

1 *Atmospheric Chemistry and Physics*

2 Supporting Information for

3 **Chemical Characterization and Source Apportionment of Carbonaceous Aerosols during**
4 **Post-Monsoon Biomass Burning and Diwali at an Upwind Site of Delhi**

5 **Vasu Singh¹, Dilip Ganguly¹, Jaswant Rathore¹, Lokesh Kumar Sahu², Ravi K. Kunchala¹, Sagnik**
6 **Dey¹**

7 ¹Centre for Atmospheric Sciences, Indian Institute of Technology Delhi, New Delhi, India,

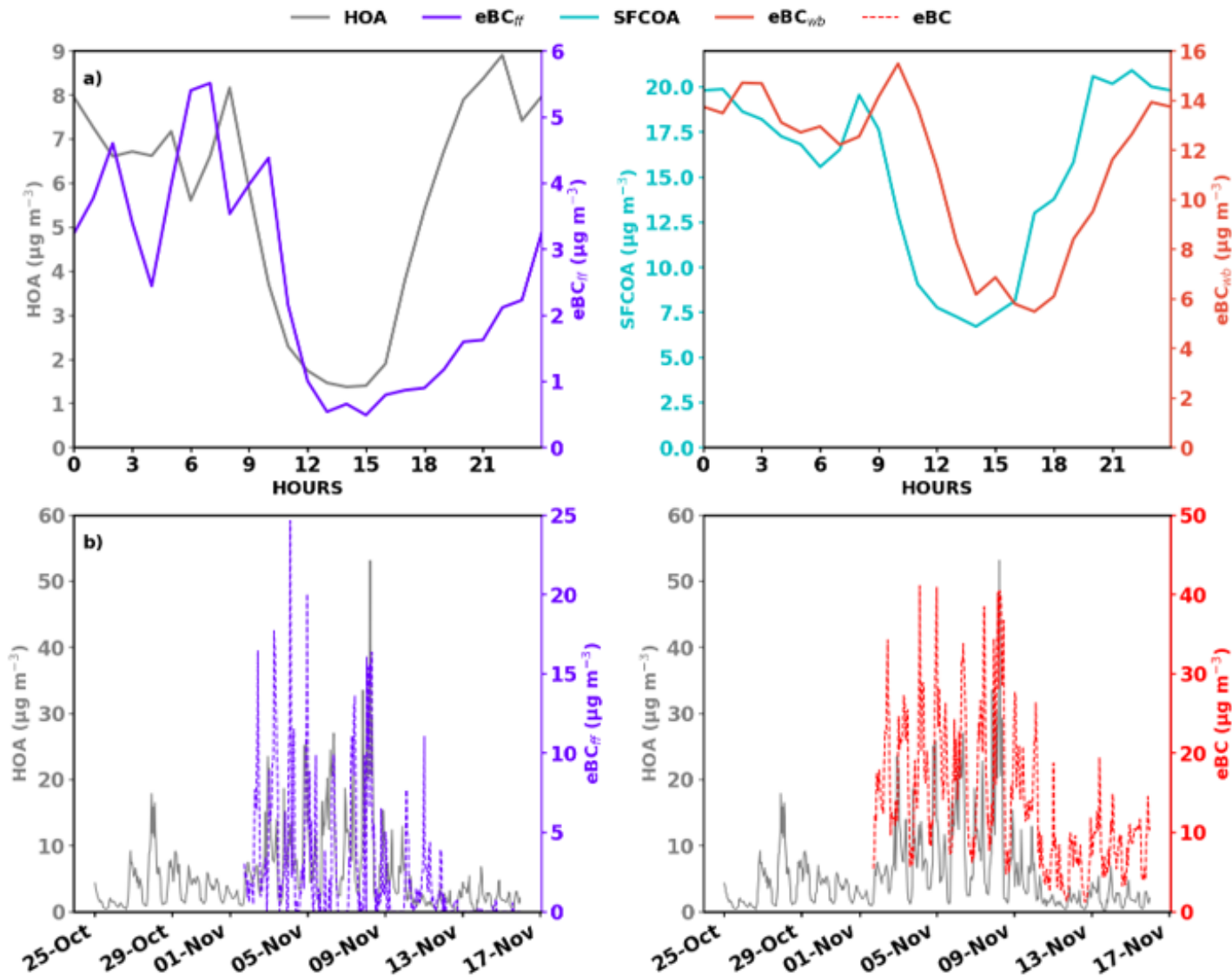
8 ²Space and Atmospheric Sciences Division, Physical Research Laboratory, Ahmedabad, India

9 Corresponding Author: Vasu Singh (Vasu.Singh@cas.iitd.ac.in, vasu.singh.iitd@gmail.com)

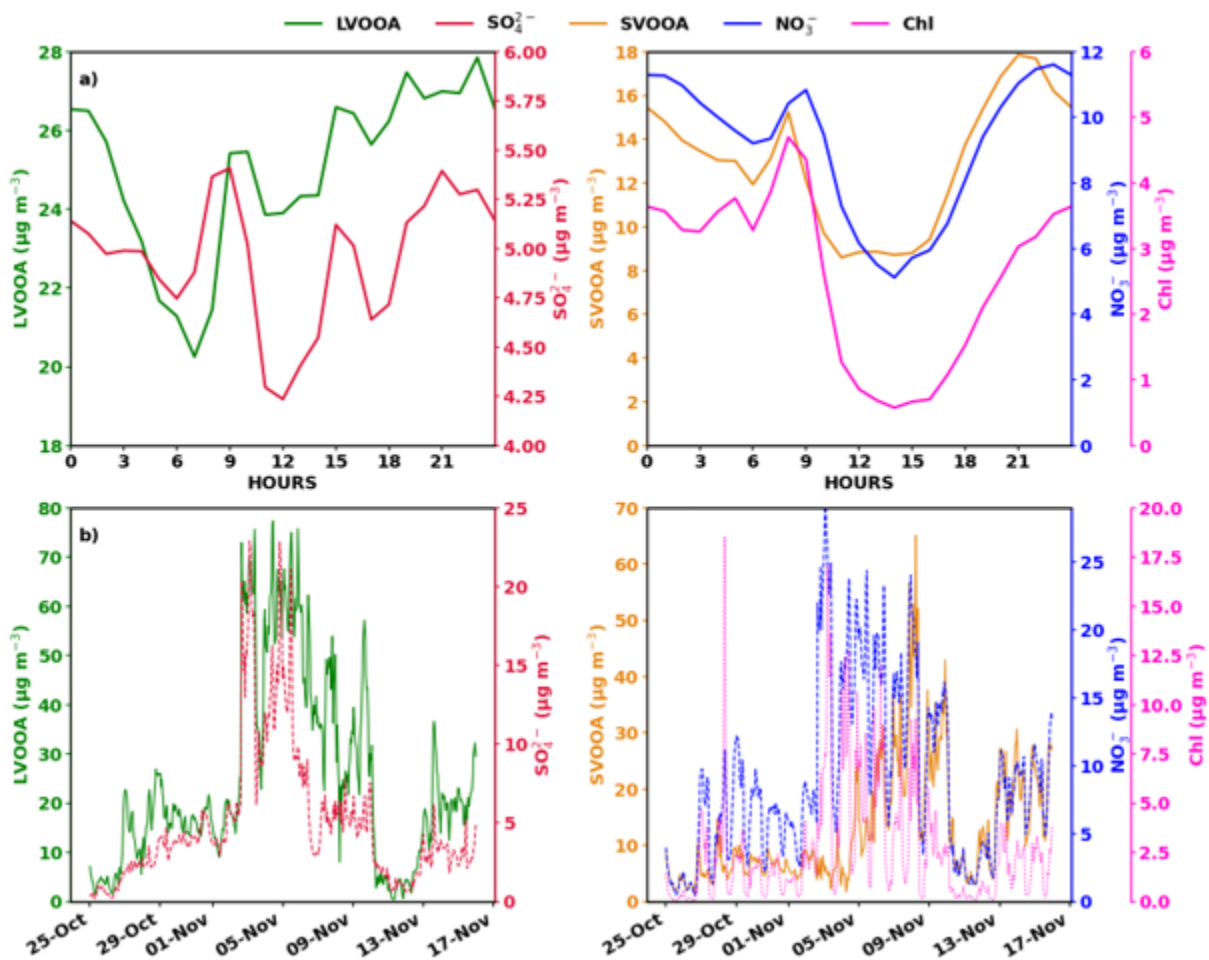
10
11
12
13 **Contents of this file**

14
15 This supporting information contains 14 additional Figures (S1-S14) and 4 Tables (S1-S5) in 18
16 pages.
17

18
19

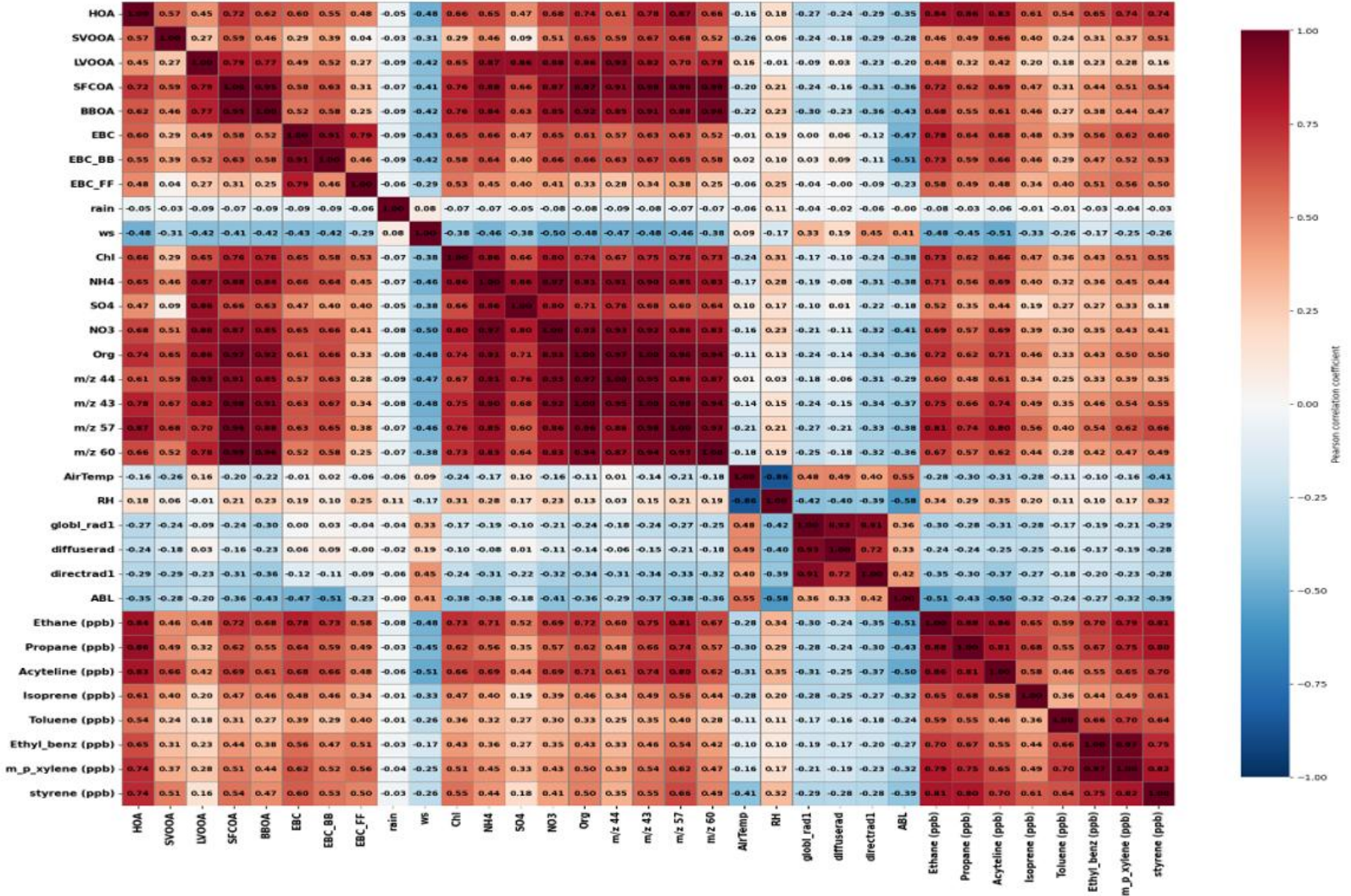


20 **Figure S1:** a) Mean diurnal mass concentrations for the Biomass Burning period. Additionally, the
21 diurnal profiles of eBC_{ff}, eBC_{wb} (from source apportionment of AE31 data) are shown with the
22 corresponding ACSM factors. b) Temporal trends of HOA with eBC and eBC_{ff}.



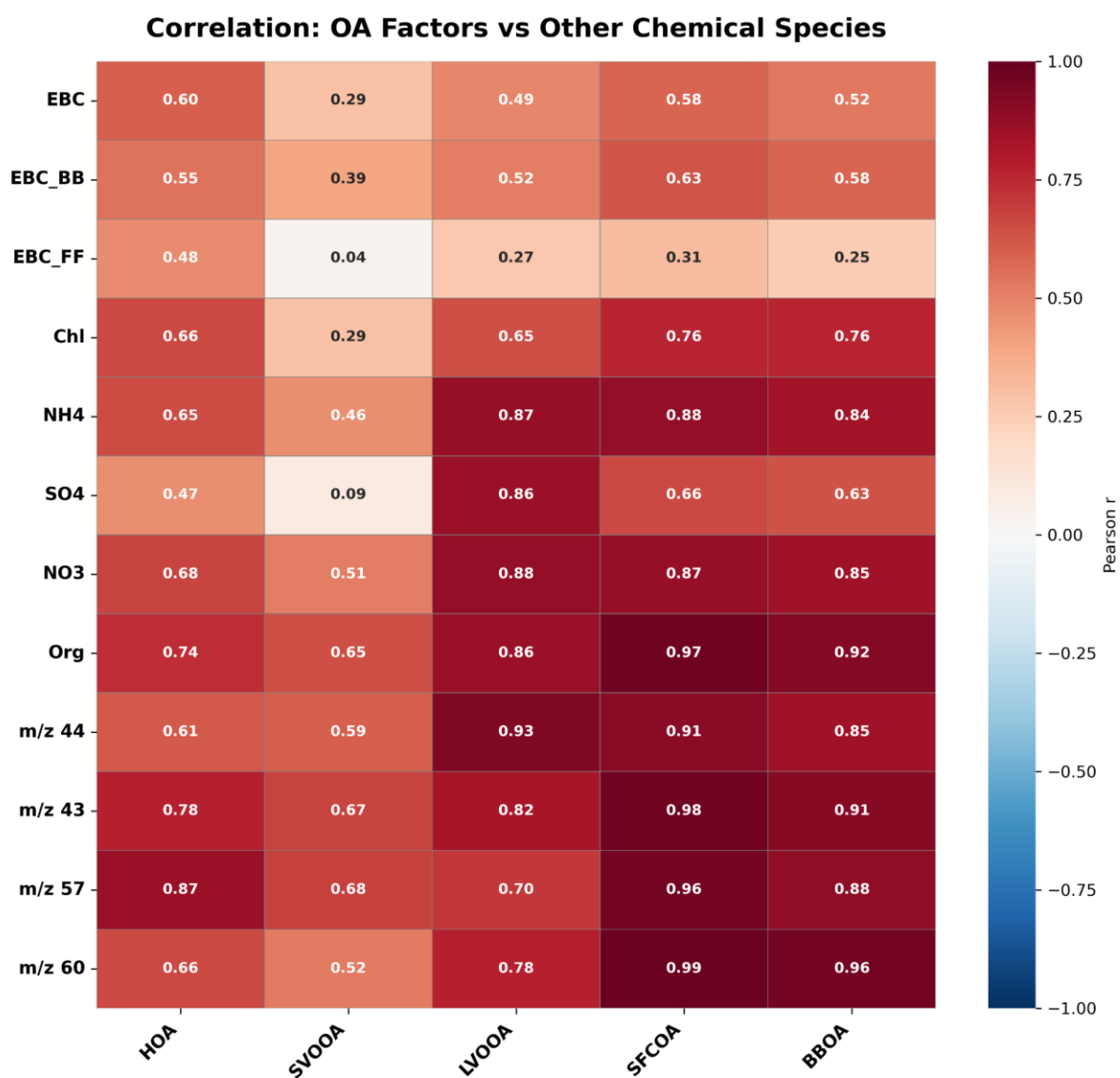
23
 24 **Figure S2:** a) Mean diurnal mass concentrations for the Biomass Burning period. Additionally, the
 25 diurnal profiles of SO_4^{2-} , NO_3^- and Chl^- are shown with the corresponding ACSM factors. b)
 26 Temporal trends of factors SVOOA and LVOOA with SO_4^{2-} , NO_3^- and Chl^- .

Correlation Matrix of Aerosol Species, Trace Gases, Meteorological and Radiation Parameters



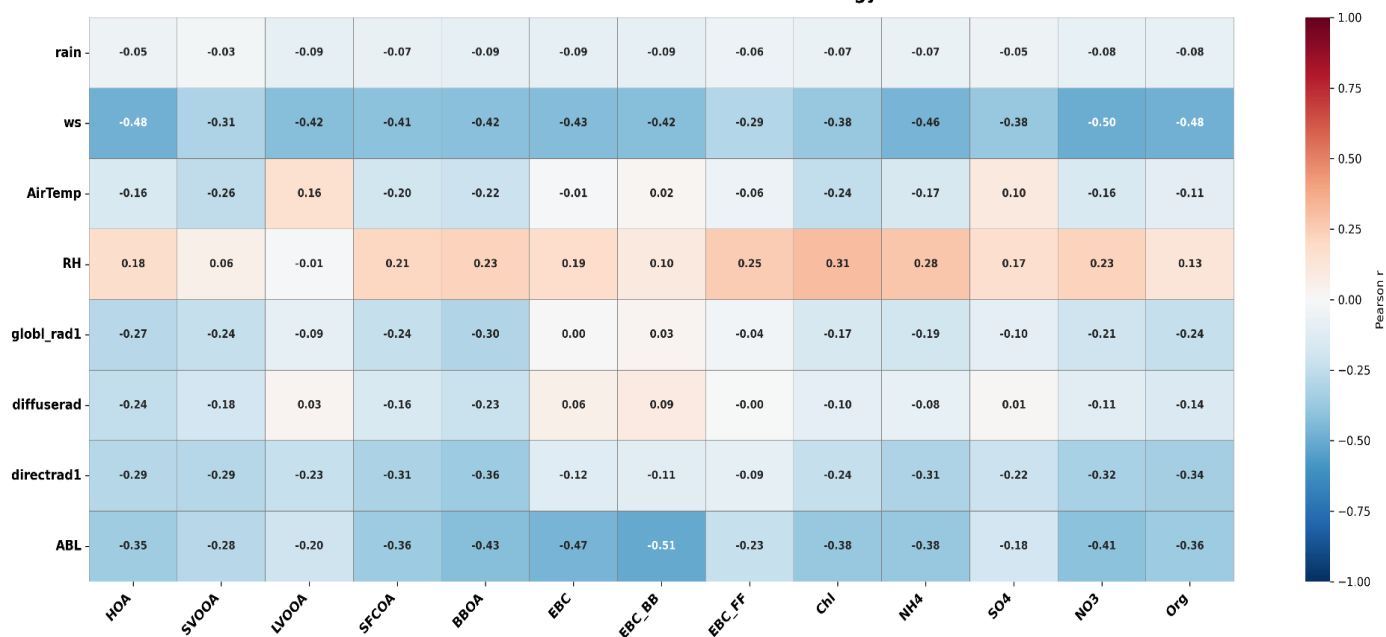
27

28 **Figure S3:** Correlation (Pearson R) of PMF factors: HOA, SVOOA, LVOOA, SFCOA and BBOA with
 29 PM_{2.5} species, gases and meteorology for data acquired from 25th October 2023 to 15th November
 30 2023.

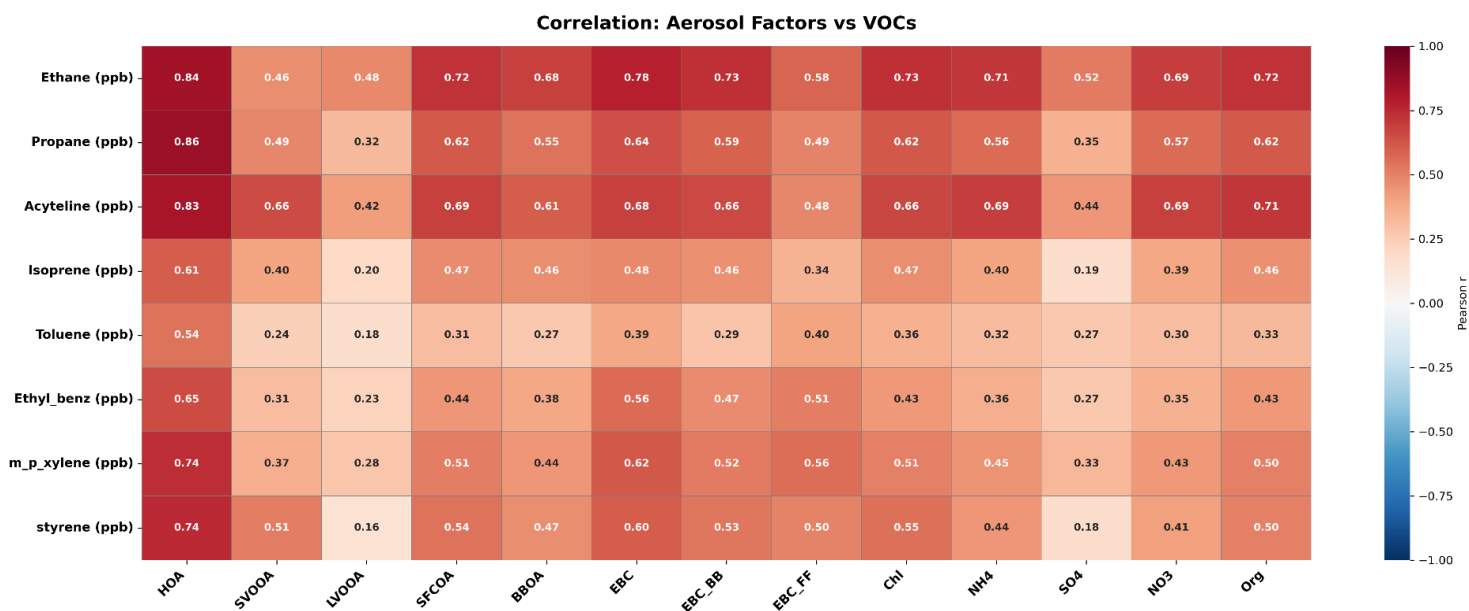


31
 32 **Figure S4:** Pearson correlation heatmap between organic aerosol (OA) factors (HOA, SVOOA,
 33 LVOOA, SFCOA, BBOA) and other chemical species, including black carbon components,
 34 inorganic ions, bulk organics, and ACSM marker fragments. Colors represent the strength and
 35 direction of correlations.

Correlation: Aerosol Factors vs Meteorology



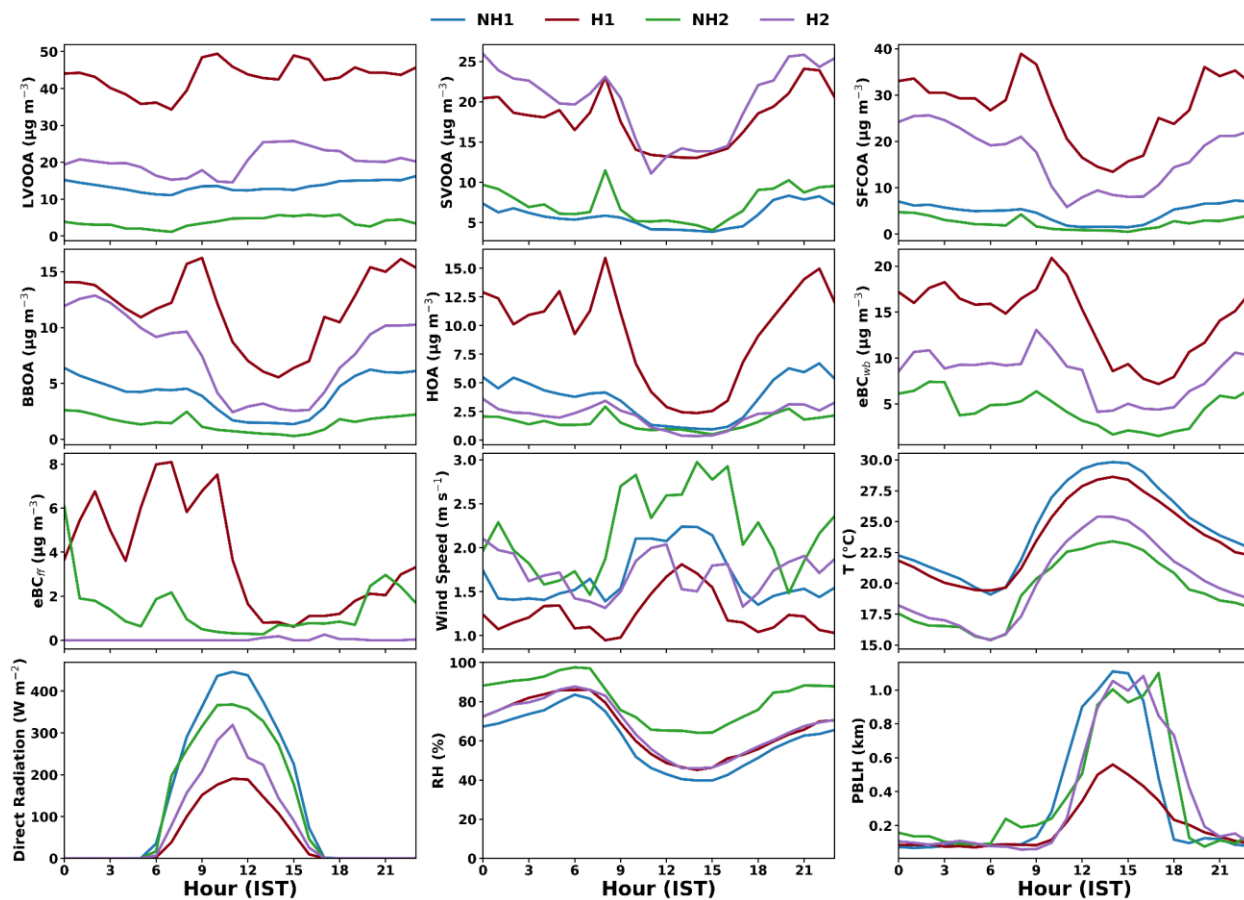
36
 37 **Figure S5:** Pearson correlation heatmap between aerosol factors (OA components, BC, and major
 38 inorganic species) and meteorological and radiative parameters. Positive and negative
 39 correlations indicate the influence of atmospheric dynamics and boundary-layer processes on
 40 aerosol variability.
 41



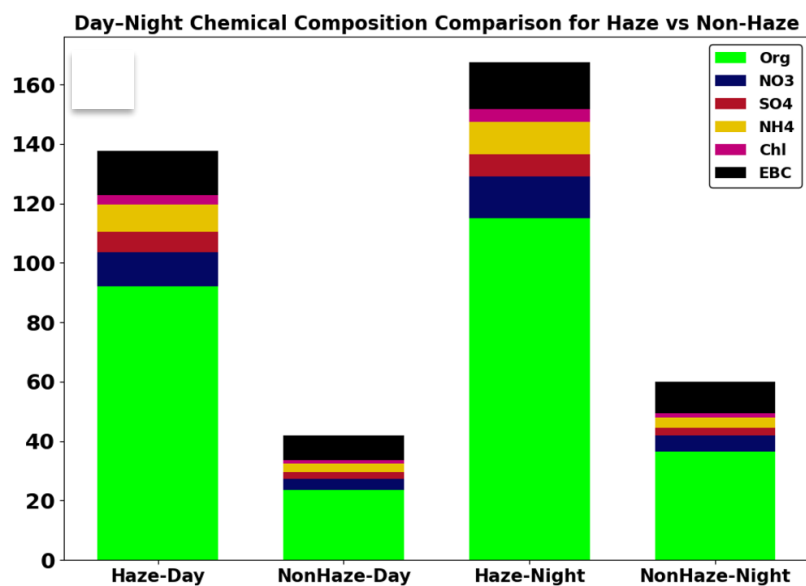
42

43 **Figure S6:** Pearson correlation heatmap between aerosol factors (OA components, BC, and
 44 inorganic species) and measured volatile organic compounds (VOCs). Correlation patterns
 45 highlight potential source linkages and secondary formation pathways.

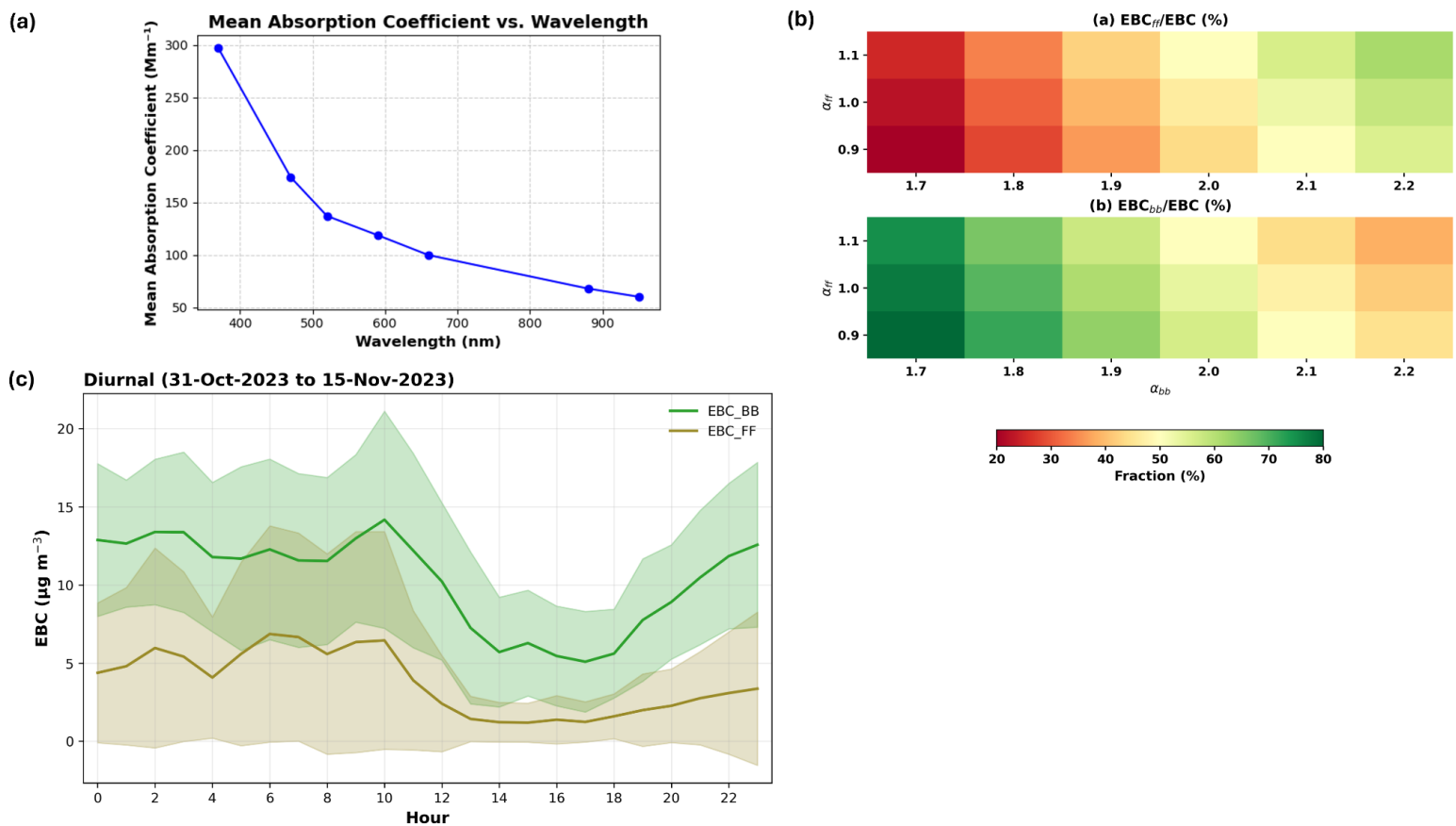
46

48
49

50 **Figure S7:** Diurnal variation of PMF factors: HOA, SVOOA, LVOOA, SFCOA and BBOA; 2 resolved
 51 BC factors: eBC_{wb} and eBC_{ff}, meteorological parameters: Wind Speed, Temperature, Direct
 52 Radiation, Relative Humidity, PBLH during Haze (H1 & H2) and Non-Haze (NH1& NH2) period from
 53 25th October 2023 to 15th November 2023.

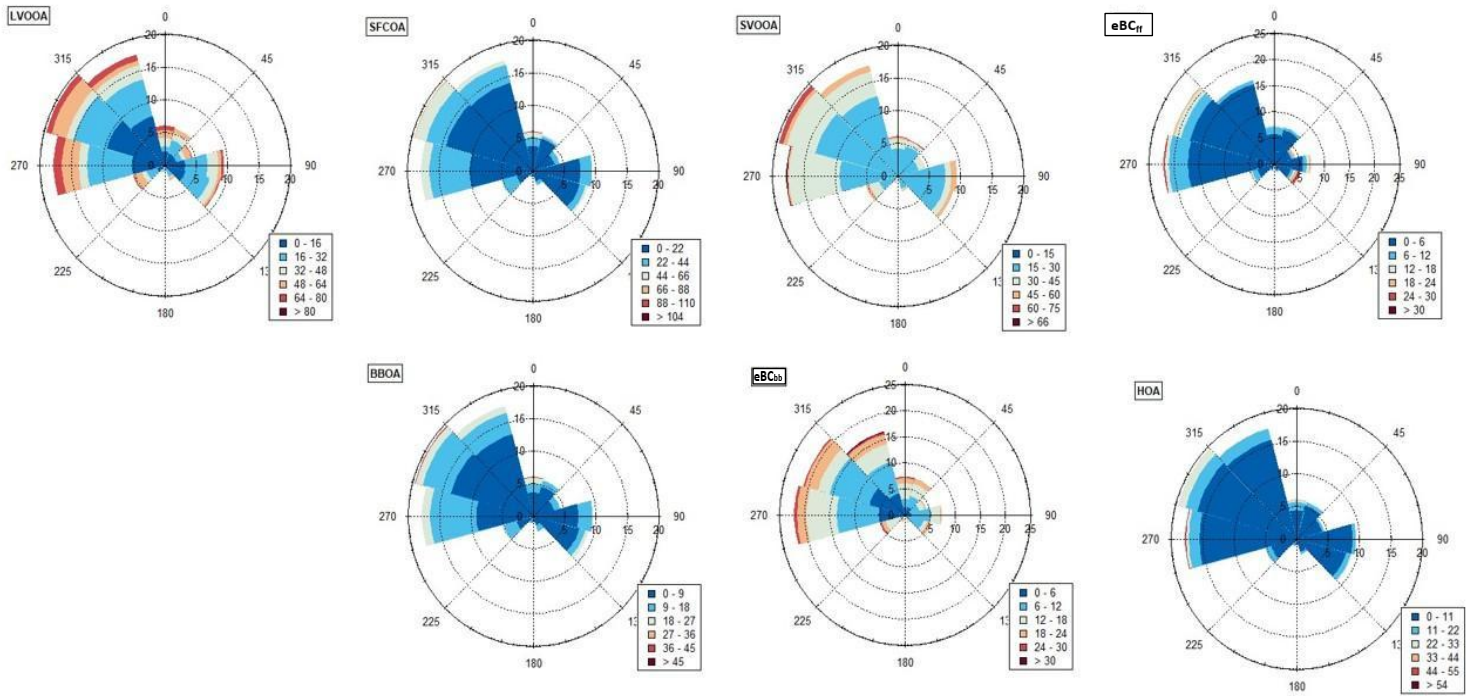


54
 55 **Figure S8:** Daytime and nighttime $PM_{2.5}$ chemical composition during haze and non-haze periods.
 56 Bars represent mean contributions of organic aerosol (Org), NO_3^- , SO_4^{2-} , NH_4^+ , chloride (Chl),
 57 and equivalent black carbon (eBC). Data is for the full period from 25th October 2023 to 15th
 58 November 2023.



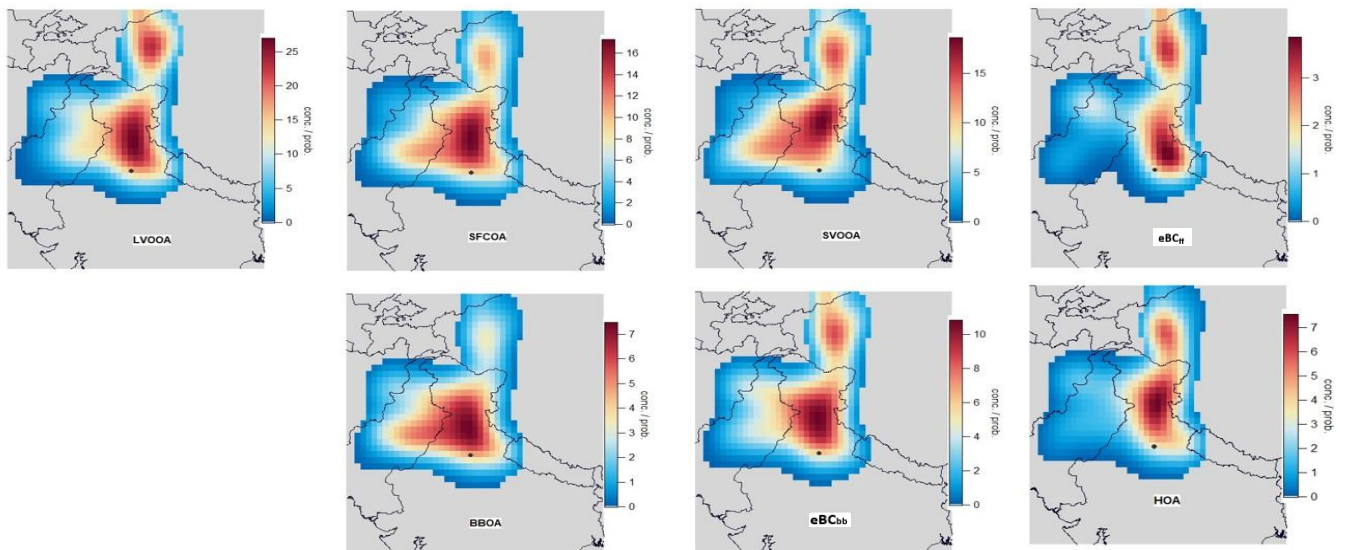
59

60 **Figure S9:** (a) Spectral variation of the mean aerosol light absorption coefficient as a function of
 61 wavelength. We can see stronger absorption in the UV region due to woodburning emissions in
 62 intense agricultural activity. (b) Sensitivity of fossil-fuel black carbon (eBC_{ff}) and biomass-burning
 63 black carbon (eBC_{bb}) fractional contributions to assumed absorption Ångström exponents (α_{ff} and
 64 α_{bb}); color shading indicates percentage contribution. (c) Mean diurnal variation of eBC_{wb} and
 65 eBC_{ff} concentrations during 31 October–15 November 2023, with shaded regions representing
 66 variability ($\pm 1\sigma$).



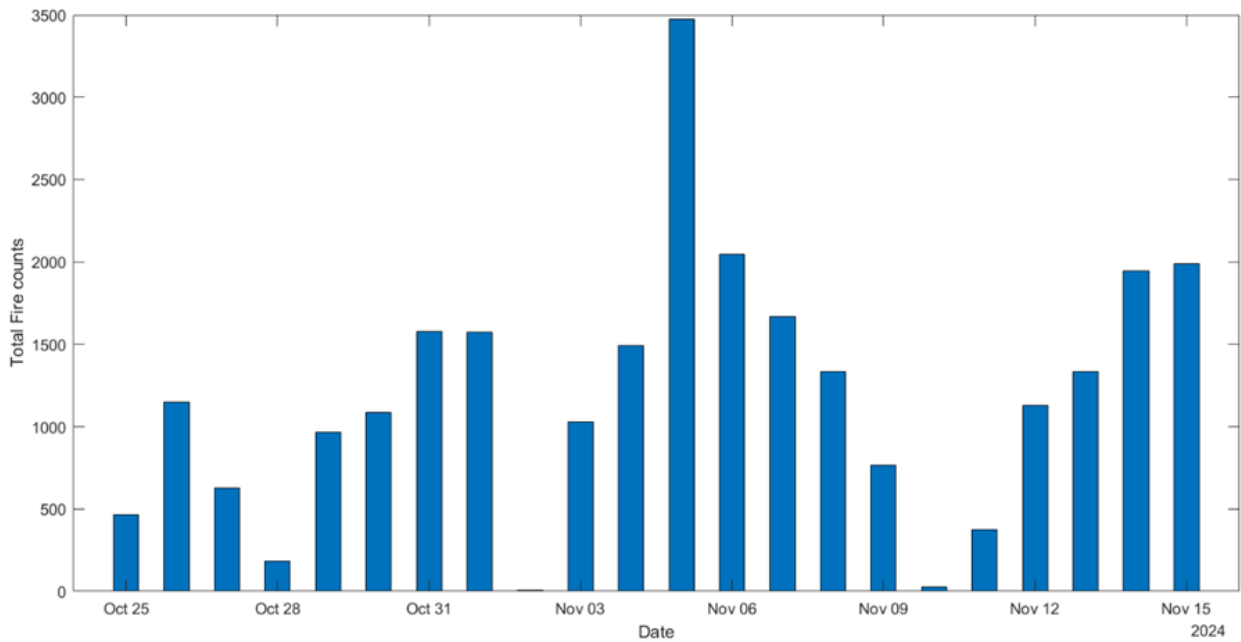
67 **Figure S10:** Pollution Rose (PR) plots for full period of data from 25th October 2023 to 15th
 68 November 2023 for 5 resolved OA factors: HOA, SVOOA, LVOOA, SFCOA and BBOA; 2 resolved
 69 eBC factors: eBC_{wb} and eBC_{ff}.

70
71
72
73
74
75
76
77
78
79
80
81
82
83

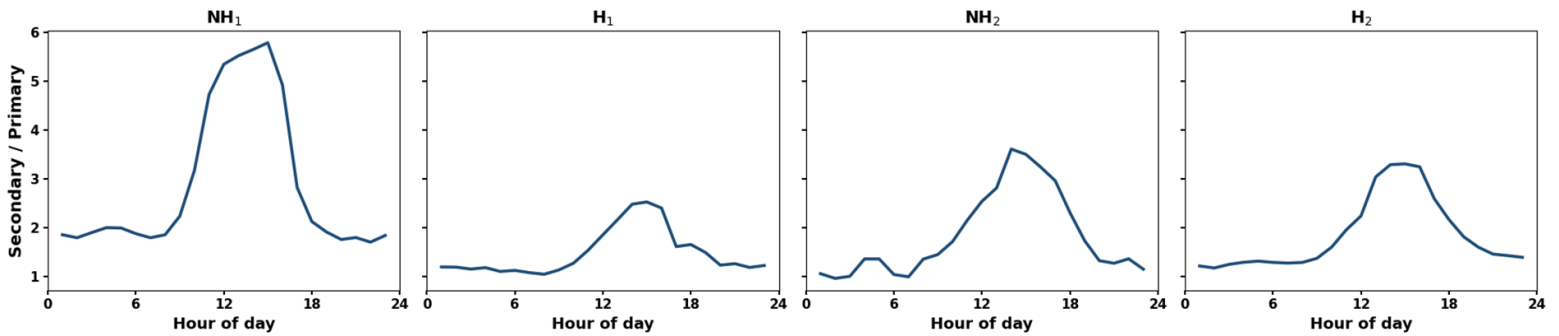


84 **Figure S11:** Concentrated Weighted Trajectory (CWT) plots calculated with Hysplit Model for
 85 period of data acquired from 25th October 2023 to 15th November 2023 for 5 resolved OA
 86 factors: HOA, SVOOA, LVOOA, SFCOA and BBOA; 2 resolved eBC factors: eBC_{wb} and eBC_{ff}.

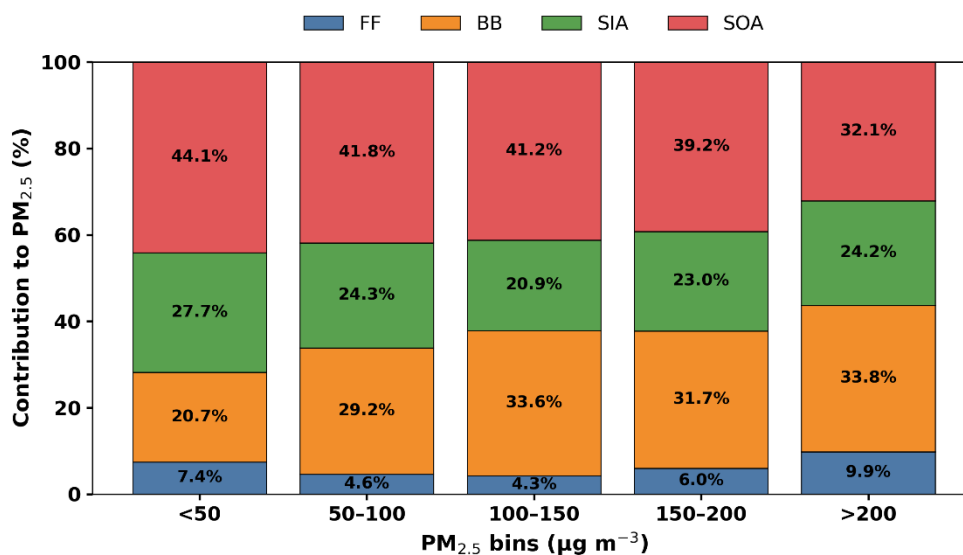
87



88 **Figure S12:** Time series of the total fire counts obtained from SUOMI VIIRS.



89 **Figure S13:** Diurnal variation of the secondary-to-primary aerosol ratio during non-haze (NH₁,
 90 NH₂) and haze (H₁, H₂) periods. Higher ratios indicate enhanced secondary aerosol formation
 91 relative to primary emissions.



93 **Figure S14:** Variation in the chemical composition of particulate matter as a function of PM
 94 concentration. Bars show the percentage contribution of secondary organic aerosol (SOA),
 95 secondary inorganic aerosol (SIA), biomass-burning aerosol (BB), and fossil-fuel-related aerosol
 96 (FF) across different PM concentration bins.

97

$$98 \text{ SOA} = \text{LVOOA} + \text{SVOOA}$$

$$99 \text{ SIA} = \text{SO}_4 + \text{NO}_3 + \text{NH}_4 + \text{Chl}$$

$$100 \text{ BB} = \text{SFCOA} + \text{BBOA} + \text{EBC}_{\text{BB}}$$

$$101 \text{ FF} = \text{HOA} + \text{EBC}_{\text{FF}}$$

102 **Table S1:** Elemental Ratio calculations(O:C, H:C and OM:OC) for 5 resolved OA factors: HOA,
103 SVOOA, LVOOA, SFCOA and BBOA.

Elemental Ratio	HOA	SVOOA	LVOOA	SFCOA	BBOA
f43	0.11	0.07	0.06	0.15	0.04
f44	0.01	0.21	0.27	0.05	0.01
O:C	0.1	0.72	0.91	0.21	0.09
H:C	1.19	1.09	1.04	1.25	0.96
OM:OC	1.3	2.1	2.34	1.45	1.28

104

105 **Table S2:** Summary of different haze period data acquired from 25th October 2023 to 15th
 106 November 2023 for 5 resolved OA factors: HOA, SVOOA, LVOOA, SFCOA and BBOA; 2 resolved
 107 eBC factors: eBC_{wb} and eBC_{ff}. Arithmetic mean (AM), Geometric mean (GM), and Geometric
 108 standard deviation (GSD) for hourly concentrations are calculated.
 109

Variable	Arithmetic Mean					Geometric Mean (Std)				
	Over all	NH1	H1	NH2	H2	Overall	NH1	H1	NH2	H2
LVOOA	25	13.5	42.8	4.1	20.2	17.2 (2.7)	11.3 (2.0)	38.2 (1.7)	3.3 (2.1)	19.4 (1.3)
SVOOA	12.8	5.8	18	7.3	20.4	9.6 (2.2)	5.3 (1.5)	14.0 (2.1)	6.6 (1.6)	19.6 (1.3)
SFCOA	15.1	4.6	27.5	2.4	17	7.0 (4.9)	2.4 (4.4)	22.4 (2.0)	1.4 (3.4)	15.0 (1.7)
BBOA	7.3	4	11.8	1.5	7.8	4.7 (2.9)	3.1 (2.2)	10.0 (1.9)	0.9 (2.8)	6.5 (1.9)
HOA	5.5	3.6	9.4	1.5	2.2	3.3 (2.8)	2.6 (2.3)	7.1 (2.2)	1.3 (1.9)	1.7 (2.4)
eBC _{bb}	10.9	---	14.2	4.2	8.3	8.9 (2.0)	---	13.1 (1.6)	3.4 (2.1)	7.6 (1.5)
eBC _{ff}	3.1	---	3.8	1.2	0.03	2.4 (4.3)	---	2.9 (3.9)	0.9 (3.4)	0.2 (2.5)

111 **Table S3:** Day time and Night time summary of different haze period data acquired from 25th
 112 October 2023 to 15th November 2023 for 5 resolved OA factors: HOA, SVOOA, LVOOA, SFCOA and
 113 BBOA; 2 resolved eBC factors: eBC_{wb} and eBC_{ff}. Arithmetic mean (AM) are calculated for all the
 114 factors.

115
 116

Variable	Overall		NH1		H1		NH2		H2	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
LVOOA	24.1	25.8	12.8	14.3	42.9	42.7	4.3	3.8	20	20.3
SVOOA	10.6	15.1	4.7	6.9	15.6	20.2	5.9	9.1	16.6	23.7
SFCOA	11.8	18.5	3.1	6.2	23.4	31.2	1.4	3.6	12.2	21.2
BBOA	5.5	9.2	2.7	5.4	10	13.5	0.9	2.2	5	10.3
HOA	3.7	7.3	2.2	5.1	6.6	12	1.2	1.9	1.6	2.7
eBC _{bb}	10	11.7	--	--	13.6	14.8	3.6	5	7.7	8.8
eBC _{ff}	3.2	3	--	--	3.8	3.7	0.7	1.9	0.046	0.012

117
 118

119 **Table S4:** Summary of different haze period data acquired from 25th October 2023 to 15th
 120 November 2023 for Primary Aerosol(PA): (HOA + SFCOA + BBOA + eBC_{ff}+ eBC_{wb}) and Secondary
 121 Aerosols(SA): (SVOOA + LVOOA + Chl⁻ + NO₃⁻ + SO₄²⁻ + NH₄⁺) . Arithmetic mean (AM), Geometric
 122 mean (GM), and Geometric standard deviation (GSD) for hourly concentrations are calculated.
 123

<i>Period</i>	<i>Aerosol Type</i>	<i>AM (µg/m³)</i>	<i>GM (µg/m³)</i>	<i>GSD</i>
<i>NH1</i>	<i>PA</i>	<i>12.22</i>	<i>8.57</i>	<i>2.53</i>
<i>NH1</i>	<i>SA</i>	<i>32.17</i>	<i>27.58</i>	<i>1.86</i>
<i>H1</i>	<i>PA</i>	<i>66.7</i>	<i>58.66</i>	<i>1.72</i>
<i>H1</i>	<i>SA</i>	<i>99.54</i>	<i>92.76</i>	<i>1.49</i>
<i>NH2</i>	<i>PA</i>	<i>10.71</i>	<i>8.91</i>	<i>1.91</i>
<i>NH2</i>	<i>SA</i>	<i>17.95</i>	<i>16.81</i>	<i>1.45</i>
<i>H2</i>	<i>PA</i>	<i>35.31</i>	<i>32.06</i>	<i>1.6</i>
<i>H2</i>	<i>SA</i>	<i>61.39</i>	<i>60.06</i>	<i>1.24</i>

124

125 **Table S5:** Percentage contribution in different haze period data acquired from 25th October 2023
126 to 15th November 2023 for Primary Aerosol(PA): (HOA + SFCOA + BBOA + eBC_{ff} + eBC_{wb}) and
127 Secondary Aerosols(SA): (SVOOA + LVOOA + Chl + NO₃⁻ + SO₄²⁻ + NH₄⁺).
128

<i>Period</i>	<i>Primary Aerosol (%)</i>	<i>Secondary Aerosol (%)</i>
<i>NH1</i>	27.5	72.5
<i>H1</i>	40.1	59.9
<i>NH2</i>	37.4	62.6
<i>H2</i>	36.5	63.5

129