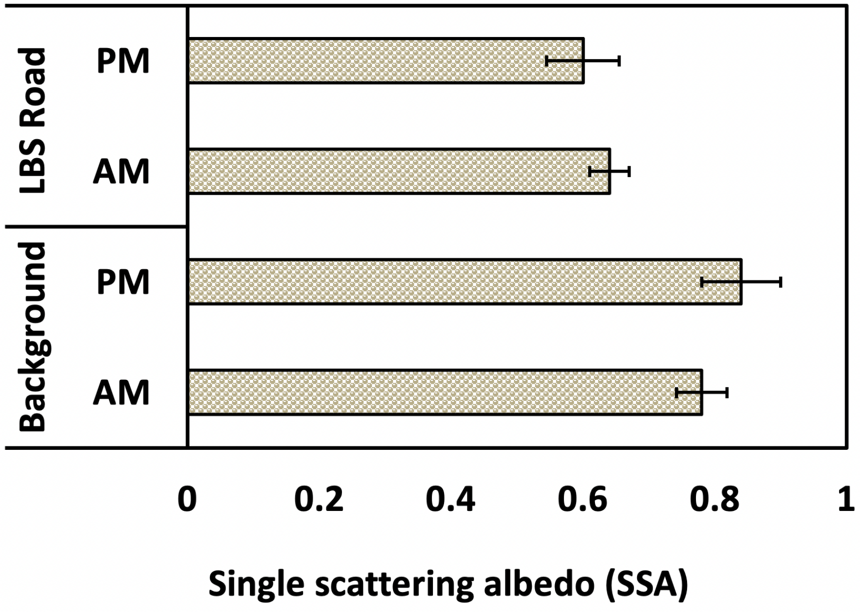


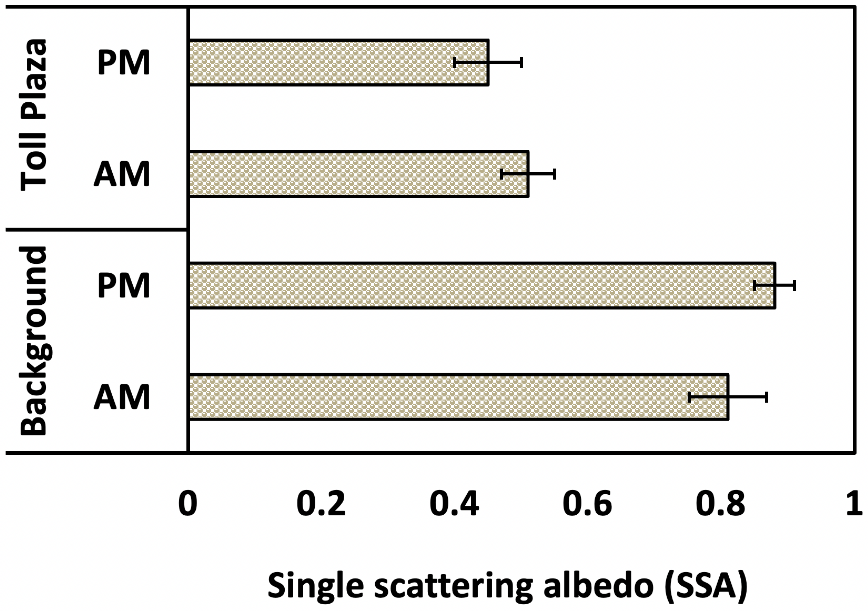
- ❑ Light absorption at Toll plaza 1.4 to 2.6 times higher
- ❑ >> during PM period when %HDDVs and %SE was high
- ❑ While lower volatile OCs and $AAE_{370/880}$ show good correlation (R^2 = 0.62), water soluble OC do not



- ❑ AAE>1 indicates presence of BrC
- ❑ AAE>2 reported for biomass burning ***(Zhang et. al., 2020)***
- ❑ Avg. contribution of BrC absorption at 370 nm was 32% ± 6% (at LBS Road)
- ❑ EC contributed to 84% ± 4% of the total absorption at 670 nm (at Toll Plaza)

Single Scattering Albedo





SSA > 0.8 : cooling aerosols

SSA < 0.6-0.7: warming aerosols

- ❑ SSA of roadside aerosols are more atmospheric warming than aerosols at the background
- ❑ EC dominated aerosols at Toll plaza attributed to lower SSA
  typically reported SSA of EC is 0.15 - 0.48, SSA of OC is 0.85-.095 ***(Bahadur et. al., 2012)***
- ❑ NO_3^- and SO_4^{2-} were highly correlated with scattering coefficient (σ_{sp}) (R^2 = 0.74)

Summary and conclusion

1. Near-road carbonaceous aerosols accounted for 36 to 52% of the total $PM_{2.5}$

2. HDDV and super-emitters emit significantly more light absorbing aerosols than other vehicles
AAE>1 indicated presence of BrC but AAE close to 1 at Toll plaza indicated dominance of BC

3. However, relationships between chemical and optical properties of aerosols measured reveal that the absorbing and scattering depends on traffic composition and secondary sources

4. Urban roadside aerosols influenced by vehicular emissions were observed to be atmospheric warming compared to aerosols at urban background

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