Diesel MItigation STudy (DeMIST)
Measuring professional driver exposures

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DIESEL OIL AND LUNG CANCER

Evidence that smoke-polluted air causes death from bronchitis and bronchopneumonia has again been confirmed this year.[1] That it causes death more insidiously is suggested also by comparing the lung-cancer mortality rate in cities with that in the country.[2] Proposals to increase or to change the character of the smoke poured into the atmosphere thus deserve to be met with anxious scrutiny, and the doubts of some medical men about the wisdom of increasing the number of diesel-fuelled motor vehicles on the road were expressed in a resolution passed by the Representative Body of the British Medical Association last year. This urged the Council of the B.M.A. "to draw the attention of the transport authorities to the possible dangers of fumes from diesel engines and to the remarkable coincidence between the increased use of diesel fuel for transport and the rise of mortality from lung cancer and other respiratory disease."

Some evidence that diesel fumes may be harmful is provided by H. L. Falk, P. Kotin, and their colleagues.[3–6] They have reported the presence of aromatic hydrocarbons, including 3:4-benzpyrene, in the atmosphere of Los Angeles and in the exhaust products from petrol and diesel engines. It is likely that most atmospheric aromatic hydrocarbons in that city arise from the use of oil products in one form or another, since virtually no coal is burnt there. In Britain, on the other hand, the air is polluted mainly by coal smoke, containing a similar range of hydrocarbons. Though smoke from this source is tending to decline, smoke from vehicles burning diesel fuel is increasing.

Br Med J. 1956 May 12; 1(4975): 1092–1094.

SMOKE IN A LONDON DIESEL BUS GARAGE
AN INTERIM REPORT

BY

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Exhaust products from motor vehicles are known to be potentially harmful to man in that they contain substances which, if inhaled in sufficiently high concentrations, are noxious. Much is known of the composition of vehicle exhausts, but such analytical data, though essential, are of limited toxicological value unless the degree of dilution in the ambient air is known. No practical assessment of the potential danger is possible without knowing what man is likely to breathe. The highest concentrations of exhaust products to which men are regularly exposed probably occur in garages, and we are at present studying air pollution in one of London Transport Executive's garages for diesel buses. This study is being supplemented by extensive analyses of exhaust products of various diesel vehicles under different running conditions on the L.T.E. test track at Chiswick. Our work is being done in the closest co-operation with London Transport Executive, which has offered us every facility for the investigations.

Our efforts have been directed initially to the study of diesel exhausts as a matter of urgency in view of recent suggestions that, because 3:4-benzpyrene has been found in soot from diesel engines, they might be at least partly responsible for the rise in the incidence of lung cancer. It is with this urgency in mind that we have prepared an interim report of our findings with respect to smoke and benzpyrene; a detailed account of our findings with respect to all suspect pollutants will be published later.

Br Med J. 1956 September 29; 2(4995): 753–754.

Br J Ind Med. 1957 October; 14(4): 232–239.

Lancet Oncology July 2012

News

Carcinogenicity of diesel-engine and gasoline-engine exhausts and some nitroarenes

In June, 2012, 24 experts from seven countries met at the International Agency for Research on Cancer (IARC; Lyon, France) to assess the carcinogenicity of diesel and gasoline engine exhausts, and some nitroarenes. These assessments will be published as Volume 105 of the IARC Monographs.[1]

The most influential epidemiological studies assessing cancer risks associated with diesel-engine exhausts investigated occupational exposure among non-metal miners, railroad workers, and workers in the trucking industry. The US miners study included a cohort analysis[2] and a nested case-

with 20 years of employment roughly doubling the risk after adjusting for tobacco smoking. When this study was extended with an exposure assessment involving contemporary measurements and exposure re-construction on the basis of elemental carbon, positive trends were observed

News

Lancet Oncology Dec 2013

The carcinogenicity of outdoor air pollution

Published Online
October 24, 2013

In October, 2013, 24 experts from 11 countries met at the International Agency for Research on Cancer (IARC), Lyon, France, to assess the carcinogenicity of outdoor air pollution. This assessment was the last in a series that began with specific combustion products and sources of air pollution and concluded with the complex mixture that contains

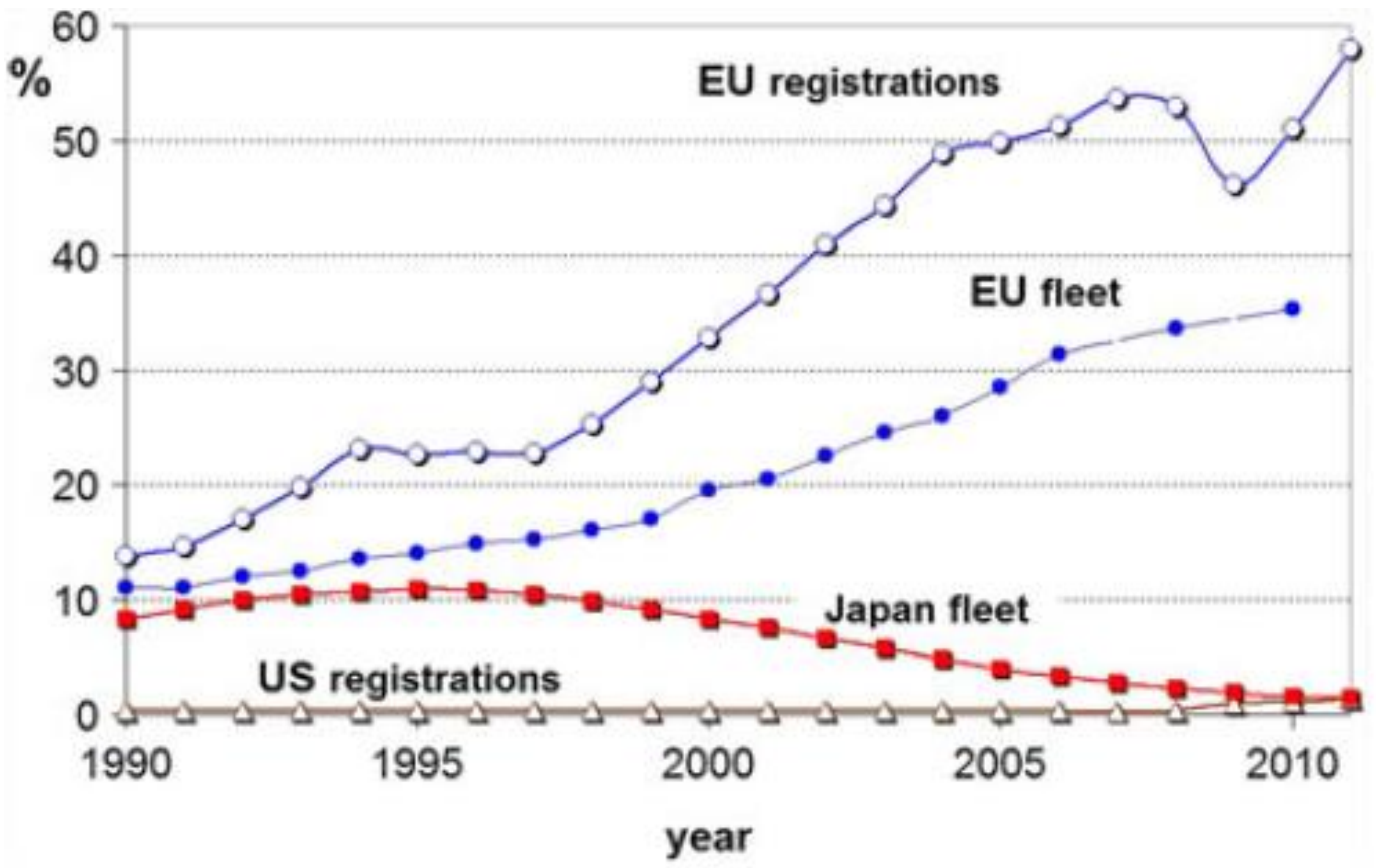
The IARC Working Group unanimously classified outdoor air pollution and particulate matter from outdoor air pollution as carcinogenic to humans (IARC Group 1), based on sufficient evidence of carcinogenicity in humans and experimental animals and strong mechanistic evidence.

The findings regarding the carcino-genicity of outdoor air pollution as

to traffic or traffic emissions, in studies that were adjusted for tobacco smoking. However, most studies assessed exposure only by employment in occupations with potentially high exposure to outdoor air pollution, so the results did not weigh heavily in the evaluation.

The Working Group also reviewed evidence regarding the

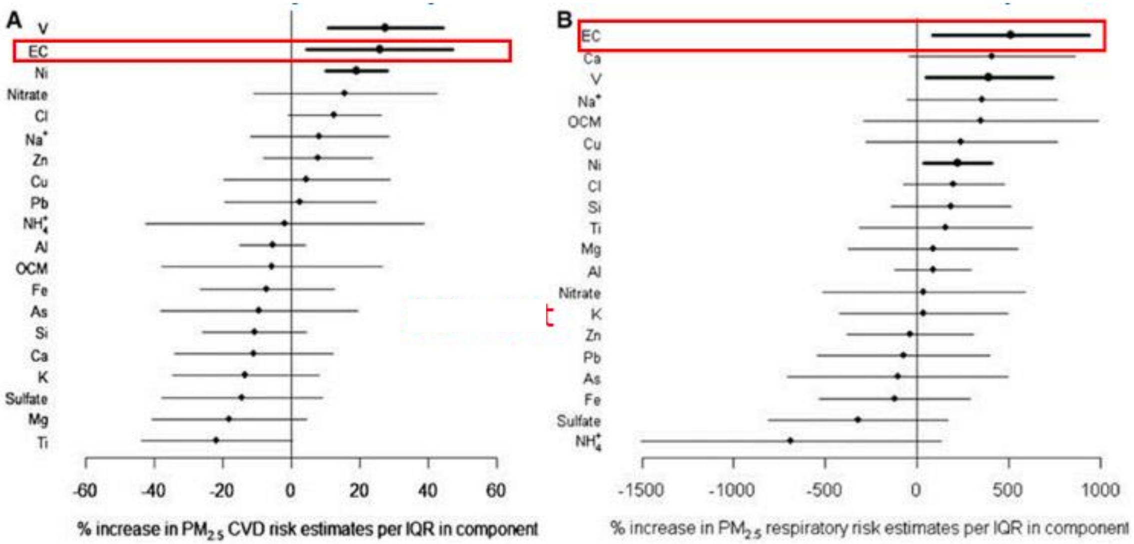
European dieselization



Cames and Helmers. Environmental Sciences Europe. 2013

Black Carbon – a better health indictor?

Toxic component or source indicator?

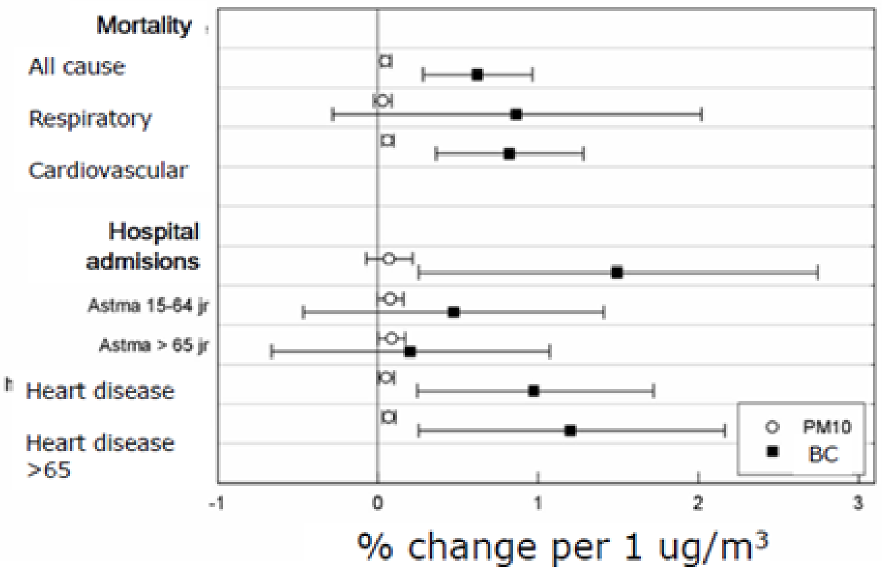


Estimated county- and season-specific relative risks (RR) of cardiovascular and respiratory hospitalization associated with $PM_{2.5}$ components in 106 U.S. counties for the years 1999 through 2005

Bell et al, Am J Respir Crit Care Med, 2009

Systematic review and meta-analysis of health effects of BC compared with PM mass based on data from time-series studies and cohort studies that measured both exposures

Janssen et al, Environ Health Perspect, 2011



Main Risk Employment Areas

- Mining
- Construction
- Shipping
- Energy extraction
- Tunnelling
- Vehicle repair

Non-road mobile machinery

THE LAW

In many countries, exposure to hazardous substances is covered under the law.

In the UK, employers are legally required to consider the risk … l of Subs … as by t … nd Mar … ns.

0.05 mg/m³

By law, employers should assess the risk of people being affected by diesel fumes, and then work to either stop exposure or reduce it with suitable control measures.

There is no current exposure limit for diesel exhaust fumes in the EU, but this may be set to change.

31st Oct 2018: The EU Commission, EU Council of Ministers and European Parliament have reached an agreement on including workplace exposure to diesel engine exhaust emissions (DEEE) in the updated **Carcinogens and Mutagens Directive 2004/37/EC (CMD)**

In the UK, the Health and Safety Executive estimates that more than **100,000 workers** could be exposed to **high levels** of **diesel engine exhaust fumes**, but Imperial College, the IOM and others put the figure closer to **500,000**

Significance

- 233,861 lorry drivers
- 259,161 van drivers
- 127,518 bus/coach drivers
- 174,780 taxi drivers

(ONS, 2011)

- 3.6% of the English and Welsh adult working population (26,681,568 in 2011)

(ONS, 2011)

Behndig AF et al. Thorax. 2011;66(1):12-9.
(Experimentally generated diesel exhaust induced airway inflammation in human volunteers)
Barath S et al., Part Fibre Toxicol. 2010;7:19.
(Experimentally generated diesel exhaust impairs vasomotor function and endogenous fibrinolysis)
McCreanor J, et al. N Engl J Med. 2007 Dec 6;357(23):2348-58.
(Real world diesel exposures in asthmatics induced inflammation and impaired lung function)
Samoli E et al. Occup Environ Med. 2016 May;73(5):300-7.
(Elemental and black carbon are the best predictors of adult cardiovascular and paediatric respiratory hospitalisations in London)

The Diesel Exposure Mitigation Study (DEMiSt)

We hypothesise that professional drivers working in congested cities are exposed to diesel emission far above the general population and therefore at increased risk of harm.

The aims of DEMiSt are to:

- characterise the black carbon exposure of professional drivers during a typical workday.
- identify low cost intervention methods to reduce exposure and health risk.

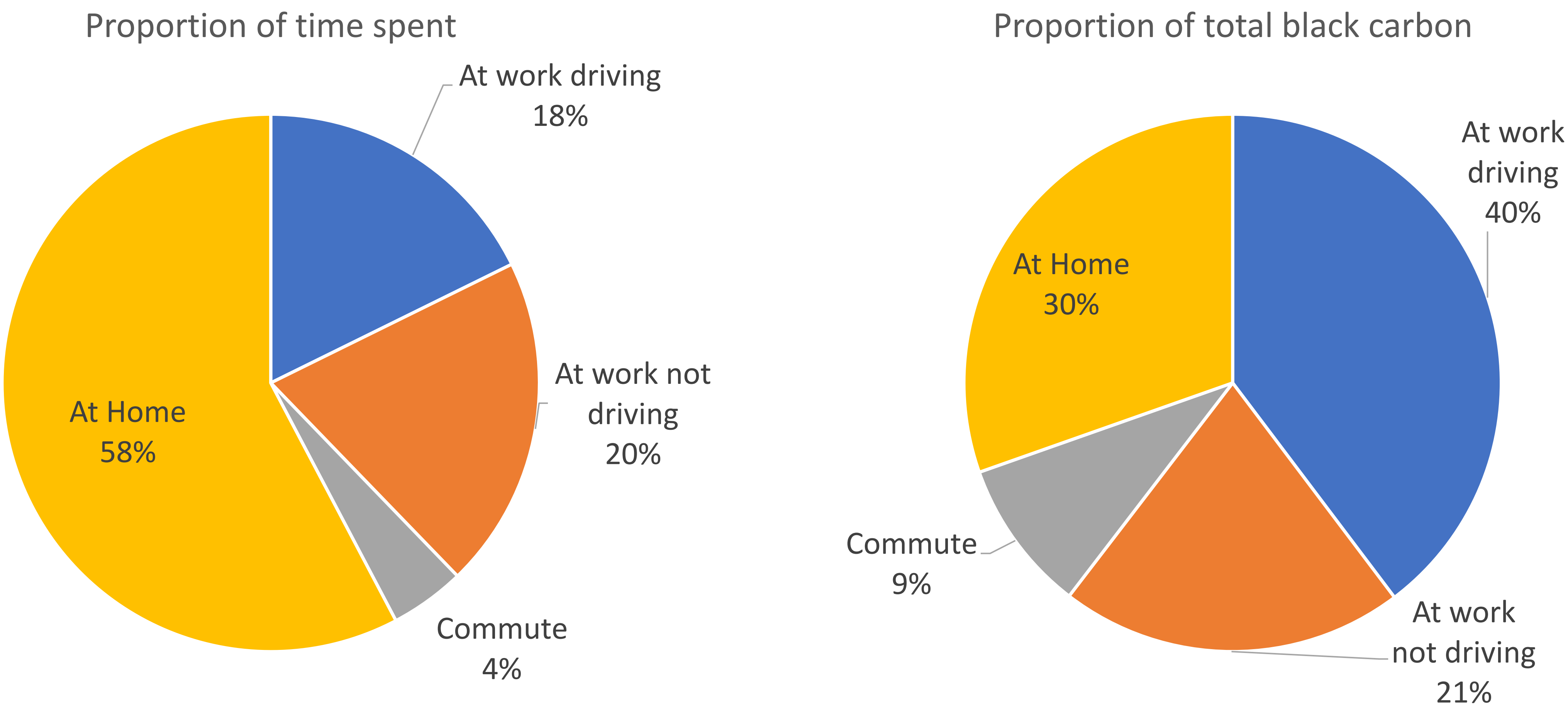
Methods

- Recruit 150 drivers across different sectors.
- Each driver is monitored for 96 continuous hours (4 days) at 10-second resolution.
- The drivers are asked to complete a questionnaire, detailing their vehicle ventilation preferences, whether they are smokers and the number of hours they drive during the day.
- The latest generation of personal GPS-linked black carbon sensors (Microaethalometer MA300/350) are used to monitor driver exposure.
- Using GPS information, participants activities are determined between driving at work, not driving at work, commuting and at home.

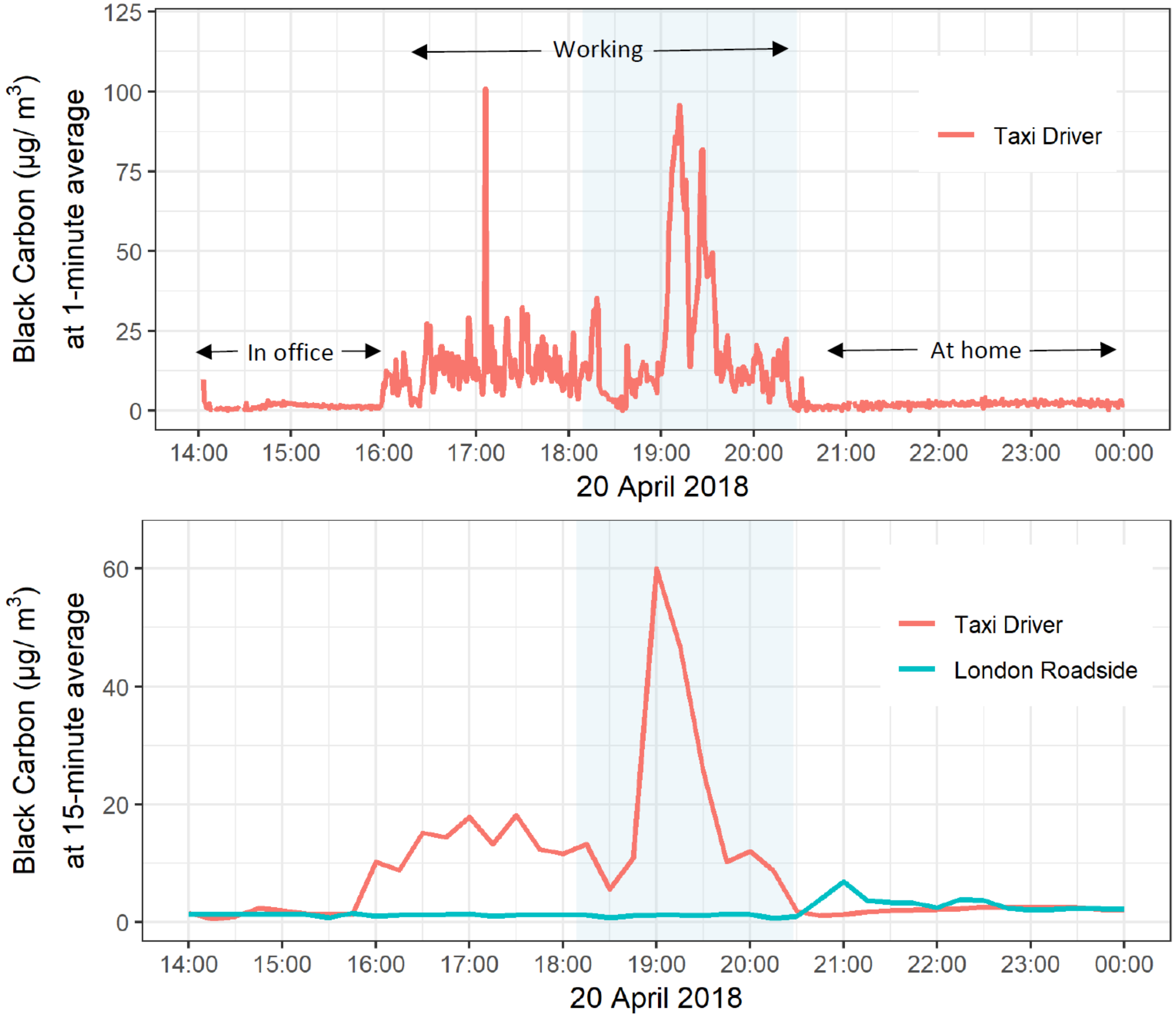
Preliminary Results

Sector	Number of shifts	Mean (standard deviation) black carbon exposure (μg/m³)				
		At work driving	**At work not driving**	**At work unknown**	**Commute**	**At home**
Taxi	73	6.5 (5.8)	4.2 (4.2)	-	3.9 (3.3)	1.1 (1.6)
Courier	55	5.1 (4.6)	2.8 (2.7)	-	3.9 (3.1)	1.5 (1.7)
Construction Waste	67	4.5 (3.8)	2.3 (3.2)	-	4.7 (4.2)	1.0 (1.6)
Waste Removal	66	4.4 (4.0)	2.9 (3.8)	-	2.8 (3.6)	1.4 (2.6)
Construction	11	-	-	3.4 (3.2)	4.0 (4.1)	1.7 (1.6)
Utility Services	32	3.0 (3.0)	1.3 (1.2)	-	4.6 (3.4)	0.6 (0.9)
Emergency Services	123	3.0 (2.5)	1.5 (1.8)	0.9 (1.1)	3.8 (3.7)	1.0 (1.3)
Heavy Freight	31	-	-	2.1 (2.6)	-	0.7 (1.2)
All	**441**	**4.3 (3.9)**	**2.4 (2.8)**	**2.3 (2.5)**	**3.9 (3.6)**	**1.1 (1.6)**

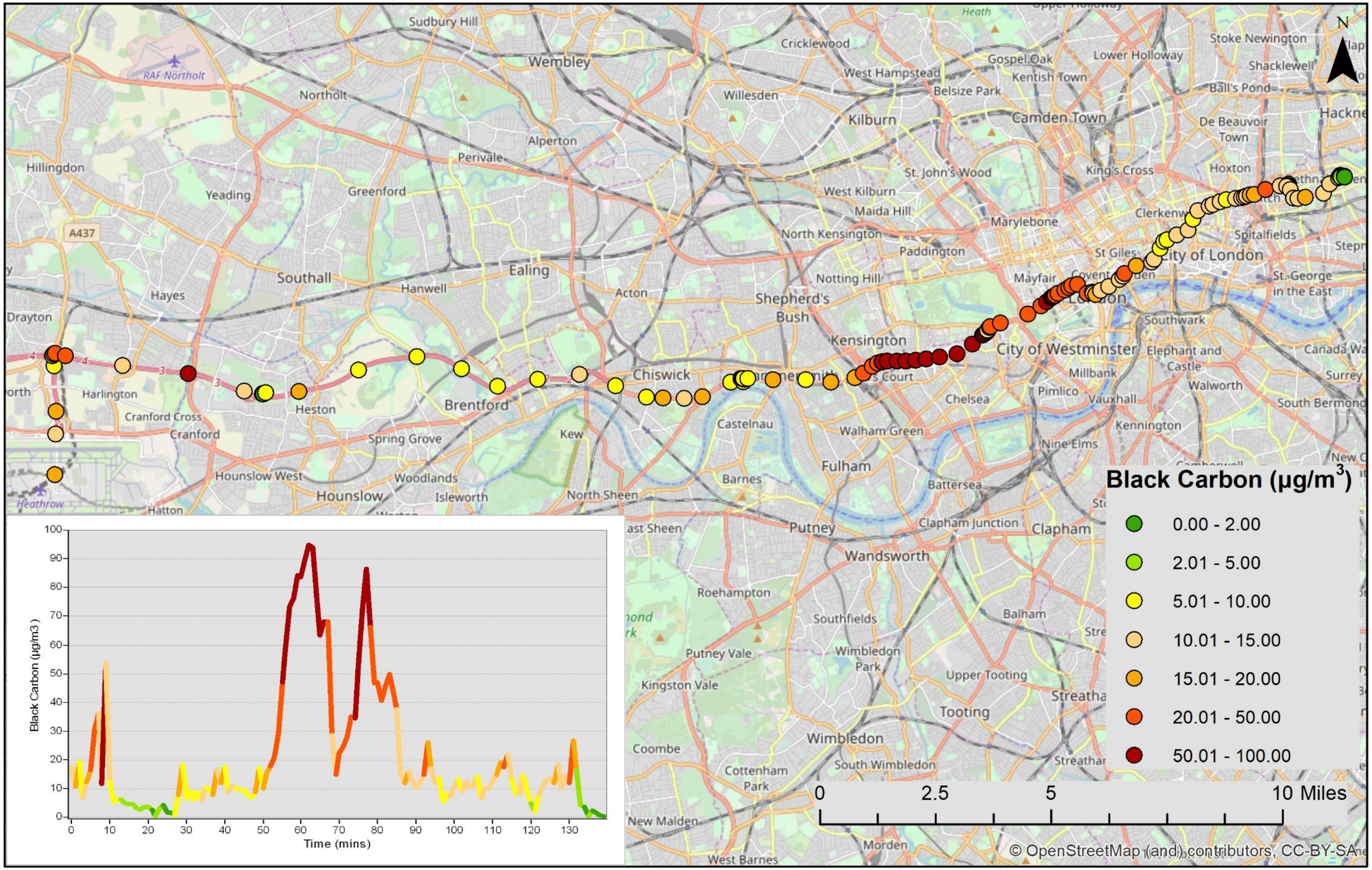
Contribution of Microenvironment on exposure



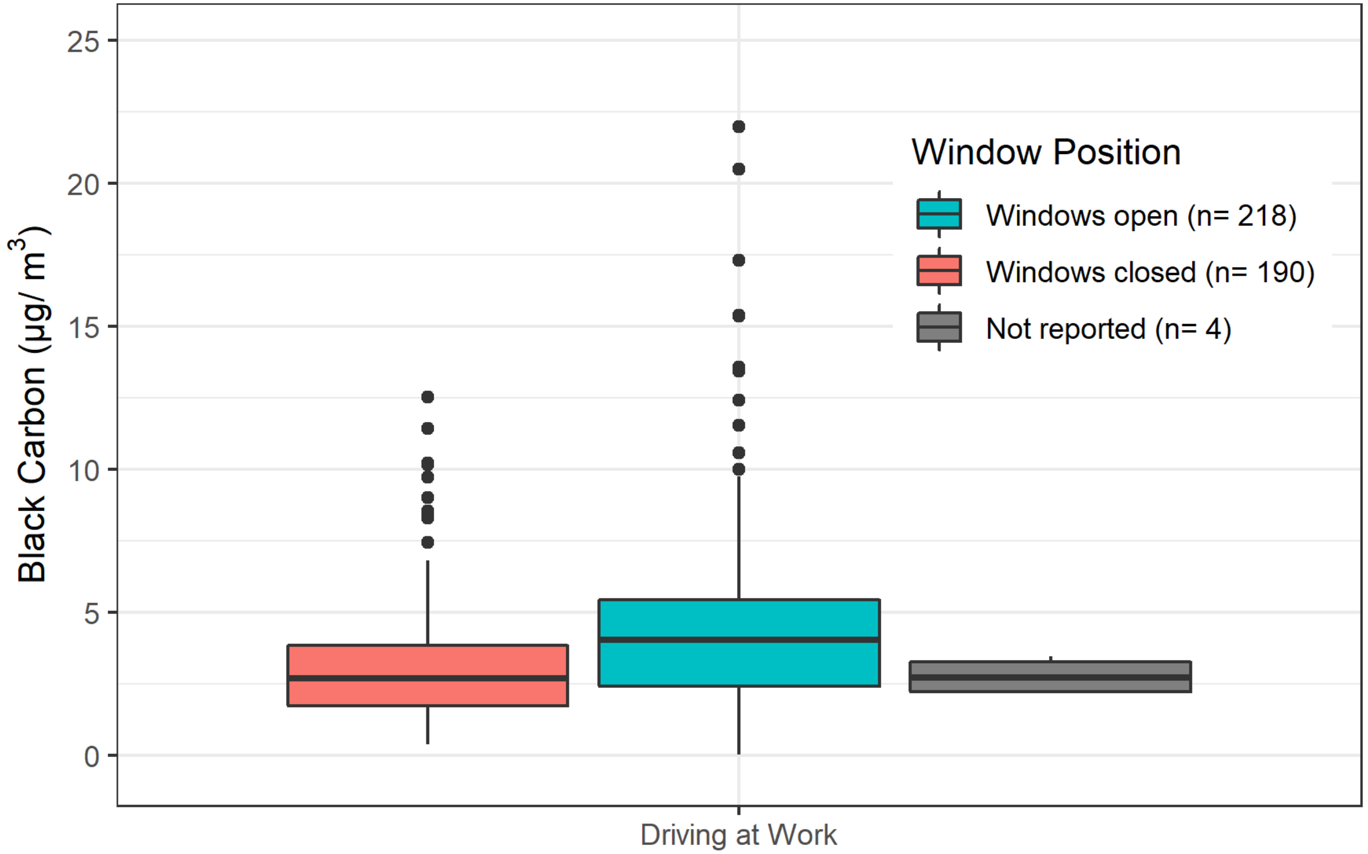
Pollution spikes



Pollution spikes

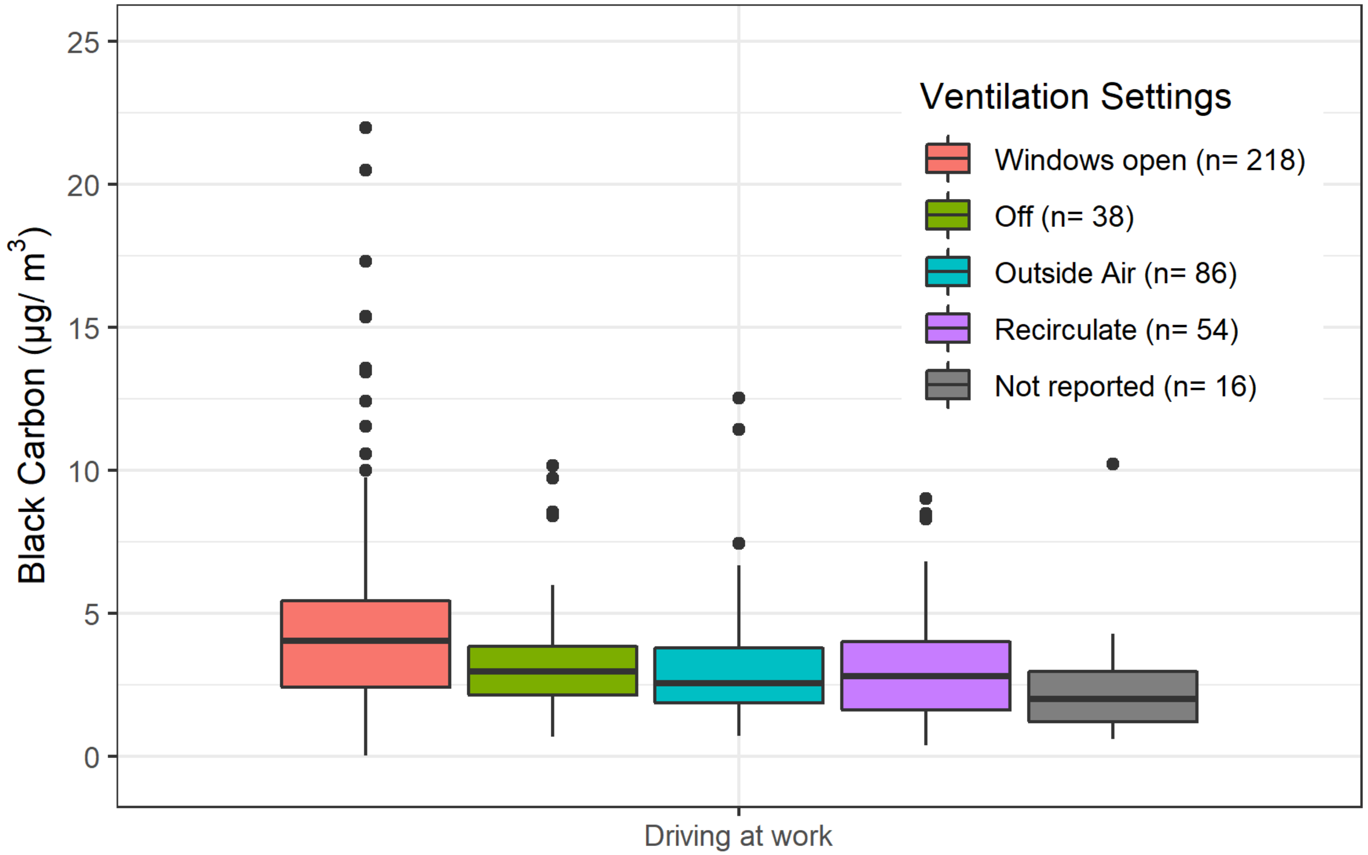


Window Position Results



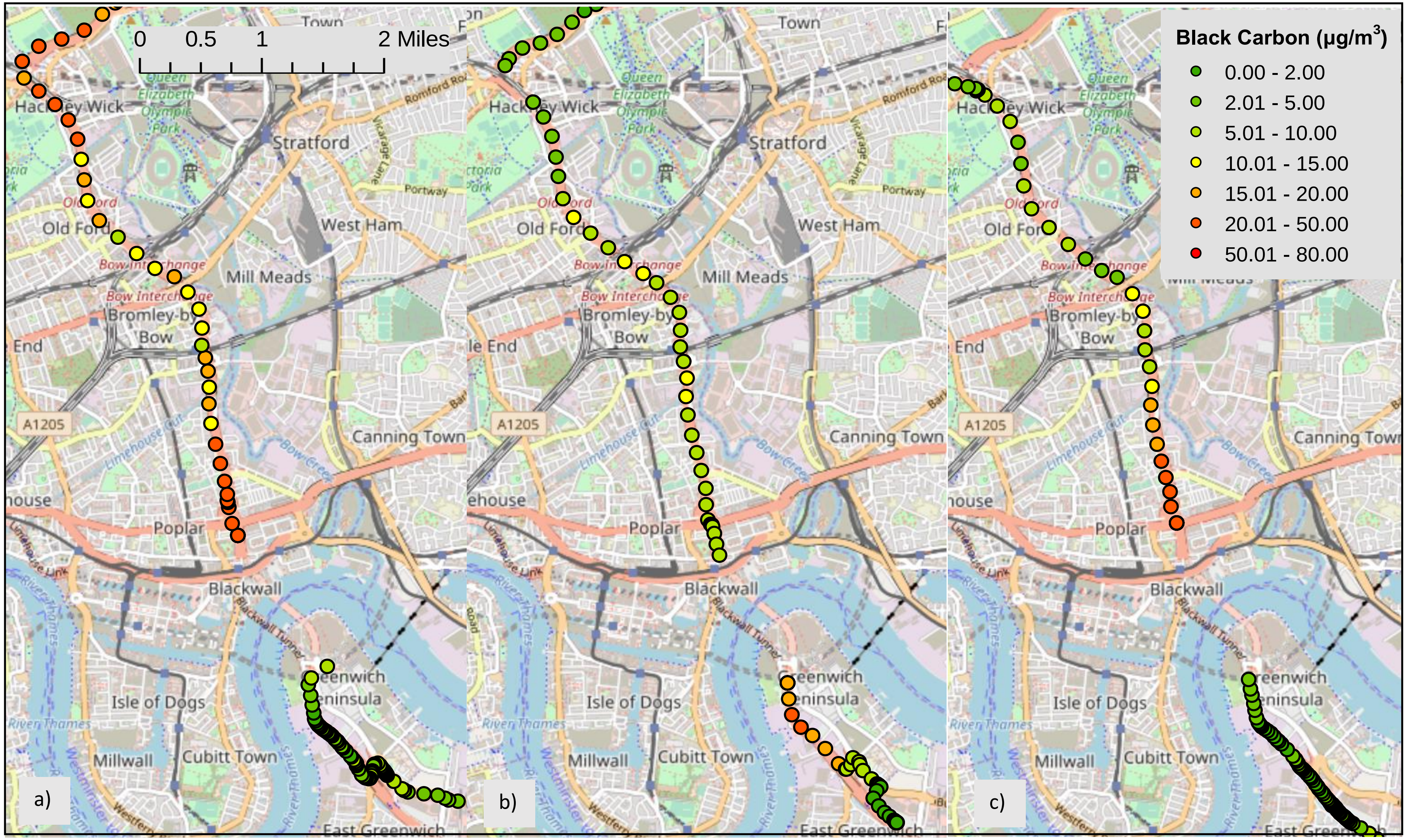
Excluding outliers, while driving, windows open had exposures at 5.1 ± 4.4 µg/m^3 compared to windows closed at 3.1 ± 2.9 µg/m^3 ($p<0.05$).

Ventilation Settings Results



Excluding outliers, while driving, ventilation settings set to 'off' had exposures at 3.5 ± 3.3 µg/m^3 , 'outside air' at 3.1 ± 2.5 µg/m^3 and 'recirculate' at 3.2 ± 3.4 µg/m^3 .

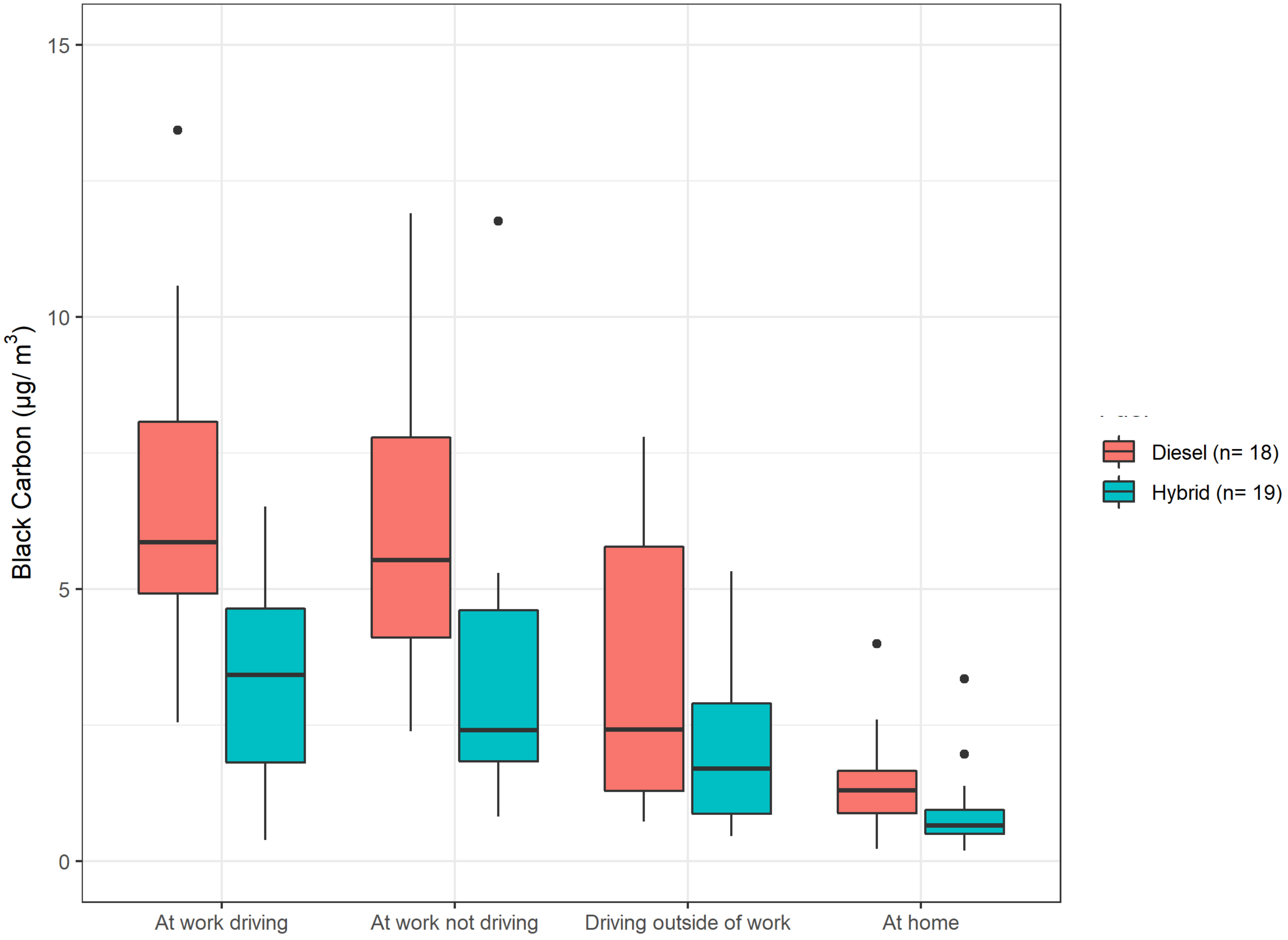
Tunnels



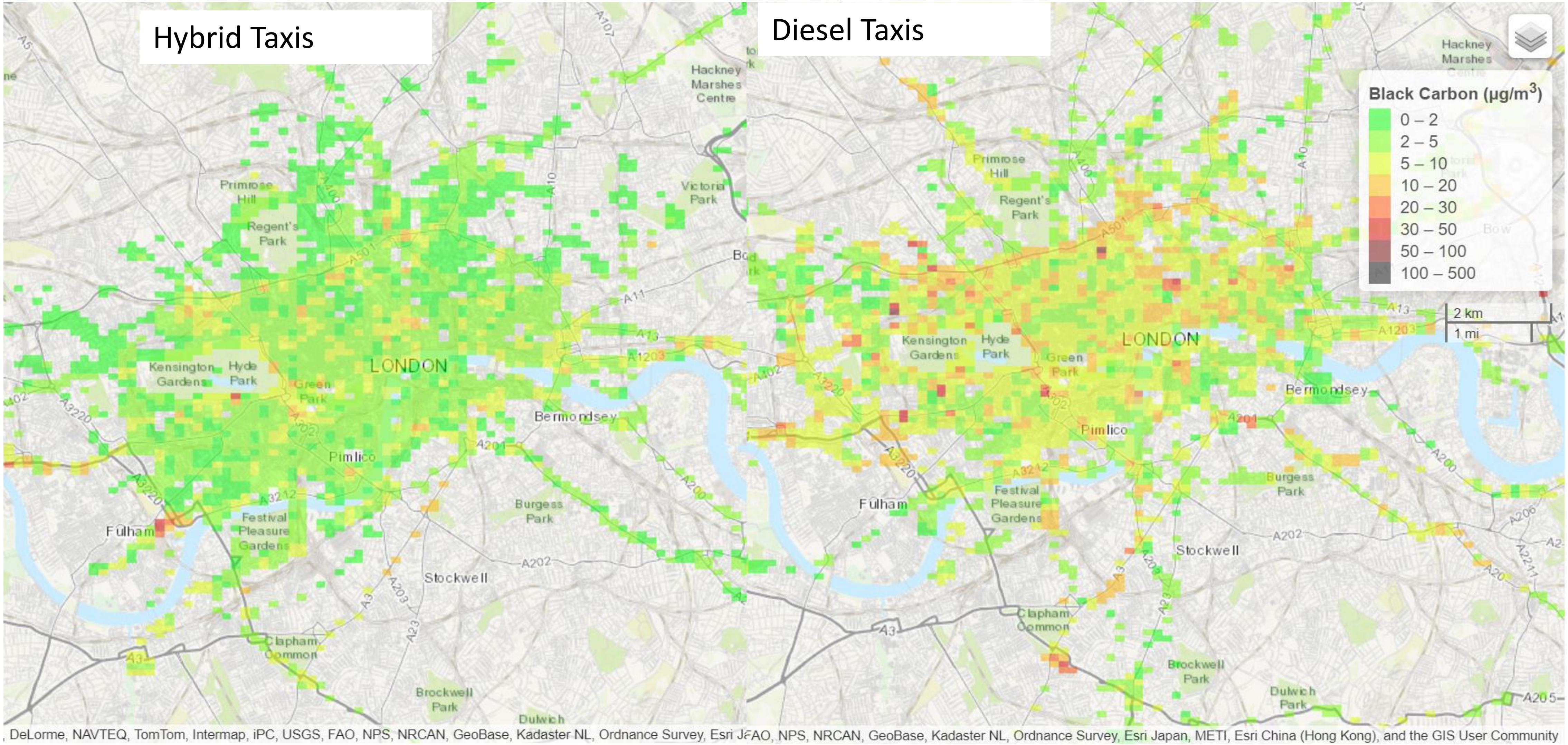
0 0.5 1 2 Miles
Black Carbon (μg/m³)
0.00 - 2.00
2.01 - 5.00
5.01 - 10.00
10.01 - 15.00
15.01 - 20.00
20.01 - 50.00
50.01 - 80.00
Stratford
West Ham
Mill Meads
Old Ford
Bow Interchange
Bromley-by-Bow
Canning Town
A1205
Poplar
Blackwall
Blackwall Tunnel
Isle of Dogs
Millwall
Cubitt Town
East Greenwich
River Thames
a)
b)
c)

Diesel and Hybrid (Electric) Taxis

Does vehicle type matter?



Spatial analysis by vehicle type



Conclusions

- Exposures between sectors, drivers and time and space are highly variable.
- Average exposure was **3 times higher at work** compared to home environments, while driving at work had around 2 times higher exposure compared to not driving at work.
- To date, taxi drivers have the highest exposures whilst driving, emergency services the lowest (congestion?)
- Spikes in in-cabin concentrations can linger for up to 20-30 minutes; reducing their occurrence and duration is likely to substantially reduce exposure.
- The preliminary results of the study show that there are simple practical steps which can reduce exposure to drivers. Window position, route choice and vehicle type all appear to influence driver exposure.

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