Supplement of Aerosol Research, 3, 503–520, 2025
https://doi.org/10.5194/ar-3-503-2025-supplement


AEROSOL Research
Open Access

*Supplement of*

# Long-term PM trends at boreal forest site in southern Finland from three different measurement techniques

**Ilona Ylivinkka et al.**

*Correspondence to:* Ilona Ylivinkka (ilona.ylivinkka@helsinki.fi)

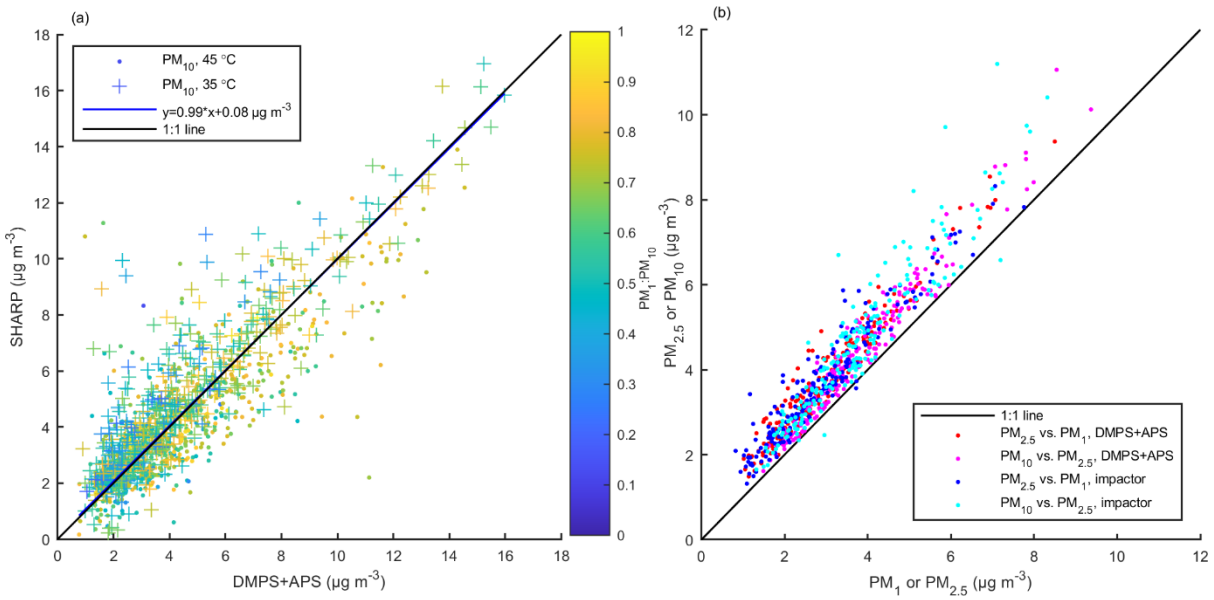
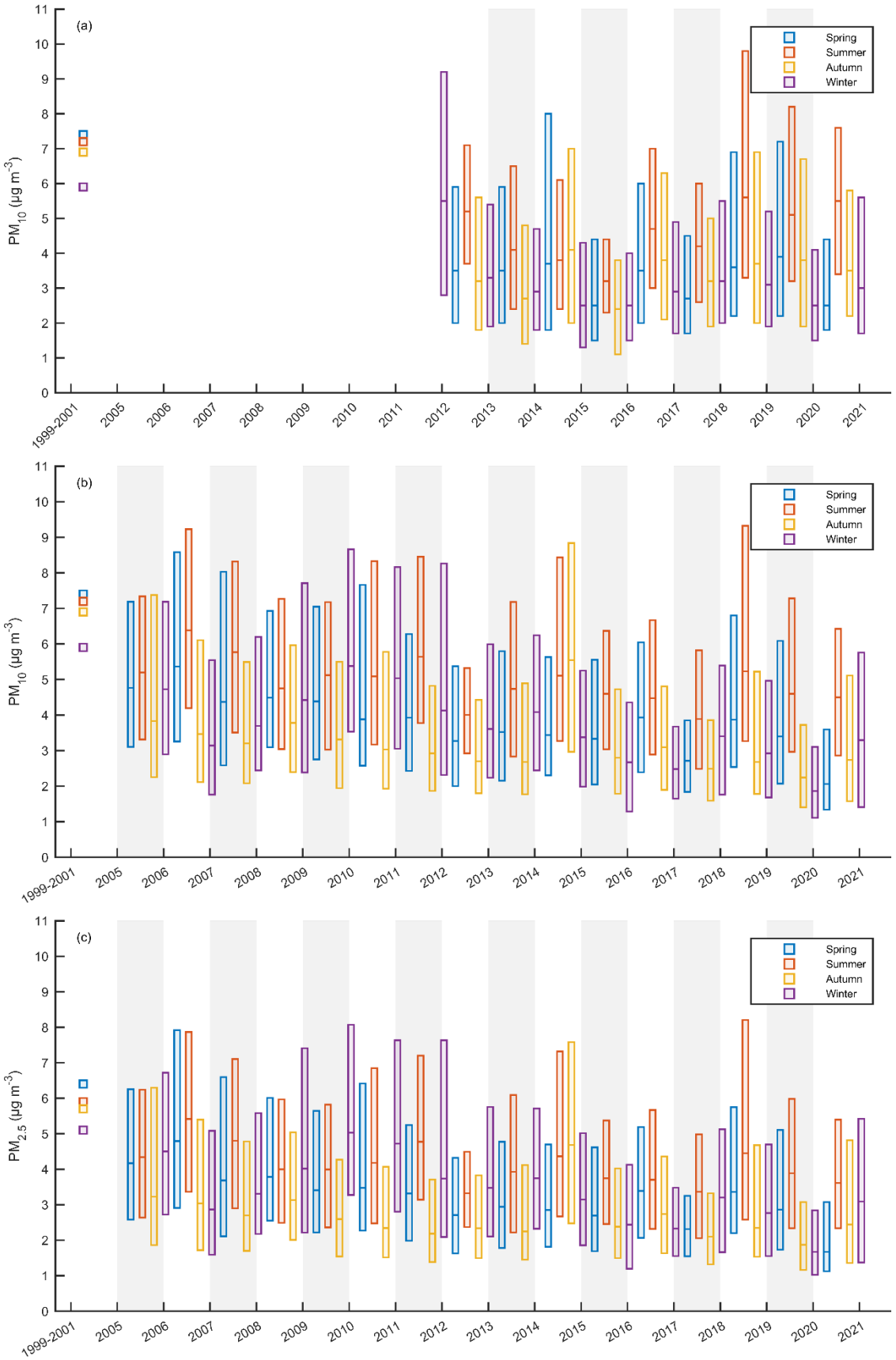



**Figure S1:** Correlation between $PM_{10}$ from SHARP and DMPS+APS derived mass measurements. Bivariate fit to the data is represented with a blue line and 1:1 line is black. Color is $PM_1$ to $PM_{10}$ ratio from impactor measurements and markers differentiate the inlet heating temperature of SHARP (circle = 45 °C and plus sign = 35 °C). Pearson's correlation coefficient is 0.84. (b) Correlation between monthly median $PM_1$ and $PM_{2.5}$ as well as $PM_{2.5}$ and $PM_{10}$ concentrations from DMPS+APS and impactor measurements. 1:1 line is shown in black.

**Table S1:** Average (mean / median) PM concentration in 2005–2020 from DMPS+APS method calculated using 1.1 and 2.0 g $cm^{-3}$ particle density. Unit is μg $m^{-3}$.

| | $\rho = 1.1$ | $\rho = 2.0$ |
|---|---|---|
| $PM_{10}$, | 4.4 / 3.7 | 5.7 / 4.8 |
| -Spring | 4.4 / 3.7 | 5.6 / 4.7 |
| -Summer | 5.2 / 4.6 | 6.9 / 6.3 |
| -Autumn | 4.0 / 3.2 | 4.9 / 3.8 |
| -Winter | 4.3 / 3.6 | 5.4 / 4.4 |
| $PM_{2.5}$, | 3.5 / 2.9 | 5.1 / 4.3 |
| -Spring | 3.4 / 2.8 | 5.0 / 4.1 |
| -Summer | 3.9 / 3.6 | 6.2 / 5.6 |
| -Autumn | 3.0 / 2.4 | 4.4 / 3.4 |
| -Winter | 3.8 / 3.2 | 5.1 / 4.2 |
| $PM_{1}$, | 2.6 / 2.1 | 4.4 / 3.6 |
| -Spring | 2.5 / 2.0 | 4.3 / 3.5 |
| -Summer | 3.1 / 2.8 | 5.3 / 4.8 |
| -Autumn | 2.1 / 1.6 | 3.6 / 2.8 |
| -Winter | 2.8 / 2.2 | 4.5 / 3.6 |


(a)
(b)
(c)
Spring
Summer
Autumn
Winter
PM10 (μg m-3)
PM2.5 (μg m-3)
1999-2001
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021

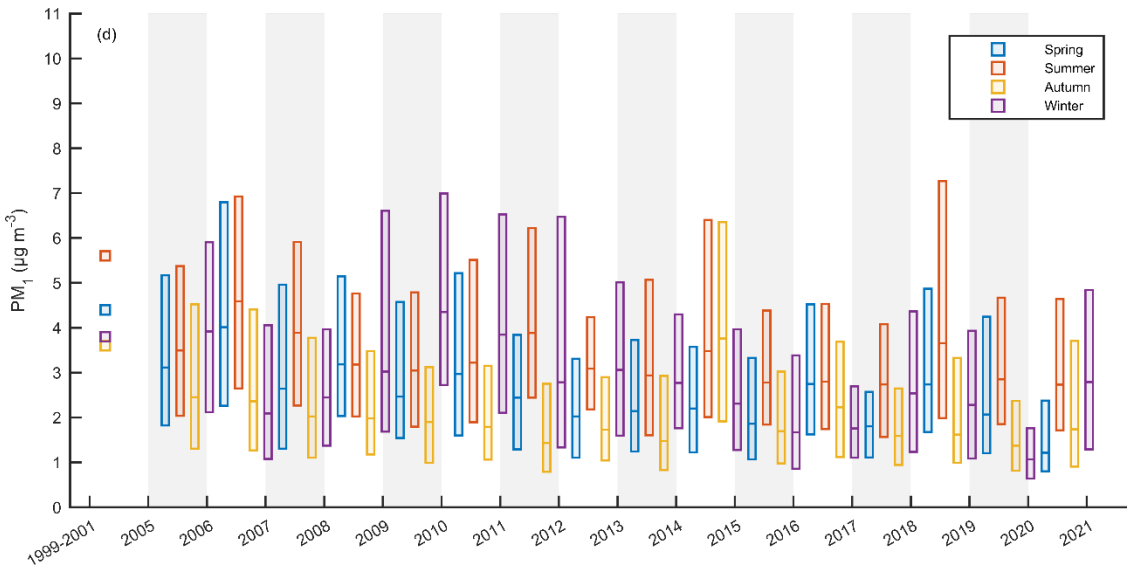



**Figure S2:** Seasonal median $PM_{10}$, $PM_{2.5}$ and $PM_1$ concentrations and their 25 and 75 quartile ranges measured with (a) SHARP (only $PM_{10}$) and (b-d) DMPS+APS. The tick marks on the x-axis are in the beginning of a year. Mean values for 1991–2002 are from Laakso et al. (2003).

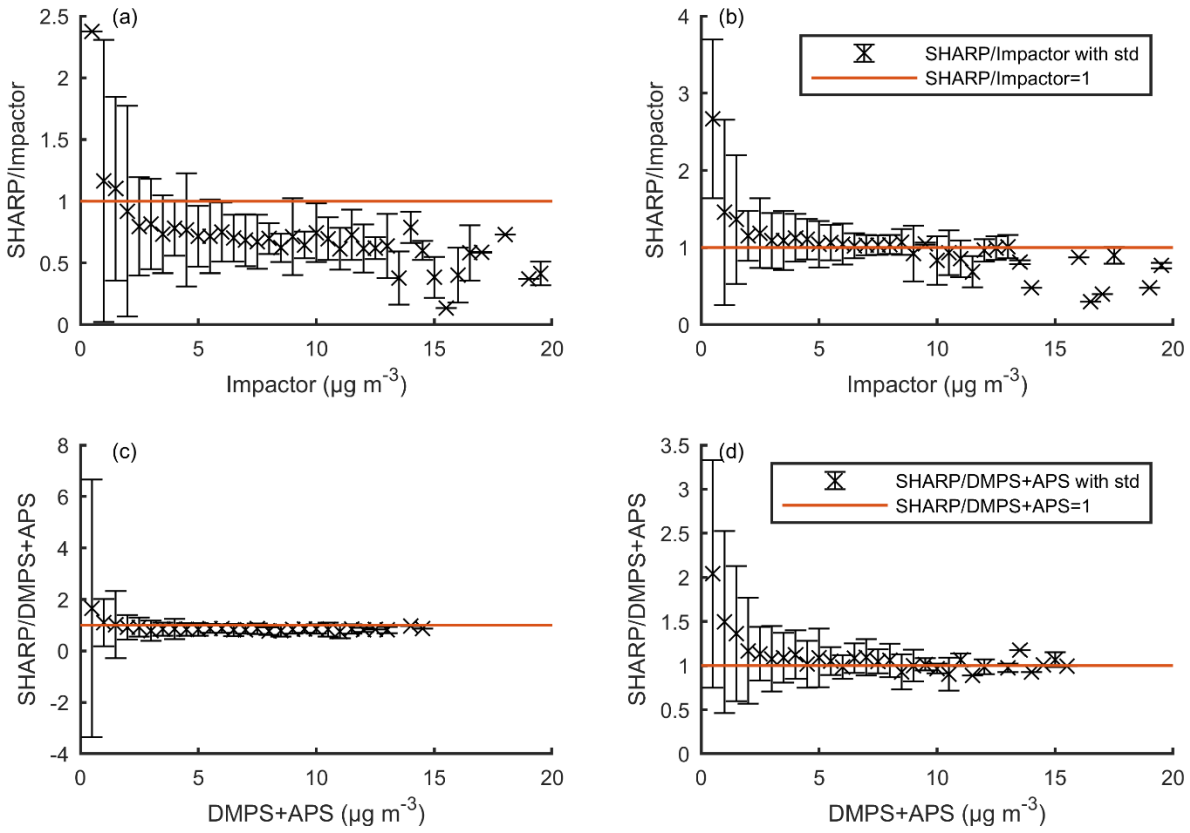
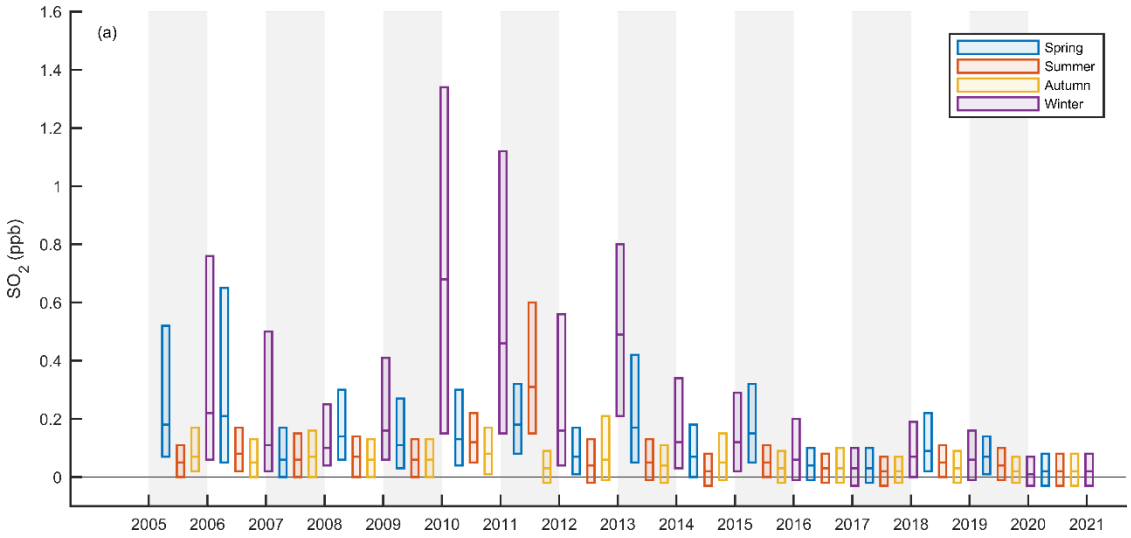
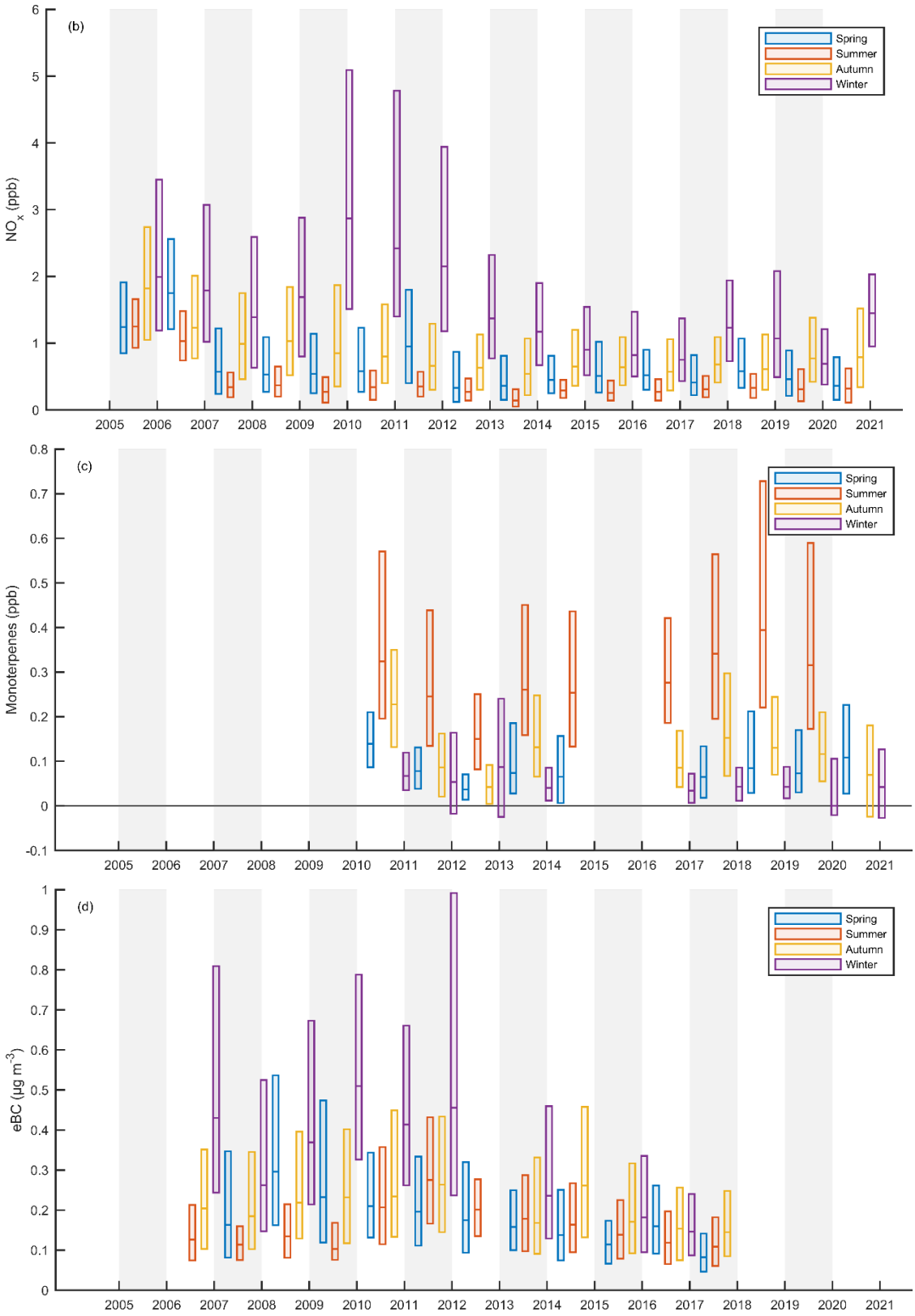



**Figure S3:** Comparison of SHARP $PM_{10}$ measurements to (a) and (b) impactor as well as (c) and (d) DMPS+APS as a function of $PM_{10}$ mass concentration from the corresponding reference method. In (a) and (c) SHARP heating set to 45 °C and in (b) and (d) SHARP heating set to 35 °C.




(b)
$NO_x$ (ppb)
Spring
Summer
Autumn
Winter
(c)
Monoterpenes (ppb)
(d)
eBC (μg m$^{-3}$)
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021

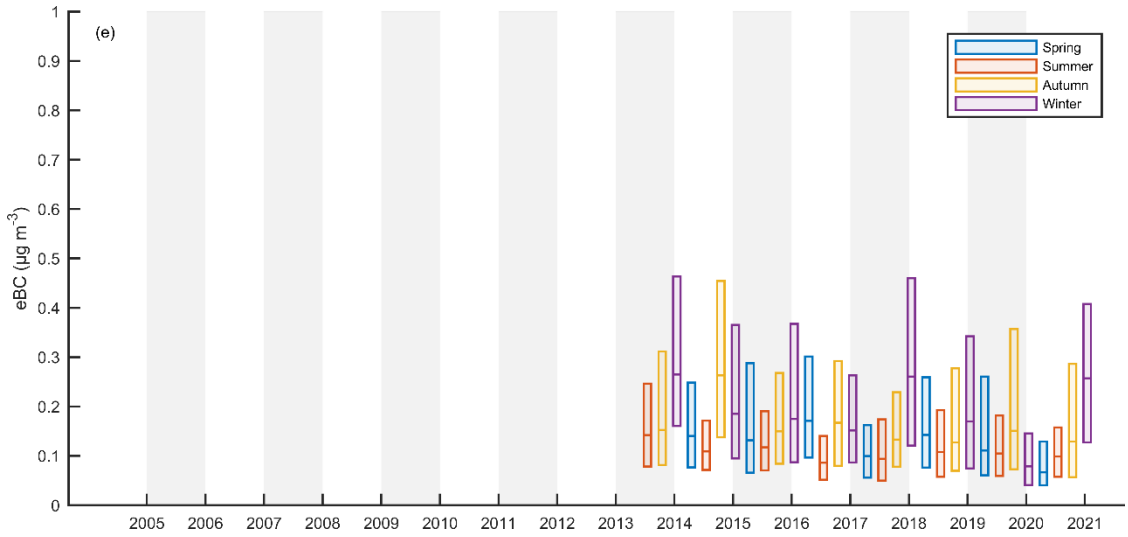
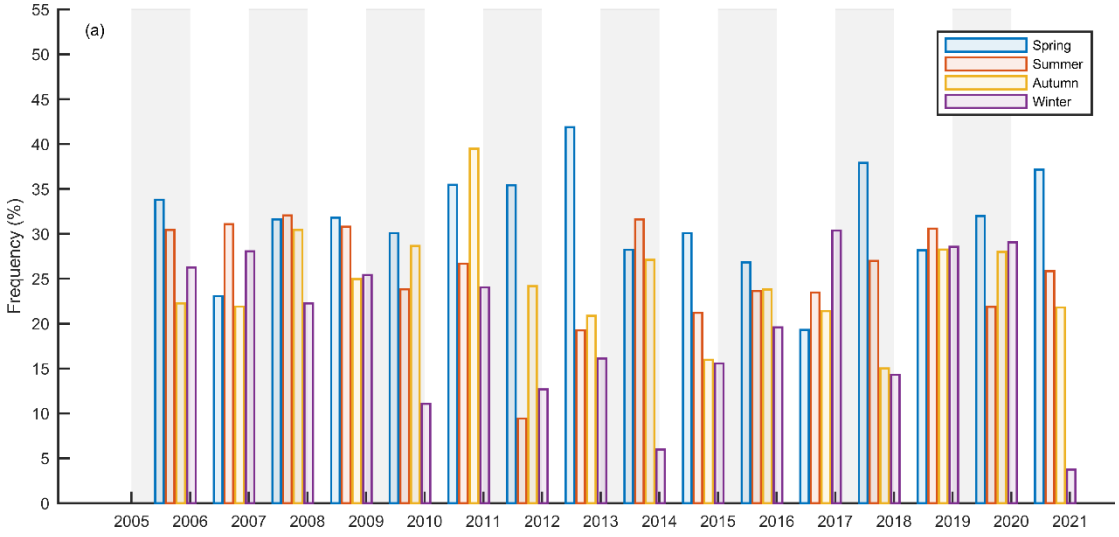
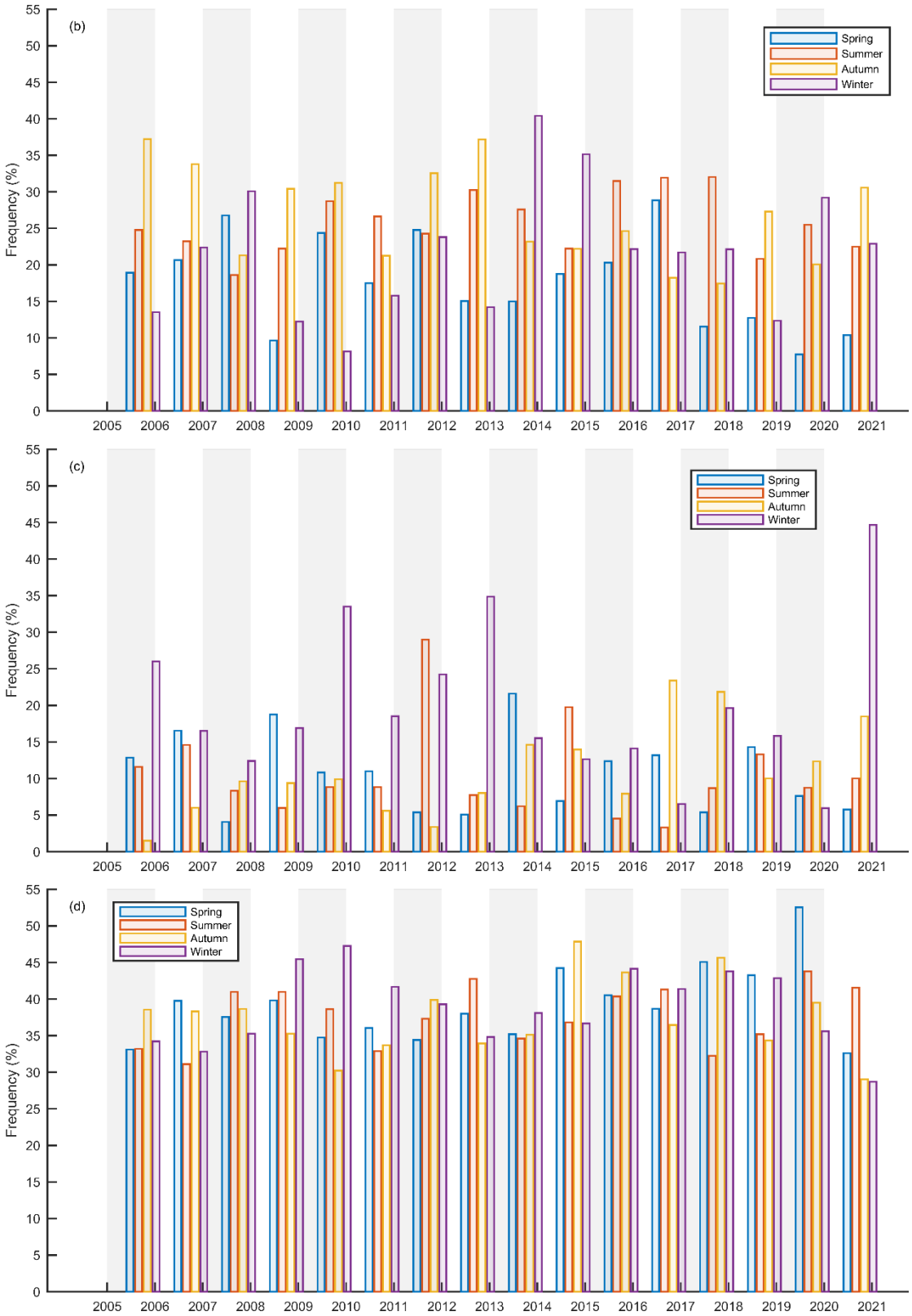



**Figure S4:** Seasonal median (a) $SO_2$, (b) $NO_x$, and (c) monoterpene concentrations as well as equivalent black carbon (eBC) measured with (d) AE31 (880 nm) and (e) Multi-Angle Absorption Photometer (MAAP; 637 nm), and their 25 and 75 quartile ranges measured at SMEAR II. The tick marks on the x-axis are in the beginning of a year.




(b)
Spring
Summer
Autumn
Winter
Frequency (%)
0
5
10
15
20
25
30
35
40
45
50
55
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
(c)
Spring
Summer
Autumn
Winter
Frequency (%)
(d)
Spring
Summer
Autumn
Winter
Frequency (%)

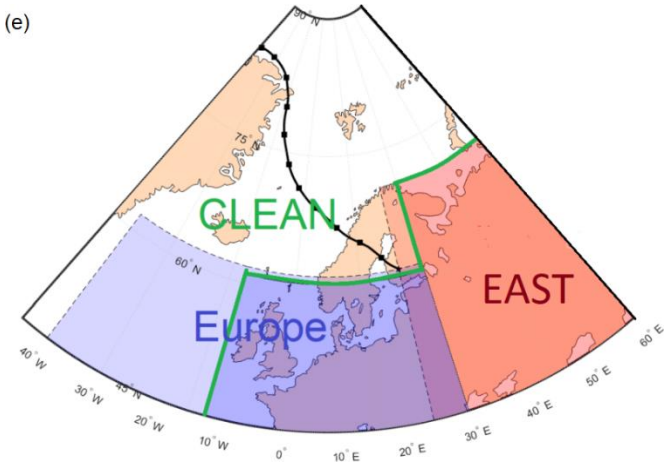



**Figure S5:** Seasonally divided frequency of different air mass origin sectors. (a) Clean sector, (b) European, (c) East, and (d) mixed sectors. (e) Map of different sectors. The tick marks on the x-axis are in the beginning of a year.

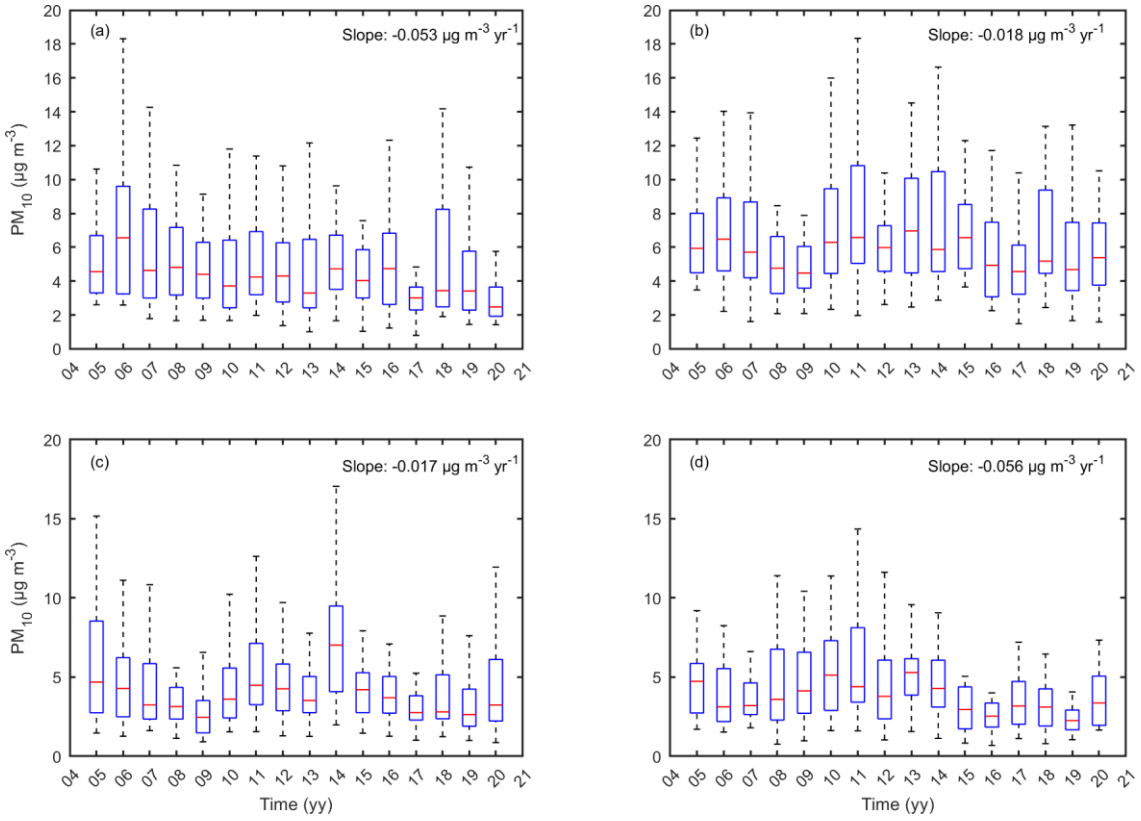



**Figure S6:** $PM_{10}$ concentration with the impactor method in (a) spring, (b) summer, (c) autumn, and (d) winter. Red horizontal line represents the median, the distance between the box edges shows the interquartile range, and whiskers extend to 1.5 times the interquartile range. Outliers are not shown. Slope represents trend calculated using Sen's slope and statistical significance is calculated using Mann-Kendall test. The trends were statistically significant in spring and winter, but not in summer and autumn.

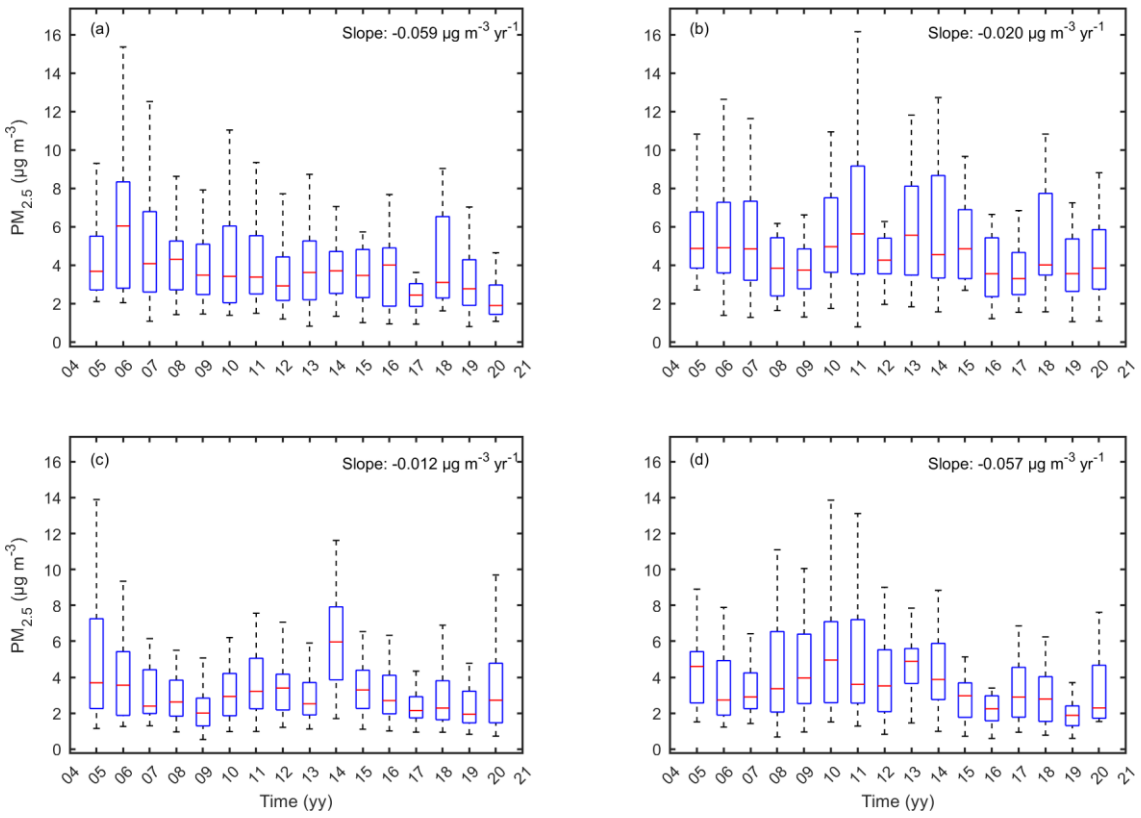



**Figure S7:** $PM_{2.5}$ concentration with the impactor method in (a) spring, (b) summer, (c) autumn, and (d) winter. Markers as in S5. The trends were statistically significant in spring and winter, but not in summer and autumn.

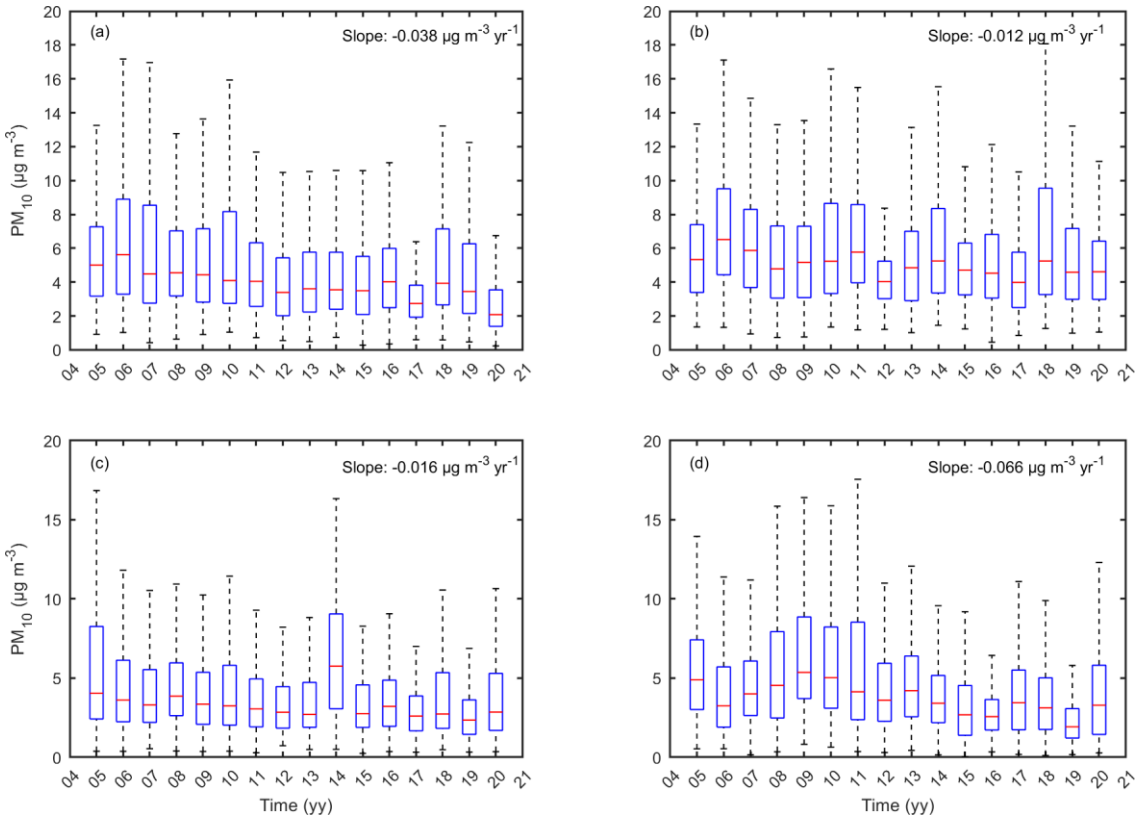



**Figure S8:** $PM_{10}$ concentration with the DMPS+APS method in (a) spring, (b) summer, (c) autumn, and (d) winter. Markers as in S5. The trends are calculated from 6 h averages and they are statistically significant.

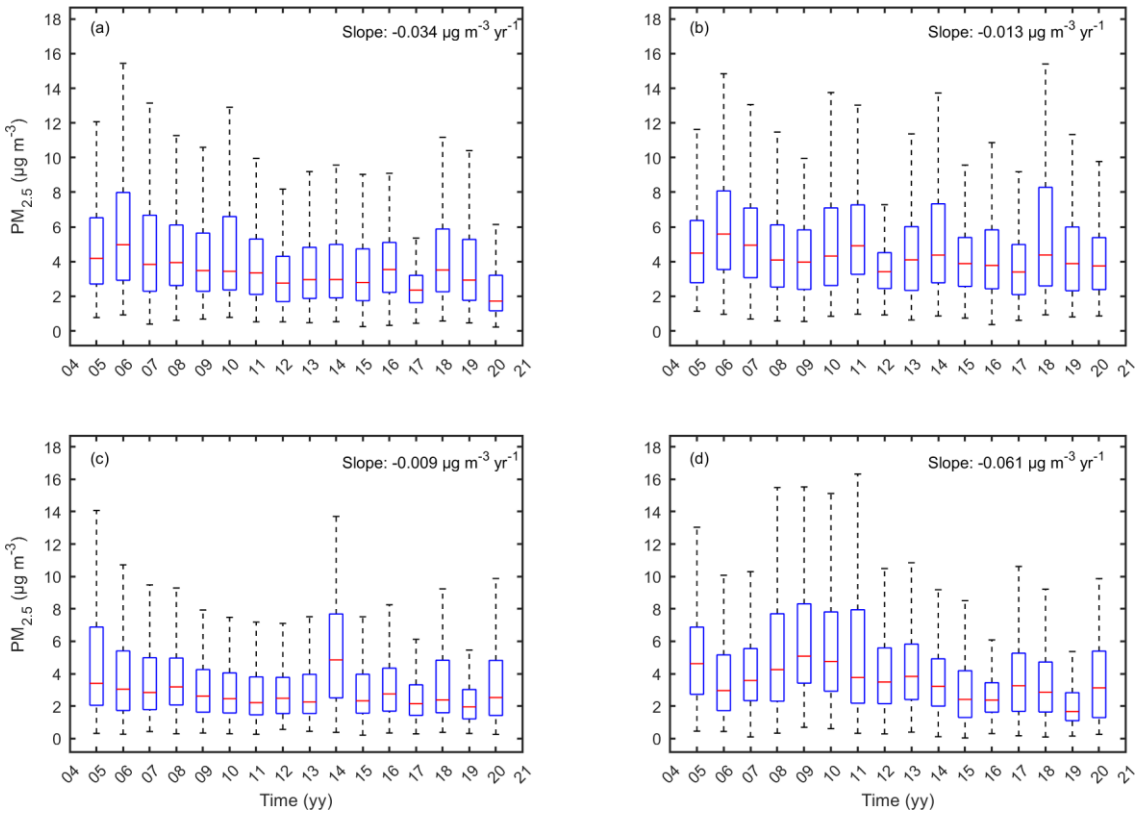



**Figure S9:** $PM_{2.5}$ concentration with the DMPS+APS method in (a) spring, (b) summer, (c) autumn, and (d) winter. Markers as in S5. The trends are calculated from 6 h averages and they are statistically significant.

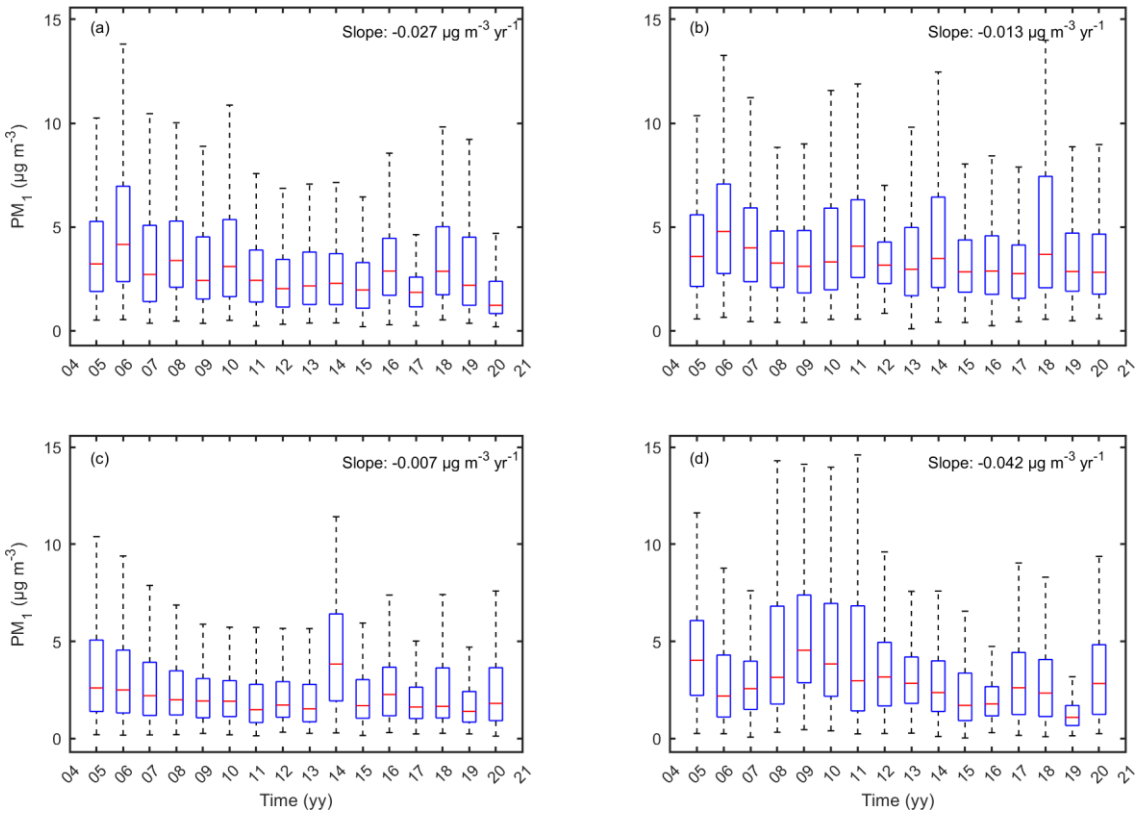



**Figure S10:** $PM_1$ concentration with the DMPS+APS method in (a) spring, (b) summer, (c) autumn, and (d) winter. Markers as in S5. The trends are calculated from 6 h averages and they are statistically significant.

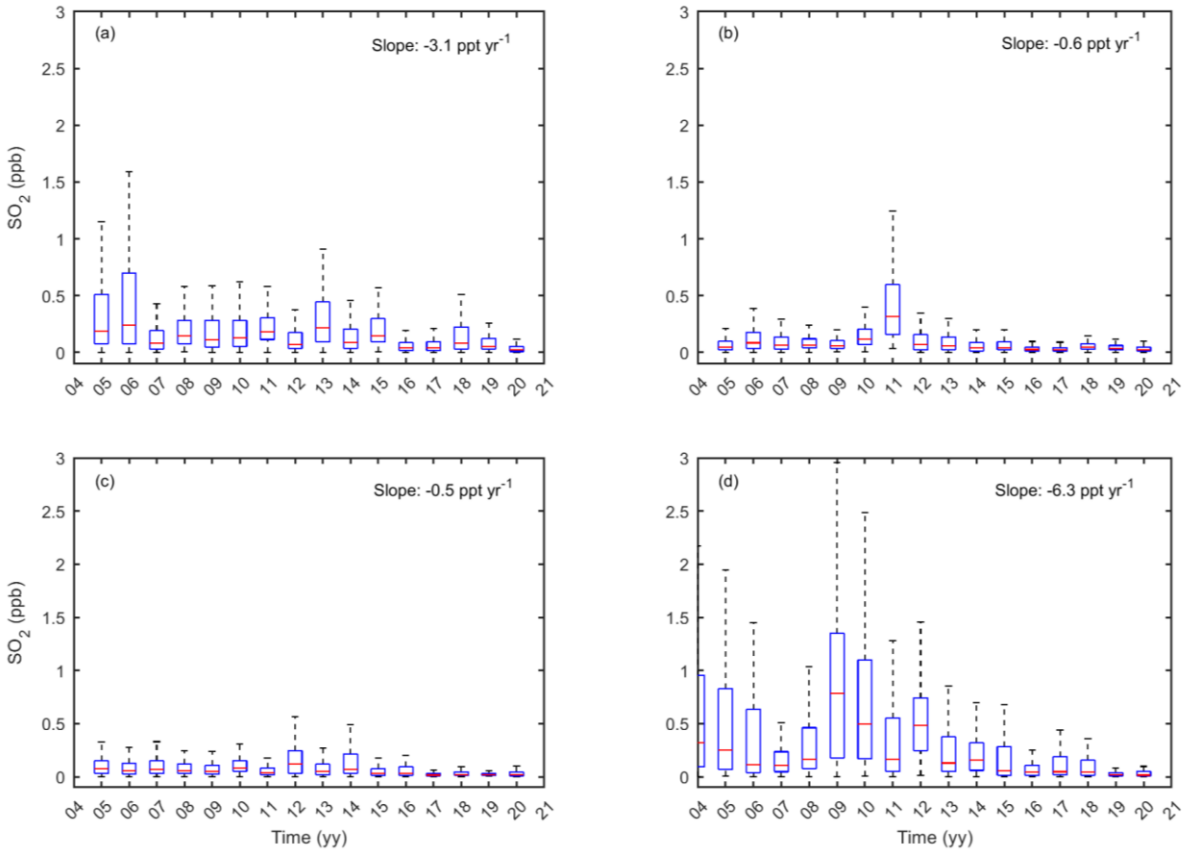



**Figure S11:** $SO_2$ concentration in (a) spring, (b) summer, (c) autumn, and (d) winter. Markers as in S5. The trends are calculated from 6 h averages and they are statistically significant.

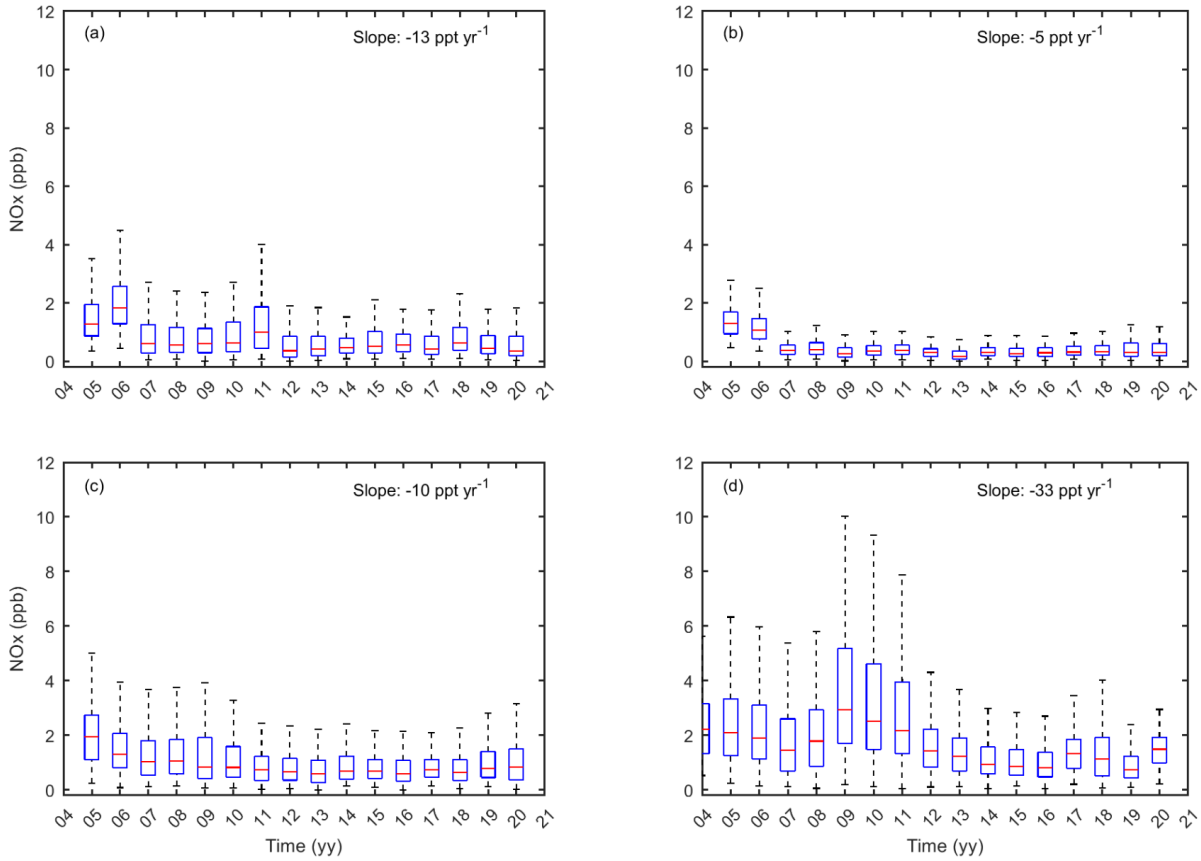



**Figure S12:** $NO_x$ concentration in (a) spring, (b) summer, (c) autumn, and (d) winter. Markers as in S5. The trends are calculated from 6 h averages and they are statistically significant.

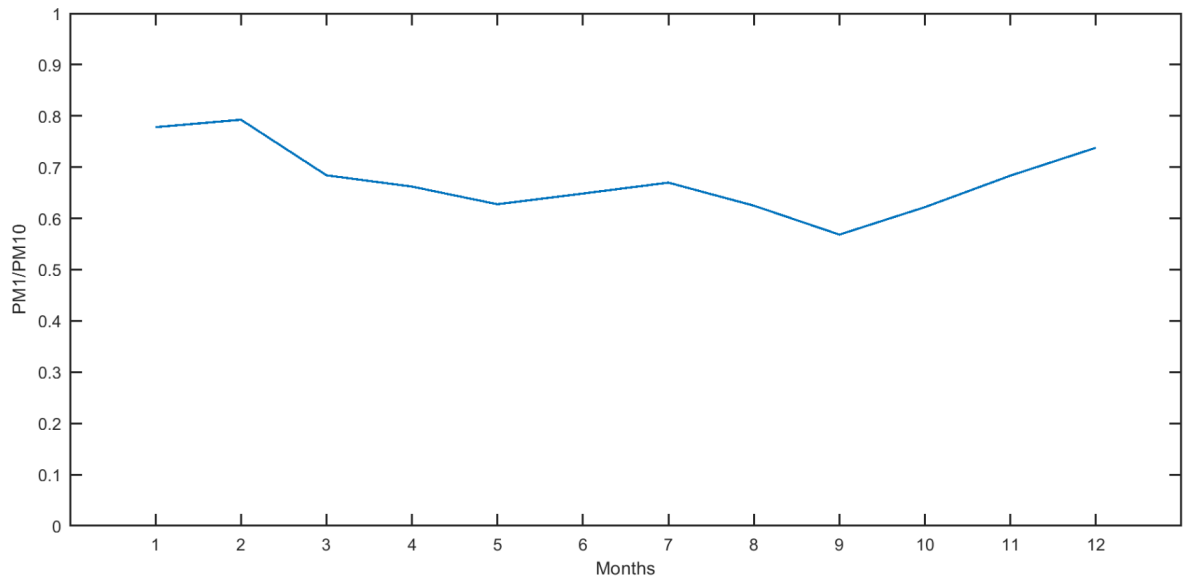



**Figure S13:** Monthly median $PM_1$ to $PM_{10}$ ratio using impactor data.

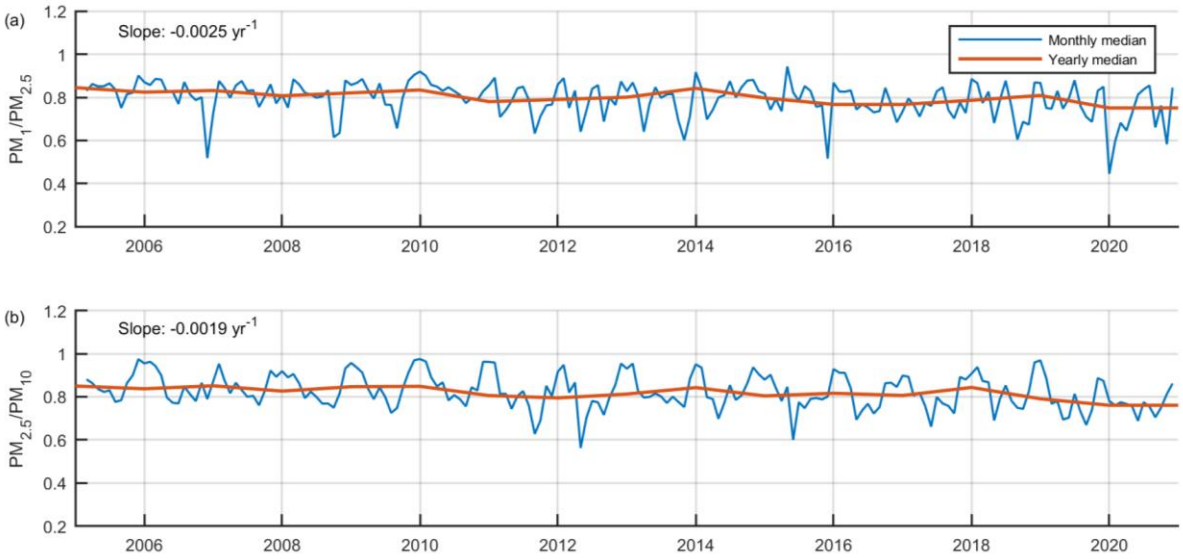



**Figure S14:** Timeseries of monthly (blue) and yearly (red) median (a) $PM_1$ to $PM_{2.5}$ and (b) $PM_{2.5}$ to $PM_{10}$ ratios using impactor data. Slope represents trend calculated using Mann-Kendall test.