

Supplemental Material

Multi-year submicron aerosols chemical composition at a high-altitude site in the Western Ghats of India

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Calibration and uncertainty for instruments used in the study:

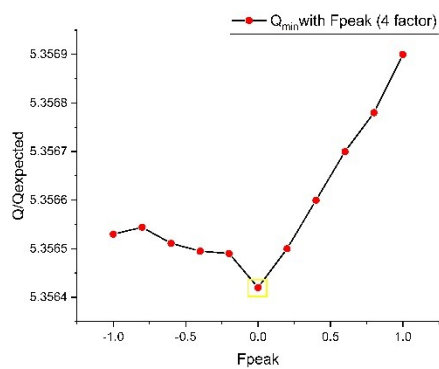
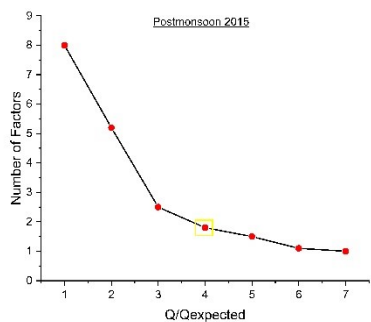
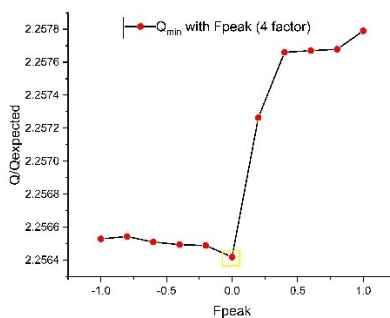
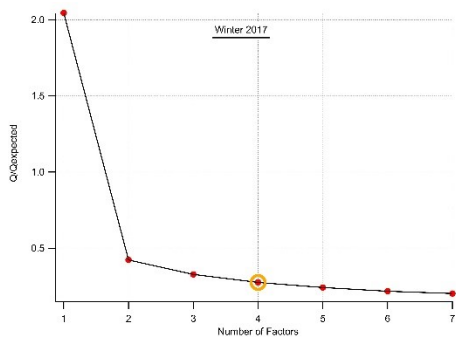
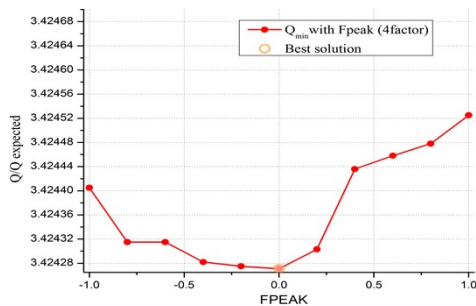
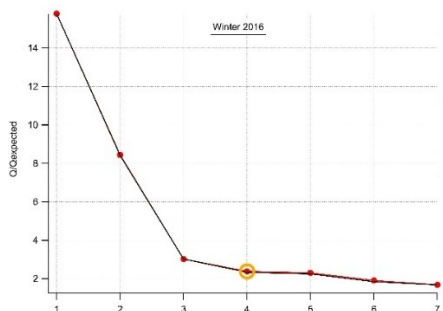
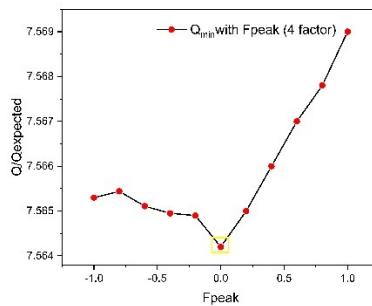
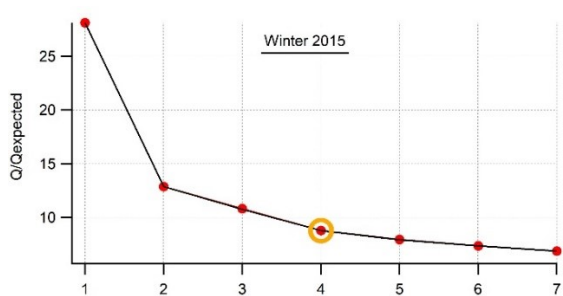
Aerosol Chemical Speciation Monitor (ACSM):

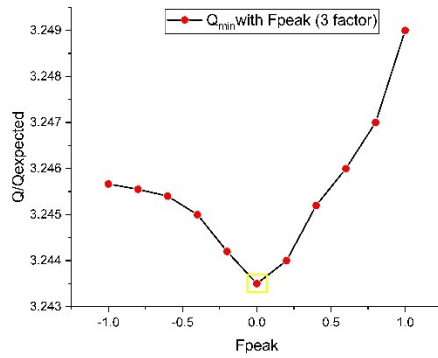
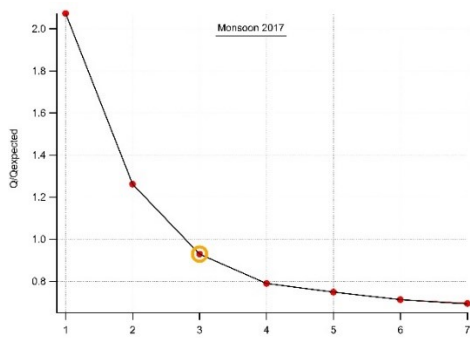
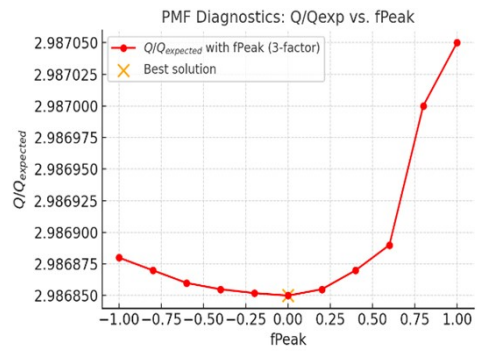
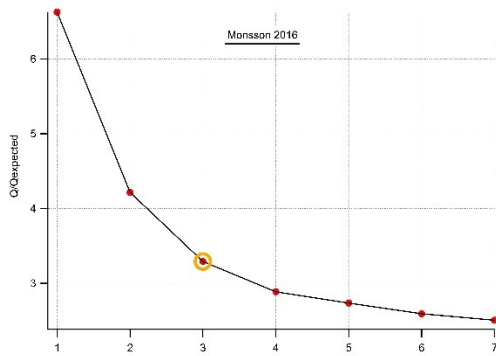
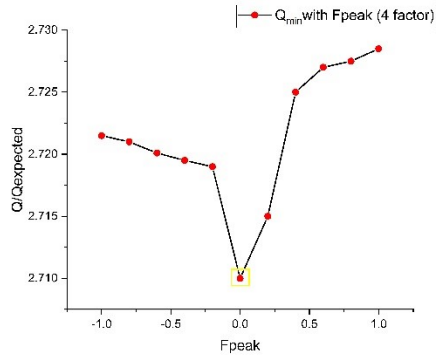
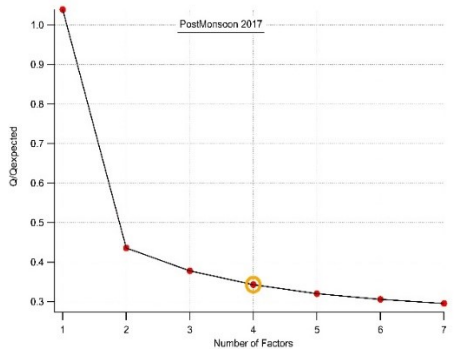
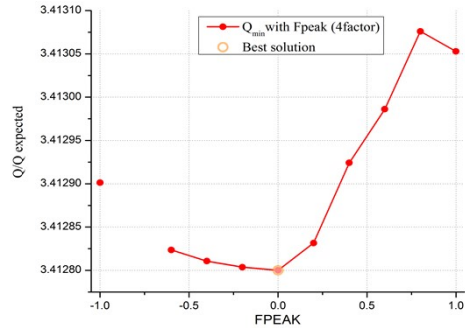
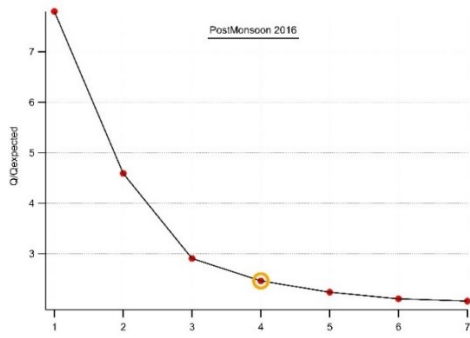
The ACSM data were analyzed for composition-based mass concentrations using the standard ACSM data analysis software implemented in Igor Pro (v6.37, Wave Metrics Inc., Oregon, USA). Data acquisition was performed with the standard DAQ software (v2.0.18) and subsequently processed in Tofware (v2.5.2). Raw mass spectral data were first imported into the analysis software, calibrated using reference ion peaks (O_2^+ , N_2^+ , H_2O^+ , CO_2^+), and integrated. Processed datasets were further examined for outliers, which were removed when necessary.

Mass concentrations of individual species were quantified from the summed ion signals of characteristic mass spectral fragments, weighted by their ionization efficiency (IE).¹ Since calibration of IE for all species is not feasible, relative ionization efficiency (RIE) values were applied following Ng et al.² The IE for nitrate was experimentally determined using monodisperse 300 nm NH_4NO_3 particles generated by a differential mobility analyzer (DMA) and simultaneously measured with the ACSM and a condensation particle counter (CPC). Based on this calibration, the RIE for ammonium was derived as 4. RIE values for organics, sulfate, and chloride were taken as 1.4, 1.2, and 1.3, respectively.² A collection efficiency (CE) of 0.5 was assumed, consistent with prior studies. Uncertainty associated with the assumed RIE values and CE is estimated to be ~20–35%.³

Detection limits were evaluated using Allan variance. ACSM measurements were acquired in filter mode for several hours to a day, processed with standard Tofware tools, and analyzed using the Allan variance routine. Limits of detection were defined as three times the standard deviation (3σ). For a 30-minute averaging interval, the 3σ detection limits were $0.21 \mu g m^{-3}$ (ammonium), $0.12 \mu g m^{-3}$ (organics), $0.03 \mu g m^{-3}$ (sulfate), $0.02 \mu g m^{-3}$ (nitrate), and $0.01 \mu g m^{-3}$ (chloride), consistent with values reported by Ng et al.²

To ensure data quality (QC/QA), ACSM operational parameters such as AB correction, chamber temperature, detector voltage, and flow rate were checked daily. To minimize humidity effects, a DRYER 027 (Aerodyne Research) was used, maintaining sample air humidity at ~19.2% while sampling at ambient temperature.





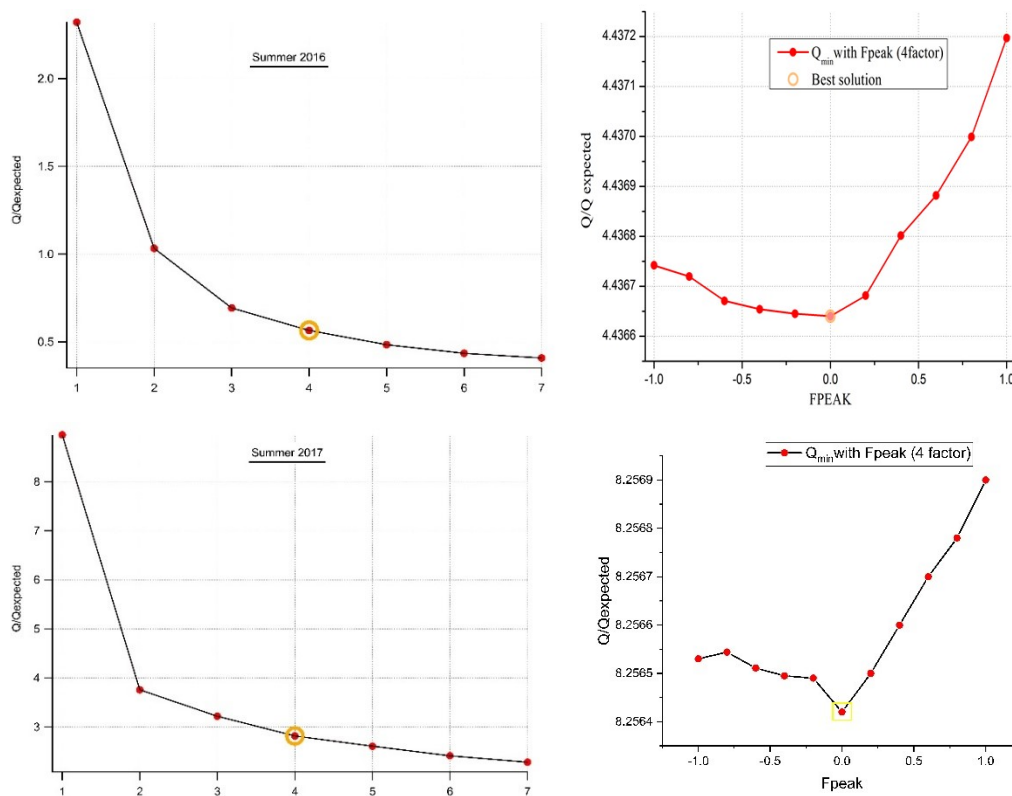


Fig. S1. Diagnostic plots of the PMF analysis on the organic mass spectra (PMF_{org}) of post-monsoon, winter, summer and monsoon data set from 2015-2018: Q/Q_{exp} vs. number of factors (left) and Q/Q_{exp} vs. FPEAK for the solution with optimal number of factors (right)

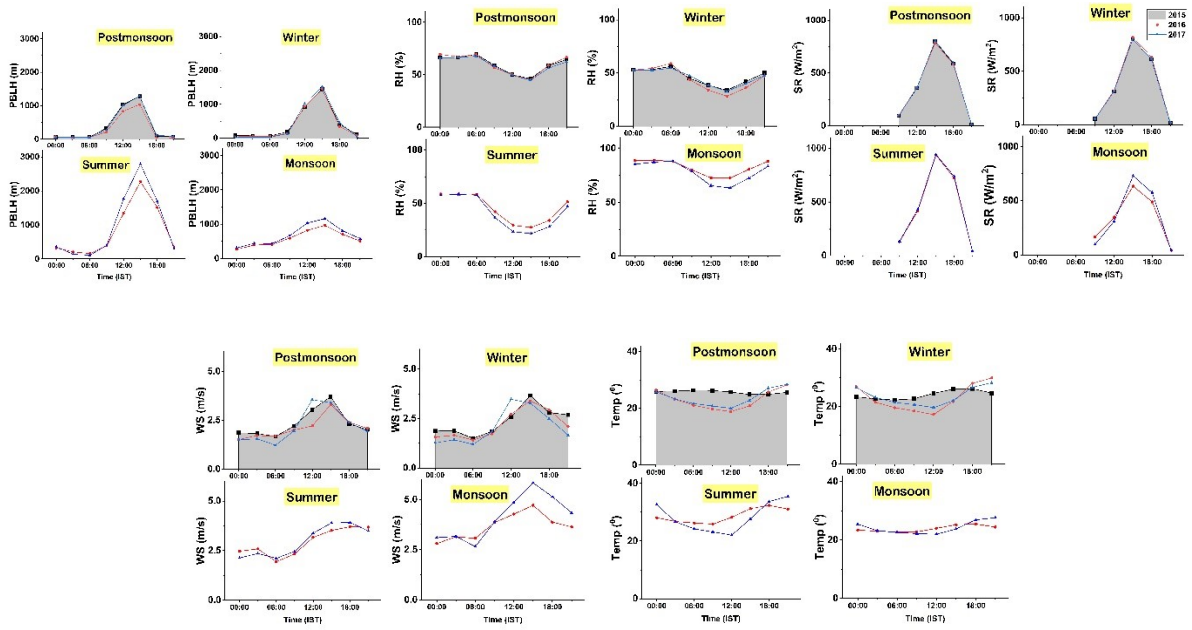


Figure S2. Average diurnal pattern of Planetary Boundary Layer Height (PBLH), relative humidity (RH), solar radiation (SR), wind speed (WS) and temperature (Temp) in different season

Table S1. Pearson correlation coefficients between NR-PM₁ and its chemical species (OA, SO₄²⁻, NO₃⁻, NH₄⁺, Cl⁻) and meteorological parameters (solar radiation, relative humidity, PBLH, wind direction and wind speed).

	NR-PM ₁	OA	SO ₄ ²⁻	NO ₃ ⁻	NH ₄ ⁺	Cl ⁻	Solar Radiation	Relative Humidity	PBLH	WDIR	WSPD
NR-PM ₁	1	0.8	0.8	0.6	0.8	0.1	0	-0.3	-0.1	-0.3	-0.3
OA		1	0.7	0.8	0.8	0.2	0	-0.4	-0.1	-0.3	-0.2
SO ₄ ²⁻			1	0.6	0.9	0.1	0	-0.3	0	-0.3	-0.2
NO ₃ ⁻				1	0.8	0.2	0	-0.4	-0.1	-0.3	-0.2
NH ₄ ⁺					1	0.1	0	-0.4	-0.1	-0.3	-0.3
Cl ⁻						1	0	-0.1	0.1	0.0	0.0
Solar Radiation							1	-0.4	0.6	-0.1	0.3
Relative Humidity								1	-0.4	0.3	0.1
PBLH									1	0.0	0.3
WDIR										1	0.3
WSPD											1

References

1. M. R. Canagaratna, J. T. Jayne, J. L. Jimenez, J. D. Allan, M. R. Alfarra, Q. Zhang, T. B. Onasch, F. Drewnick, H. Coe, A. M. Middlebrook and A. Delia, *Chemical and microphysical characterization of ambient aerosols with the Aerodyne Aerosol Mass Spectrometer*, *Mass Spectrom. Rev.*, **2007**, *26*, 185–222.
2. N. L. Ng, S. C. Herndon, A. Trimborn, M. R. Canagaratna, P. L. Croteau, T. B. Onasch, D. Sueper, D. R. Worsnop, Q. Zhang, Y.-L. Sun and J. T. Jayne, *An Aerosol Chemical Speciation Monitor (ACSM) for routine monitoring of the composition and mass concentrations of ambient aerosol*, *Aerosol Sci. Technol.*, **2011**, *45*, 780–794.

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