Supplement of

Influence of semi-volatile aerosols on physical and optical properties of aerosols in the Kathmandu Valley

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S1: Calculation of Angstrom exponent of semi-volatile aerosol absorption/scattering

As mentioned in the original manuscript, 'wet' sample always represents ambient aerosol and 'dry' sample represents ambient air passing through TDD. For better clarification, how we computed AAE and SAE, we provide below text as additional supplementary material.

The semi-volatile aerosol fraction contribution to ambient aerosol properties were measured through the difference between wet and dry aerosol properties.

$$SV_{AP} = WA_{AP} - DA_{AP}$$

Where,
SV_{AP} = Semi-Volatile aerosol fraction contribution which can be number, scattering or absorption
WA_{AP}=Wet aerosol property which is ambient aerosol number, scattering or absorption
DA_{AP}= Dry aerosol property which is TDD derived aerosol number, scattering or absorption at different TDD set temperatures

For example semi-volatile aerosol fraction absorption contribution was calculated from the below formula.

$$SV_{Abs\_\lambda} = WA_{Abs\_\lambda} - DA_{Abs\_\lambda}$$

Where,
SV_{Abs_λ} = Semi-Volatile aerosol fraction absorption at wavelength λ
WA_{Abs_λ}=Wet aerosol absorption at wavelength λ
DA_{Abs_λ}= Dry aerosol absorption at wavelength λ

Wet and dry aerosol absorption were measured using identical aethalometers (AE-33) at seven different wavelengths. We derived semi-volatile aerosol fraction absorption at seven different wavelengths from above equation and aethalometer's (wet and dry) absorption data.

$$AE = -\frac{log\frac{E_{\lambda 1}}{E_{\lambda 2}}}{log\frac{\lambda_1}{\lambda_2}}$$

AE= Angstrom Exponent
$E_{\lambda 1}$= Absorption/Scattering/Extinction coefficient at wavelength λ1
$E_{\lambda 2}$= Absorption/Scattering/Extinction coefficient at wavelength λ2

From the above equation we derived wet, dry and semi-volatile aerosol fraction absorption/scattering angstrom exponent.

S2. Calculation of Single Scattering Albedo (SSA)

There is a constant fraction contribution of semi-volatile aerosol physical-optical properties in our experiments (figure 3, 7 and 10). Linear regression and correlation coefficients indicated that the average absorption and scattering losses at each temperature were almost consistent for a particular TDD set temperature with very little variation in the slope. Taking this into account, the linear slopes were used to derive the semi-volatile fraction contribution for wet (ambient) aerosol absorption and scattering. Same fractions were used to understand semi-volatile aerosol fraction contribution for given wet aerosols SSA. This will give important information on the nature of semi-volatile aerosol contribution to aerosol radiative forcing.

Single scattering albedo (SSA) is defined as the ratio of scattering to total extinction due to atmospheric aerosols as suggested in the equation below.

$$SSA = \frac{Scattering}{(Scattering + Absorption)} \quad (1)$$

Assuming wet aerosol SSA = 0.9 and scattering = 100, we derived the absorption using the above equation;

$$0.9 = \frac{100}{(Absorption + 100)} \quad (2)$$

$$=> Absorption = \frac{100-90}{0.9} \quad (3)$$

So, wet aerosol absorption = 11.11

Similarly, when we consider wet aerosol SSA = 0.95 and scattering = 100, absorption = 5.2

The semi-volatile aerosol fraction contribution derived from regression slopes were used in below equations.

$$Semi - volatile\ aerosol\ scattering = wet\ aerosol\ scattering * (\%\ contribution\ of\ semi - volatile) \quad (4)$$

$$Semi - volatile\ aerosol \text{ absorption} = wet\ aerosol \text{ absorption} * (\%\ contribution\ of\ semi - volatile) \quad (5)$$

For wet aerosols scattering =100 and absorption=11.11

Semi-volatile aerosol scattering from equn. 4 = 24.58 (Table S1 Column 3, given below) (for TDD set temperature 50°C while absorption = ((11.11*17)/100)) (Table S1 Column 2, given below)

$$SSA = \frac{Semi{-}volatile\ aerosol\ scattering}{Semi{-}volatile\ aerosol\ scattering + \ Semi{-}volatile\ aerosol\ absorption} \quad (6)$$

Semi-volatile SSA at 50°C = (24.58/(24.58+2.73))

=0.861595 (Table S1 Column 4) (for TDD set temperature 50°C)

Where;

Scattering (%) = Loss of scattering at T_i

Absorption (%) = Loss of absorption at T_i

T_i = TDD set temperature

Table S1: Table for wavelength interpolation

At 450nm	TDD temp	Absorption fraction	Scattering Fraction	SSA of semi-volatile fraction assuming wet SSA=0.9	SSA of semi-volatile fraction assuming wet SSA=0.95
	Room Temp	16.57	18	0.907291	0.954318
	50	24.58	17	0.861703	0.930072
	100	19.15	29	0.931707	0.966802
	150	23.05	39	0.938435	0.970183
	200	27.96	48	0.939269	0.970601
	250	30.36	62	0.948448	0.975169
	300	31.73	71	0.952738	0.977289
At 550nm					
	Room Temp	14.7	15	0.901892	0.951511
	50	23.59	13	0.832347	0.913776
	100	18.32	27	0.92996	0.965919
	150	22.02	38	0.939566	0.970749
	200	27.04	46	0.938748	0.97034
	250	29.13	59	0.948044	0.974969
	300	30.33	70	0.954112	0.977966
At 700nm					
	Room Temp	12.73	8	0.849886	0.923578
	50	20	8	0.782779	0.884956
	100	14.89	20	0.923668	0.962729
	150	18.33	32	0.940219	0.971075
	200	23.73	40	0.938218	0.970074
	250	25.64	52	0.948109	0.975001
	300	26.79	66	0.956887	0.979329

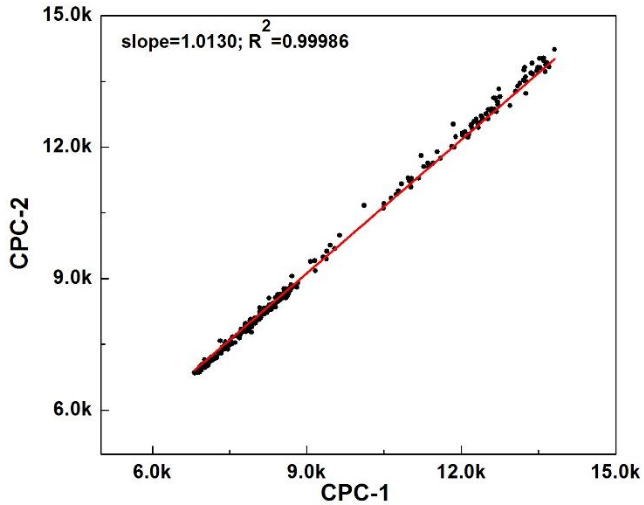

Figure S1. (a) Comparison of collocated CPC particle concentration (CPC-1 and CPC-2 indicate the particle concentration (#/cm^3) measured in individual CPC instruments)

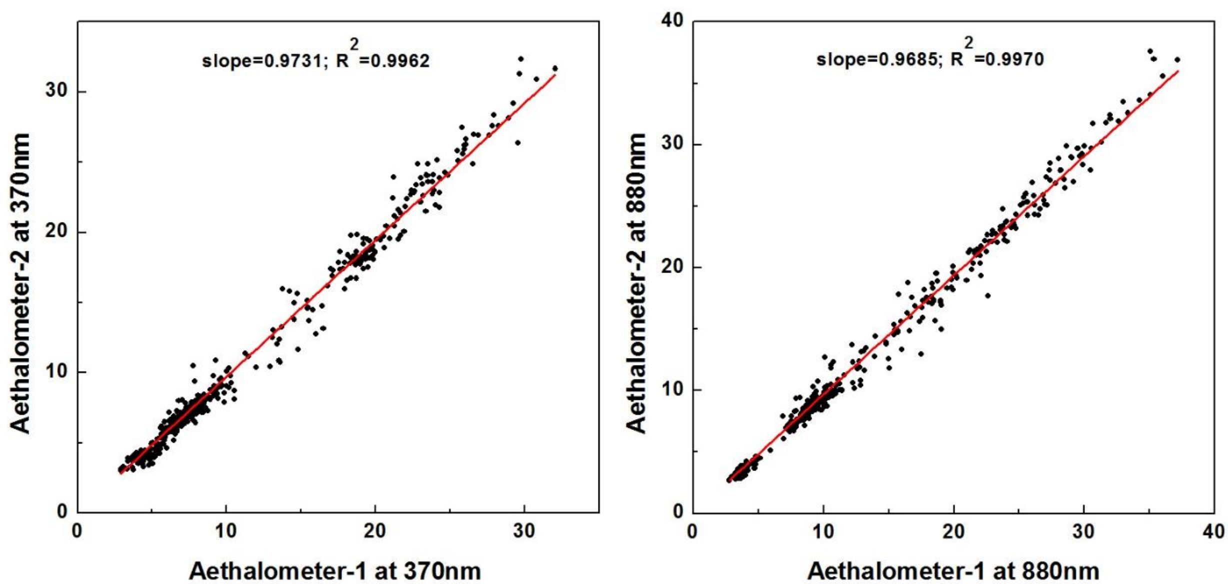

Figure S1. (b) Comparison of collocated Aethalometers black carbon concentration at 880 and 370nm (Aethalometer-1 and Aethalometer-2 indicate the black carbon concentration (µg/m^3) measured in individual Aethalometers).

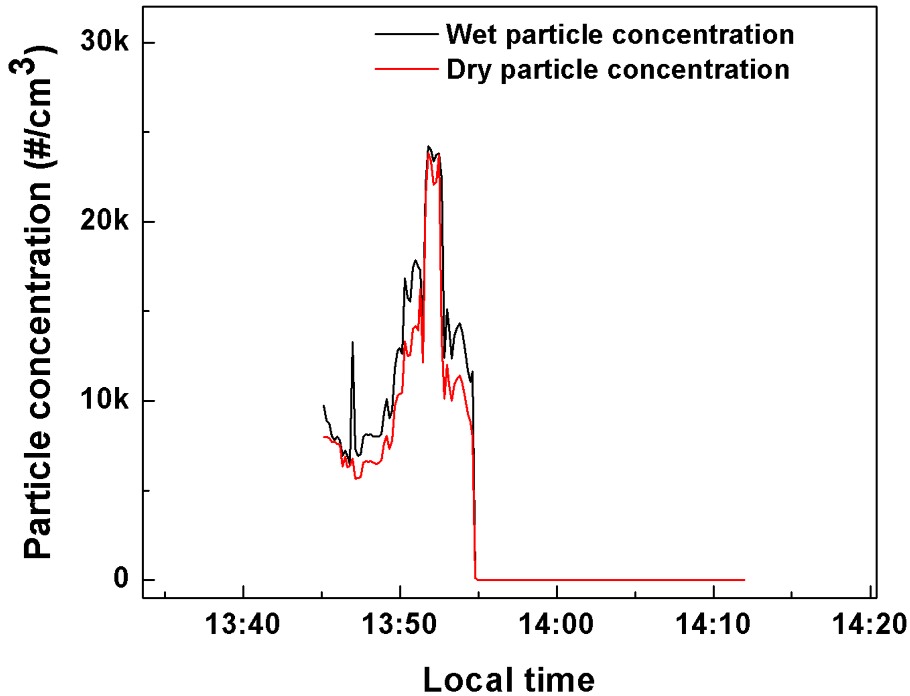

Figure S2. Leakage test conducted with CPC showing number concentration abruptly decreased to zero value in both instruments sampling wet and dry sample when HEPA filter is placed.

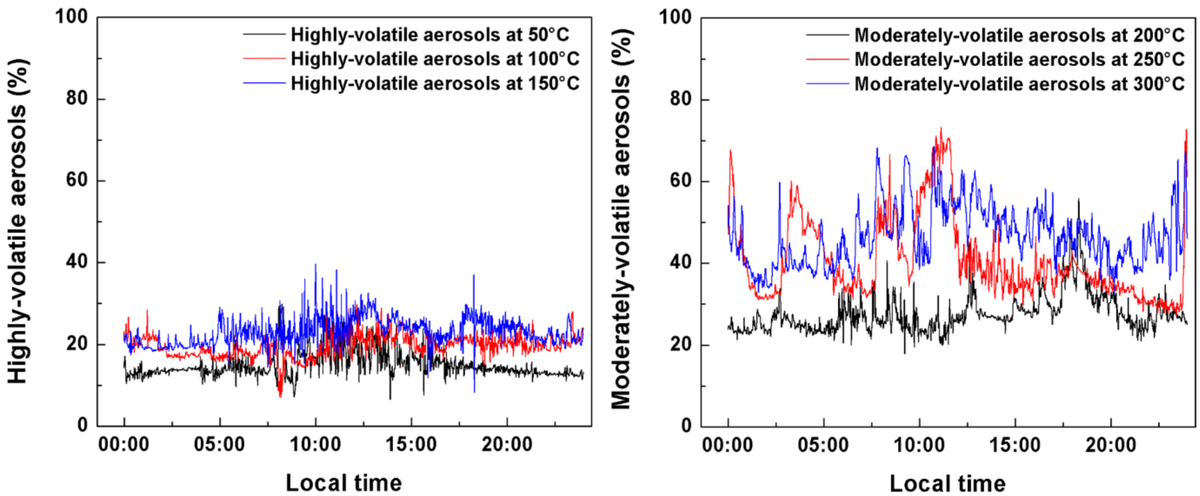

Figure S3. Diurnal variation of highly-volatile and moderately volatile aerosols.