Supplement of

Finding candidate locations for aerosol pollution monitoring at street level using a data-driven methodology

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Instrumentation for aerosol measurements

Table S1 shows the characteristics of the instruments used for the aerosol pollution measurements at the background site above the urban canopy (a balcony in a 28th floor) and transects along the streets of the neighborhood of Rochor investigated in this study.

The DustTrak sensors measure particles size segregated mass-fraction concentrations with a laser photometer, whose readings depends on the ambient humidity and particle properties, such as size distribution, morphology and refractive index. We follow the approach of Ramachandran et al. (2003) to correct the humidity effect using the relative humidity (RH) data measured by the HOBO loggers. Prior to the study, the individual response of each individual sensor to the properties of the particles in the tropical atmosphere of Singapore was evaluated through gravimetric calibrations. Similar to Apte et al. (2011), power-law regression relationships were obtained from comparisons with 24-h PM$_{2.5}$ concentrations determined by gravimetric analysis of 23 colocated filter samples with concentrations ranging from 10 to 80 µg m$^{-3}$.

Similarly, the micro-aethalometer readings of black carbon (BC) are sensitive to mechanical shock or vibrations of the instrument. The black carbon data were corrected using software based on the Optimized Noise-reduction Averaging method (ONA) available on the manufacturer website (www.aethlabs.com). A second correction was needed to account for the instrument’s sensitivity associated with the filter load. Briefly, because BC concentration is measured by changes in the light attenuation on a disposable filter through which sample air is drawn at 100 cm$^3$ min$^{-1}$, concentrations were adjusted using the empirical relationship of Kirchstetter and Novakov (2007) based on the instrument-reported attenuation coefficient.

The data collected by the Condensation Particle Counter (CPC), Compact Real-Time Diffusion Charger and Compact Real-Time Photoelectric Aerosol Sensor measuring particle number concentration, active surface area and concentration of particles-bound polycyclic aromatic hydrocarbons (pPAHs), respectively, did not require additional corrections. They only passed through a quality assurance in which suspicious data were removed using as reference notes taken during the sampling (e.g.
if the CPC does not keep a horizontal position, the internal optical sensor may deliver erroneous readings).

Prior to each day of measurement, all instruments were synchronized to a computer clock in the laboratory. This ensured that the time stamp was consistent across all instruments. Instruments with removable parts were dismantled and re-assembled for each day of sampling. Upon arrival at the background site, zero calibration procedures for the CPCs and DustTrak sensors were carried out. Instruments were then set to log data for 10 min prior to the actual sampling. All instruments were placed side-by-side with inlets close together during these parallel measurement periods. Data from this parallel measurement were later used to correct the instruments at the background site to those used in the transects at street level. The data post-processing after the measurements included a second synchronization. The lag times of each instrument were computed through cross-correlations against the DustTrak sensors to achieve better synchronization across all instruments. Lag times ranged from 2 to 15 s on average. Instruments at the background site were also adjusted to the instruments used for the transects.

Table S1. Instruments information

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Instrument</th>
<th>Accuracy</th>
<th>Lower threshold</th>
<th>Response time</th>
<th>Model</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particles size segregated mass-fraction concentration (PM$<em>1$, PM$</em>{2.5}$, PM$_{10}$)</td>
<td>Hand-held DustTrak DRX Aerosol Monitor</td>
<td>±0.1% of reading or 1 µg m$^{-3}$</td>
<td>1 sec</td>
<td>TSI 8534</td>
<td>TSI, MN USA</td>
<td></td>
</tr>
<tr>
<td>Particle number concentration (particles &lt; 1 µm)</td>
<td>Hand-held Condensation Particle Counter (CPC)</td>
<td>±20%</td>
<td>1 particle cm$^{-3}$ (min. particle size 10 nm)</td>
<td>1 sec</td>
<td>TSI 3007</td>
<td>TSI, MN USA</td>
</tr>
<tr>
<td>Black carbon</td>
<td>Micro-aethalometer</td>
<td>±0.1 µg m$^{-3}$</td>
<td>1 ng m$^{-3}$</td>
<td>1 sec</td>
<td>AE51</td>
<td>AethLabs, CA USA</td>
</tr>
<tr>
<td>Active surface area</td>
<td>Compact Real-Time Diffusion Charger</td>
<td>±15% of reading ± 2 mm$^2$ m$^{-3}$</td>
<td>1 mm$^2$ m$^{-3}$</td>
<td>10 sec</td>
<td>DC 2000CE</td>
<td>EcoChem Analytics, TX USA</td>
</tr>
<tr>
<td>Total pPAHs concentration (particles &lt; 1)</td>
<td>Compact Real-Time Photoelectric</td>
<td>±15% of reading ± 3 ng m$^{-3}$</td>
<td>1 ng m$^{-3}$</td>
<td>10 sec, PAS 2000CE</td>
<td>EcoChem Analytics, TX USA</td>
<td></td>
</tr>
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</tr>
<tr>
<td>μm) Aerosol Sensor</td>
<td>HOBO Pro v2 logger</td>
<td>0.2°C, ±2.5% RH</td>
<td>0.02°C at 25°C, 0.03% RH</td>
<td>1 sec</td>
<td>U23-001</td>
<td>Onset Computer Corp., MA USA</td>
</tr>
</tbody>
</table>

52

53 **List of Urban Parameters**

54 There are three category of urban parameters used in our work.

55 For the first category, land use, the urban parameters are defined by the area occupied
56 by 17 different types of surface covers and building uses, such as residences, parks,
57 water bodies, open spaces, roads, commercial establishments, schools, worship
58 places, etc. therefore, we have the following sub criteria of land use as follows:

59 1. Sum-Residential
60 2. Sum-RESIDENTIAL-WITH-COMMERCIAL-AT-1ST-STOREY
61 3. Sum-COMMERCIAL
62 4. Sum-HOTEL
63 5. Sum-WHITE
64 6. Sum-BUSINESS-1-WHITE
65 7. Sum-HEALTH---MEDICAL-CARE
66 8. Sum-EDUCATIONAL-INSTITUTION
67 9. Sum-PLACE-OF-WORSHIP
70 10. Sum-CIVIC-COMMUNITY-INSTITUTION
73 11. Sum-OPEN-SPACE
75 12. Sum-PARK
76 13. Sum-BEACH-AREA
77 14. Sum-SPORTS-RECREATION
78 15. Sum-WATERBODY
79 16. Sum-ROAD
80 17. Sum-TRANSPORT-FACILITIES
81 18. Sum-UTILITY
82 19. Sum-RESERVE-SITE
84 20. Sum-Commercial

85 The Space Syntax Method (Hillier et. al., 1976), which is a network analysis method,
86 uses different analytics to measure parameters in the second category, street network
87 indicators. Connectivity measures the number of immediate neighbors to a segment.
88 Further, Space Syntax consists of three indicators, namely Integration, Choice and
89 Depth. Integration calculates the numbers of turns that must be made from a street
90 segment to reach all other street segments in the network, using shortest paths. If we
91 consider all the segments from all the segments the radius is selected to be ‘n;’
however, if one sets a limit on the possible number of turns, then the most integrated
segments are those that have the highest number of connections in the limited number
of. Therefore, it is common to have different integration measures based on different
radii.

The second indicator is called Choice, which is a measure in the category of network
flow analysis. It measures how a segment is relatively connected to other segments.
Similar to integration, there are choices of radius to be analyzed around each
individual node of the street network. Further, it is common to use logarithmic value
of Choice indicator, which is called Log Choice in our work.

Depth measure simply calculates the distance between the centers of each segment to
all the other segments. Similarly, we can limit the distance to a radius and count the
number of streets nearby to each segment.

In Space Syntax methodology, there are different ways of measuring the shortest path.
In this work we chose the Angular way, in which the shortest path is the one that
minimizes the angle between the origin and the destination. Further, for the choice of
radius there are such options as metric distance, angular or segment and segments
with length as the weight. Metric distance is the usual distance. Angular radius is
based on the angle between points. Segment radius is the limit on the number streets
that one can pass starting from a street segment and weighted segment is when one
consider the length of streets as well as the number of streets. Based on these
combinations of indicators with different ways of measuring the radius and shortest
paths we used the following features in the category of urban network parameters.

1. Connectivity 14. T1024-Choice-Segment-
2. LogChoice 13. T1024-Choice-Segment-
3. LogChoice 15. T1024-Choice-Segment-
4. T1024-Choice 16. T1024-Choice-Segment-
5. T1024-Choice-R10000-metric 17. T1024-Choice-Segment-
6. T1024-Choice-R1200-metric 18. T1024-IntegrationN
7. T1024-Choice-R15000-metric 19. T1024-Integration-R10000-
8. T1024-Choice-R2000-metric 20. T1024-Integration-R1200-
9. T1024-Choice-R5000-metric 21. T1024-Integration-R15000-
10. T1024-Choice-R800-metric
11. T1024-Choice-Segment-
12. T1024-Choice-Segment-
13. T1024-Choice-Segment-
14. T1024-Choice-Segment-
15. T1024-Choice-Segment-
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20. T1024-Integration-R1200-
21. T1024-Integration-R15000-
22. T1024-Integration-R1200-
23. T1024-Integration-R15000-
And finally, for the third category of urban parameters, building topology, the following parameters were calculated for each grid cell.

1. Total area covered by buildings
2. Average buildings’ height
3. The number of corners in the buildings

References for Supplementary Material

Apte, J. S., Kirchstetter, T. W., Reich, A. H., Deshpande, S. J., Kaushik, G., Chel, A., Marshall, J. D. and Nazaroff, W. W.: Concentrations of fine, ultrafine, and black
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