atmosphere

A High Resolution Spatiotemporal Model for In-Vehicle Black Carbon Exposure: Quantifying the In-Vehicle Exposure Reduction Due to the Euro 5 Particulate Matter Standard Legislation

Supplementary data

Spatial extent of the citizen science measurement campaign

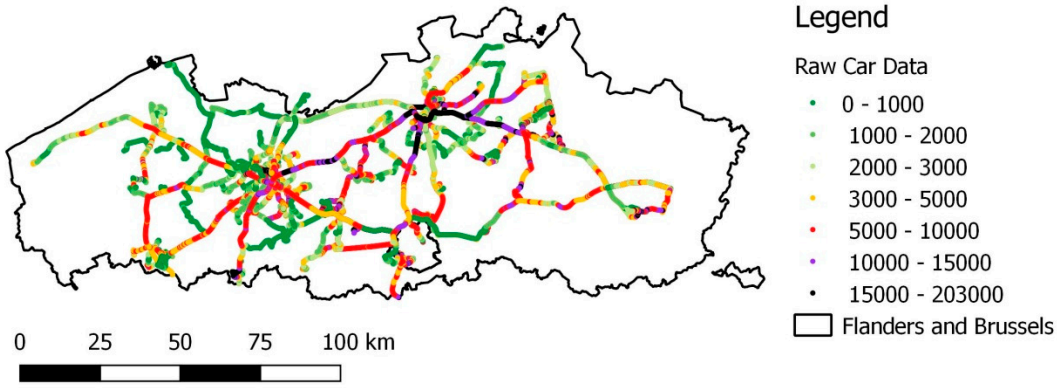

Figure S1. Spatial extent of the commutes of the volunteers: raw BC measurements (ng/m^3) in a 10 second resolution across the Flemish Region and Brussels (North part of Belgium).

Meteorological stations (KMI)

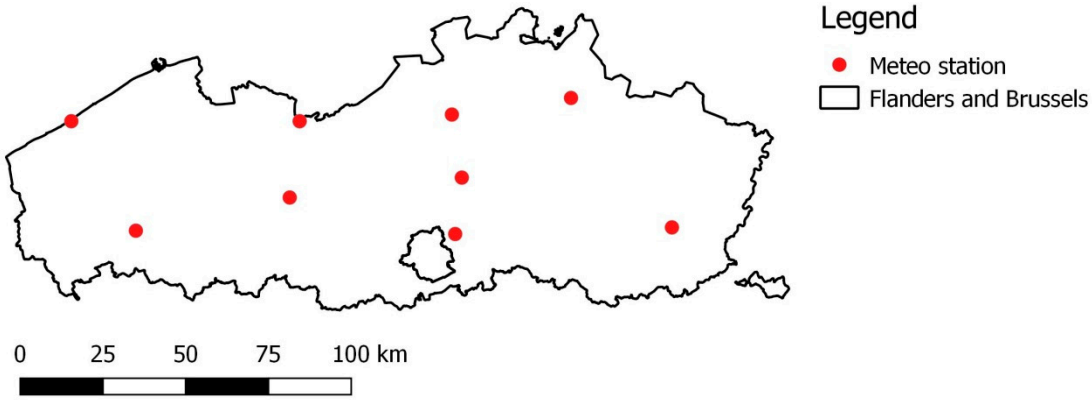

Figure S2. Measurement locations for meteorological stations. (data made available by KMI: https://www.meteo.be).

Black Carbon measurement network of the Flemish Environmental Agency

The measurement data is made available by the VMM (Flanders Environmental Agency). The on-line data is available through the joint website (http://www.irceline.be/en), merging de results from the different region into a Belgian context.

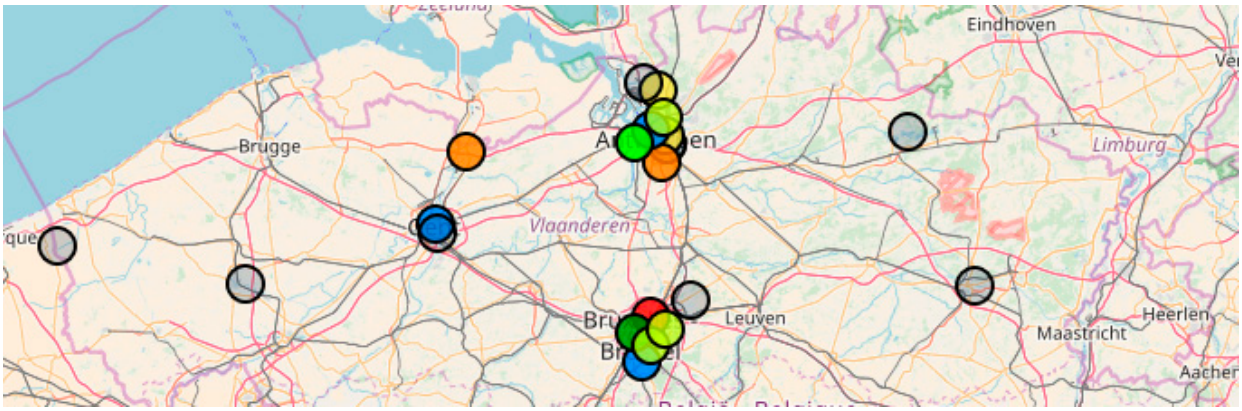

Figure S3. (**a**) Black Carbon measurement locations in Belgium of the Flemish Environmental Institute (VMM), situation in 2017.

Spatial detail of the measurement locations in Antwerpen.

- Background location in the models: Antwerpen Linkeroever
- In-city main road locations (two points), used in investigation of the discrepancy in the validation.

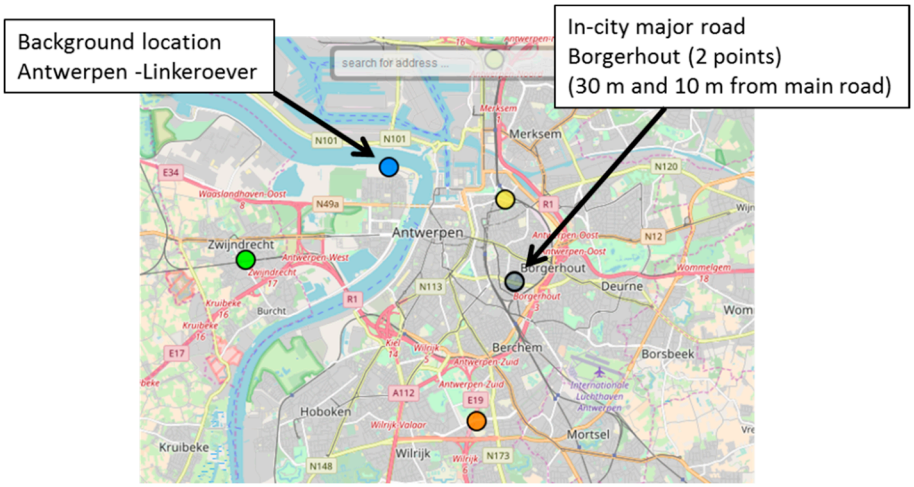

Figure S3. (**b**) Black Carbon measurement locations in Belgium of the Flemish Environmental Institute (VMM), situation in 2017. Detail in Antwerpen.

Noise maps of Flanders.

Noise mapping is performed within a two/three year cycle of environmental evaluation for the Flemisch institute responsible of all environmental reporting (Vlaamse Milieu Maatschappij). The noise map is built on the traffic data of 2012. The noise map is calculated with ISO 9613-2, using the emission definitions of the European Cnossos project. It is calculated for Flanders and Brussels using a spatial resolution of 10, 20 and 50 m buffers around the roads and a spatial resolution of 100 m further away from the road network. This result is interpolated to a grid with grid size of 20 m for the whole region under investigation. Screening of buildings is not included (not possible to calculate this on Flemish scale). Noise screens near highways are included.

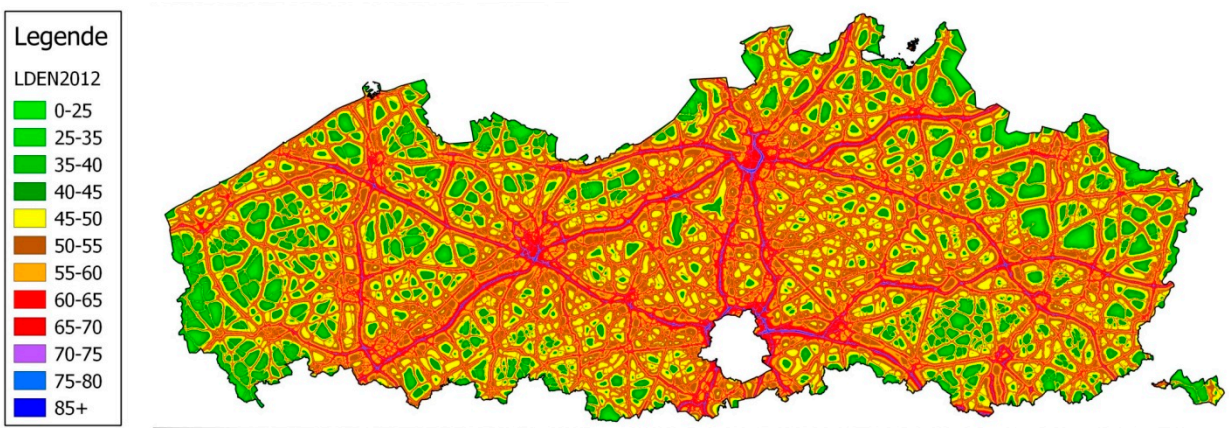

Figure S4. (**a**) LDEN Noise map for Flanders for 2012 (Brussels also available but not shown).

The traffic attribution of the generalized link to the actual roads is performed by local routing of the traffic links, resulting is a high spatial resolution in local communities.

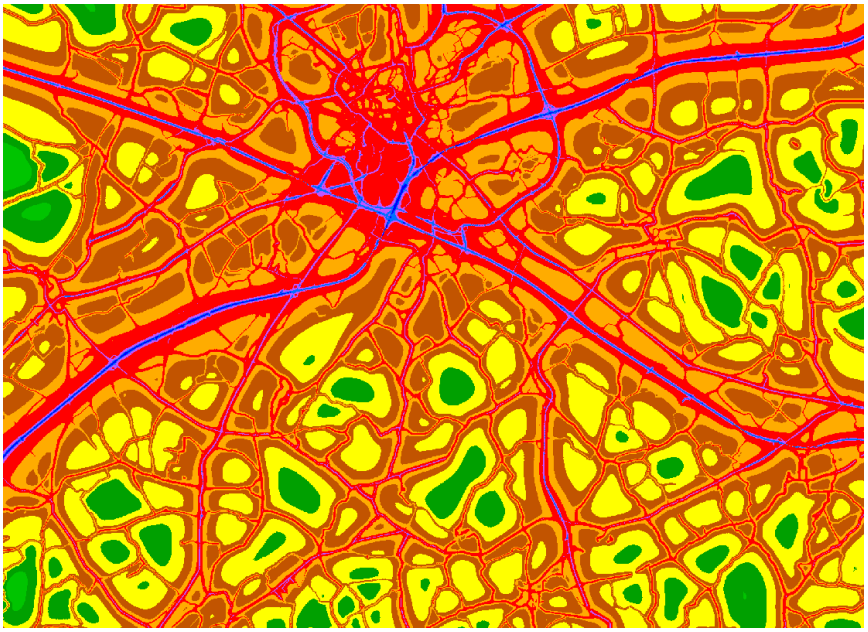

Figure S4. (**b**) Detail of the noise map showing the spatial resolution of the low density roads (due to the traffic attribution by routing). Along the highways, the locations of the noise screens along the highways are visible.

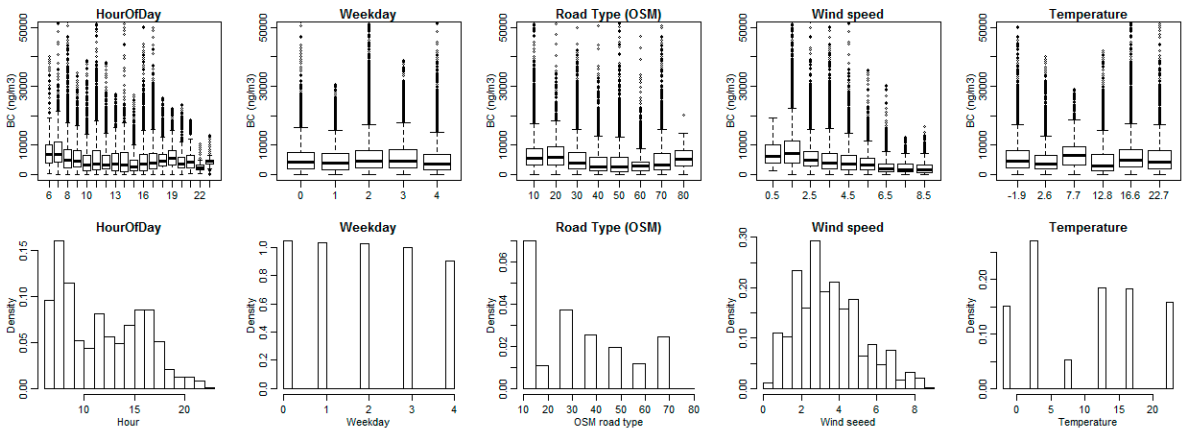

Figure S5. Overview of spatial and temporal variability in the BC_LAG60 BC data set: BC distributions by covariate groups (top row) and frequency of occurrence (bottom row) for hour of the day, day of the week (weekdays only, Monday = 0), Road type (Open Street Map classification (10 = highways, 20 = exits, 30/40 = main roads, 50/60/70 local roads, 80= parking lots and private facilities), Wind speed and Temperature.

Table S1. GAM summary of BCLAG60_WBC model.

Family: gaussian

Link function: identity

Formula:

bclog ~ +s(relative_speed, k = 6) + s(acceleration, k = 4) +
s(actual_speed, k = 4) + s(wind_speed, k = 4) + s(temperature,
k = 4) + s(rel_humidity, k = 4) + s(hourly_traffic, k = 4) +
s(LDEN_noisemap, k = 4) + s(hourOfDay, k = 9) + s(BC_background, k = 4) +
s(PM10_pollution_map, k = 4) + s(streetcanyon_index, k = 4)

Parametric coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	8.301143	0.003291	2522	<2e-16	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:

	edf	Ref.df	F	p-value	
s(relative_speed)	4.984	5.000	369.04	<2e-16	***
s(acceleration)	2.876	2.989	65.00	<2e-16	***
s(actual_speed)	2.919	2.995	205.48	<2e-16	***
s(wind_speed)	1.000	1.001	5699.78	<2e-16	***
s(temperature)	2.998	3.000	1006.82	<2e-16	***
s(rel_humidity)	2.789	2.967	233.11	<2e-16	***
s(hourly_traffic)	2.985	3.000	827.04	<2e-16	***
s(LDEN_noise_map)	2.986	3.000	1154.40	<2e-16	***
s(HourOfDay)	7.950	7.999	245.37	<2e-16	***
s(BC background)	2.988	3.000	943.96	<2e-16	***
s(PM10_pollution_map)	2.887	2.990	60.72	<2e-16	***
s(streetcanyon_index)	1.003	1.006	276.79	<2e-16	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.464 Deviance explained = 46.7%

-REML = 1.2636e+05 Scale est. = 4.9641 n = 79158

Table S2. Yearly average reduction at three long-term measurements locations evaluated on Q1 during the night-time and Q3 during morning rush hour, including estimates of the expected reduction between citizen science campaigns based on the official monitoring network.

Yearly Averaged Reduction			
	Antwerpen Linkeroever (40AL01)	Borgerhout (background) (42R801)	Borgerhout streetside (42R802)
Available data (years)	2010–2016	2010–2016	2012–2016
Reduction based on Q1, nighttime versus all day			
Q1,ngt (3:30–5:30)	−8.4%	−7.3%	−9.9%
Q1,tot	−8.0%	−6.1%	−5.9%
Relative difference: Q1,ngt vs day	5%	20%	68%
Reduction based on Q3, morning rush hour versus all day			
Q3,rush (7:30–9:30)	−6.8%	−7.5%	−10.6%
Q3,tot	−6.1%	−6.7%	−5.5%
Relative difference: Q3,rush vs day	11%	12%	93%
Concentration reduction between citizen science campaigns (3.5 years)			
Q1,ngt (typical value)	−25%	−20%	−19%
Q3,day (typical value)	−20%	−22%	−18%
Q1,day (lower limit)	−26%	−23%	−31%
Q3,rush (typical value, less than maximum expected)	−22%	−24%	−32%