**Supplementary Information**

**Quantifying the impacts of PM2.5 constituents and relative humidity on visibility impairment in a suburban area of eastern Asia using long-term in-situ measurements.**

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**Figure S1.** Comparison of PM2.5 mass concentrations between the in-situ measurements of PM2.5 and PM2.5 reconstructed by the chemical compositions.

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**Figure S2.** Wind rose plots for each season. Wind speed (m s-1) has been coloured and the scales of the frequencies are 0.1 - 0.4 for spring and summer, 0.1 - 0.6 for autumn and winter, respectively.

**Table S1.** The hourly average concentrations of air pollutants, meteorological conditions and extinction coefficients over the year.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Species** | **Total** | **Spring** | **Summer** | **Autumn** | **Winter** |
| **Bext\_550 nm****(M m-1)** | 105.86 ± 75.53 | 127.2 ± 70.70 | 70.22 ± 40.42 | 96.33 ± 73.15 | 111.66 ± 82.96 |
| **PM2.5 (µg m-3)** | 27.17 ± 17.28 | 34.34 ± 17.25 | 15.02 ± 9.35 | 23.43 ± 13.85 | 35.80 ± 18.27 |
| **NO3- (µg m-3)** | 3.99 ± 4.99 | 5.73 ± 6.50 | 1.82 ± 2.22 | 2.75 ± 2.89 | 5.68 ± 5.67 |
| **SO42- (µg m-3)** | 5.35 ± 3.64 | 7.02 ± 4.24 | 4.29 ± 3.29 | 4.32 ± 2.58 | 5.75 ± 3.49 |
| **Cl- (µg m-3)** | 0.72 ± 0.87 | 0.85 ± 1.13 | 0.44 ± 0.54 | 0.51 ± 0.35 | 1.12 ± 1.02 |
| **NH4+ (µg m-3)** | 4.98 ± 3.39 | 6.17 ± 3.35 | 3.21 ± 2.35 | 4.31 ± 2.55 | 6.37 ± 4.07 |
| **Na+ (µg m-3)** | 0.43 ± 0.36 | 0.49 ± 0.39 | 0.33 ± 0.30 | 0.48 ± 0.38 | 0.41 ± 0.34 |
| **K+ (µg m-3)** | 0.26 ± 0.69 | 0.48 ± 0.64 | 0.18 ± 0.32 | 0.08 ± 0.15 | 0.27 ± 1.09 |
| **Mg2+ (µg m-3)** | 1.99 ± 1.28 | 2.60 ± 1.33 | 3.27 ± 1.53 | 1.62 ± 0.86 | 1.27 ± 0.77 |
| **Ca2+ (µg m-3)** | 1.91 ± 1.37 | 1.83 ± 1.19 | 1.87 ± 1.01 | 2.86 ± 1.55 | 0.93 ± 0.67 |
| **OC (µg m-3)** | 4.93 ± 2.28 | 5.21 ± 2.08 | 4.24 ± 1.18 | 4.20 ± 2.14 | 5.59 ± 2.52 |
| **EC (µg m-3)** | 1.16 ± 0.84 | 1.31 ± 0.75 | 0.69 ± 0.74 | 0.87 ± 0.71 | 1.45 ± 0.88 |
| **CO (ppm)** | 0.92 ± 0.51 | 0.99 ± 0.48 | 0.77 ± 0.32 | 0.99 ± 0.46 | 0.91 ± 0.68 |
| **NO (ppb)** | 12.58 ± 13.55 | 11.97 ± 12.47 | 7.73 ± 9.06 | 12.35 ± 12.01 | 18.35 ± 17.30 |
| **NOx (ppb)** | 31.84 ± 21.74 | 34.18 ± 22.91 | 21.50 ± 14.75 | 31.60 ± 17.49 | 40.25 ± 25.91 |
| **SO2 (ppb)**  | 1.81 ± 1.62 | 2.10 ± 1.85 | 1.84 ± 2.10 | 1.58 ± 1.36 | 1.71 ± 0.81 |
| **NH3 (ppb)** | 15.91 ± 8.62 | 19.32 ± 7.81 | 18.24 ± 8.79 | 10.37 ± 4.52 | 15.80 ± 9.69 |
| **O3 (ppb)** | 26.81 ± 15.30 | 28.20 ± 16.97 | 25.30 ± 13.99 | 29.29 ± 16.08 | 24.30 ± 13.17 |
| **WS (m s-1)** | 0.89 ± 0.84 | 0.90 ± 0.82 | 0.64 ± 0.63 | 0.75 ± 0.75 | 1.29 ± 0.99 |
| **Temperature (°C)** | 22.43 ± 5.91 | 23.17 ± 4.94 | 27.22 ± 3.25 | 23.54 ± 4.14 | 15.57 ± 4.18 |
| **RH (%)** | 80.21 ± 14.71 | 75.87 ± 14.25 | 82.95 ± 12.36 | 82.13 ± 16.67 | 79.94 ± 14.14 |
| **BLH (m)** | 412.13 ± 213.38 | 372.65 ± 232.79 | 442.16 ± 192.90 | 428.64 ± 221.89 | 405.08 ± 196.62 |

**Table S2.** Fractions of the main chemical species in PM2.5 during the sampling period. (Sum = NO3- + SO42- + Cl- + NH4+ + OM + EC)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **%** | **Total** | **Spring** | **Summer** | **Autumn** | **Winter** |
| **Sum/ PM2.5\_reconstruct**  | 83.2 ± 12.3  | 84.0 ± 9.8 | 81.7 ± 10.6 | 74.6 ± 12.9 | 91.5 ± 6.7 |
| **NO3-/ PM2.5\_reconstruct** | 12.8 ± 7.8 | 16.2 ± 8.9 | 7.3 ± 4.4 | 9.0 ± 5.7 | 15.2 ± 7.2 |
| **SO42-/ PM2.5\_reconstruct** | 18.2 ± 6.8 | 19.9 ± 6.7 | 19.6 ± 9.6 | 16.8 ± 6.9 | 17.9 ± 5.9 |
| **Cl-/ PM2.5\_reconstruct** | 2.7 ± 2.1 | 2.7 ± 2.2 | 1.9 ± 2.9 | 2.4 ± 1.8 | 3.3 ± 2.0 |
| **NH4+/ PM2.5\_reconstruct** | 17.5 ± 5.9 | 16.6 ± 4.5 | 16.1 ± 6.8 | 16.5 ± 6.5 | 19.5 ± 5.4 |
| **OM/ PM2.5\_reconstruct** | 28.0 ± 8.9 | 24.7 ± 8.0 | 33.7 ± 9.4 | 26.6 ± 7.8 | 30.7 ± 9.0 |
| **EC/ PM2.5\_reconstruct** | 4.0 ± 2.5 | 3.8 ± 2.2 | 3.1 ± 3.3 | 3.4 ± 2.5 | 4.8 ± 2.3 |



**Figure S3.** Scatter plot of [NO3-] + 2[SO42-] versus [NH4+] during the observation period.



**Figure S4.** The fractions of chemical compositions in PM2.5\_reconstruct as a function of bext\_wet coloured by RH over the year.



**Figure S5.** Comparison among the bext\_m, bext\_dry and bext\_m.



**Figure S6.** The linear regression analysis between (left panel) bext\_dry and bext\_m, and (right panel) bext\_wet and bext\_m.

**Table S3.** Mass concentrations of chemical compositions in PM2.5, RH, NOR, SOR and BLH of clusters for each season. Percentage (%) means the fractions of the trajectories in total for each season.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cluster** | **PM2.5** | **NO3-** | **SO42-** | **Cl-** | **NH4+** | **OM** | **EC** | **RH** | **NOR** | **SOR** | **BLH** | **Vis\_wet** |
| **Spring** | **µg m-3** |  |  |  |  |  |  | **%** |  |  | **m** | **km** |
| **C1 (17%)** | 25.55 | 3.57 | 5.92 | 0.78 | 5.64 | 7.51 | 1.04 | 78.70 | 0.07  | 0.43 | 384.25 | 13.4 |
| **C2 (22%)** | 41.51 | 7.97 | 8.68 | 1.01 | 7.50 | 9.77 | 1.71 | 75.91 | 0.11 | 0.50 | 249.76 | 8.1 |
| **C3 (11%)** | 16.62 | 2.43 | 5.66 | 0.33 | 6.08 | 9.89 | 1.15 | 76.68 | 0.08 | 0.49 | 460.69 | 8.0 |
| **C4 (28%)** | 29.75 | 3.23 | 4.78 | 0.64 | 3.98 | 6.51 | 0.93 | 73.98 | 0.06 | 0.44 | 461.17 | 17.0 |
| **C5 (22%)** | 45.89 | 9.57 | 9.50 | 1.23 | 7.85 | 9.43 | 1.54 | 76.01 | 0.13 | 0.50 | 333.56 | 7.8 |
| **Summer** |  |  |  |  |  |  |  |  |  |  |  |  |
| **C1 (12%)** | 18.46 | 2.36 | 5.12 | 0.37 | 3.52 | nan | nan | 78.87 | 0.06 | 0.48 | 447.12 | nan |
| **C2 (29%)** | 21.71 | 3.22 | 6.82 | 0.51 | 5.15 | 7.43 | 1.14 | 79.86 | 0.07 | 0.47 | 367.36 | 9.7 |
| **C3 (25%)** | 14.11 | 1.38 | 4.44 | 0.38 | 3.35 | 7.38 | 0.44 | 79.25 | 0.05 | 0.36 | 392.53 | 13.5 |
| **C4 (34%)** | 9.48 | 0.86 | 2.18 | 0.44 | 1.69 | 6.22 | 0.43 | 88.47 | 0.03 | 0.29 | 508.74 | 23.6 |
| **Autumn** |  |  |  |  |  |  |  |  |  |  |  |  |
| **C1 (27%)** | 26.83 | 3.99 | 5.76 | 0.49 | 5.61 | 7.98 | 1.16 | 86.56 | 0.08 | 0.43 | 317.53 | 9.2 |
| **C2 (32%)** | 22.45 | 2.67 | 3.83 | 0.52 | 4.10 | 6.32 | 0.87 | 85.24 | 0.05 | 0.39 | 358.77 | 12.8 |
| **C3 (24%)** | 16.75 | 1.34 | 3.25 | 0.53 | 3.11 | 5.00 | 0.54 | 81.02 | 0.03 | 0.41 | 590.62 | 19.5 |
| **C4 (2%)** | 25.19 | 3.25 | 3.46 | 0.45 | 7.15 | nan | nan | 78.25 | 0.06 | 0.26 | 246.95 | nan |
| **C5 (15%)** | 28.08 | 2.59 | 4.48 | 0.50 | 3.71 | 8.17 | 0.91 | 71.92 | 0.05 | 0.41 | 457.25 | 18.2 |
| **Winter** |  |  |  |  |  |  |  |  |  |  |  |  |
| **C1 (41%)** | 31.59 | 4.66 | 4.86 | 0.91 | 5.73 | 8.51 | 1.35 | 83.11 | 0.08 | 0.43 | 373.96 | 11.5 |
| **C2 (16%)** | 34.78 | 4.45 | 5.66 | 0.80 | 5.68 | 8.94 | 1.51 | 72.16 | 0.09 | 0.41 | 551.14 | 13.9 |
| **C3 (18%)** | 28.85 | 3.37 | 5.38 | 0.89 | 4.92 | 6.98 | 1.02 | 76.05 | 0.07 | 0.44 | 629.53 | 17.8 |
| **C4 (21%)** | 48.48 | 10.04 | 7.35 | 1.84 | 8.69 | 11.17 | 1.89 | 84.47 | 0.12 | 0.45 | 224.60 | 7.1 |
| **C5 (4%)** | 48.02 | 7.77 | 8.15 | 1.47 | 7.90 | 11.94 | 1.89 | 71.22 | 0.09 | 0.46 | 129.37 | 9.8 |