16th ETH-Conference on Combustion Generated Nanoparticles
June 24th – 27th 2012

Paper/Poster-Abstract Form

Name of Author………Bert Brunekreef………………………………
Co-Authors……………………………………………………………………………….
Affiliation ……………IRAS University of Utrecht…………..
Mailing address ……PO Box 81078 3508TD Utrecht NL………………
Phone / Fax…31302539494 (t) 9499 (f) E-mail…b.brunekreef@uu.nl

Title: Health effects of airborne ultrafine particles: observations from epidemiology

Abstract: (min. 300 – max. 500 words)

Airborne ultrafine particles generated by combustion processes have been suggested to adversely influence human health. The respiratory, cardiovascular and central nervous system may be affected. Epidemiological studies have provided some evidence that such effects occur in exposed human populations. Studies include time series studies in which the day-to-day variation in ultrafine particle counts was related to the day-to-day variations in mortality, hospital admissions and changes in health status in panels of respiratory or cardiovascular disease patients. It has often been difficult to derive conclusive evidence from such studies for two reasons: 1) there is no wide scale routine monitoring of ultrafine particles so that the available exposure data are inevitably weaker than they are for major urban air pollutants such as PM10, PM2.5 and NO2; 2) ultrafine particles co-vary with other combustion generated pollutants and it has often been difficult to obtain effect estimates which were independent from those of other pollutants.
In the absence of measurements or models to characterize the long term spatial distribution of ultrafine particles adequately, it has been even more difficult to investigate the effects of long term exposure to ultrafine particles on population health. It is well known that in urban areas, vehicular traffic is a main source of ultrafine particles in the air. Gradients of particle number counts with distance from busy roads are often steeper than for routinely measured components such as NO2 and, especially, PM2.5 and PM10. However, traffic exhaust contains many different pollutants co-varying with ultrafine particles and identification of their independent effects has been very difficult. Many studies have suggested that living close to busy roads is detrimental to health. Effects have been reported on childhood respiratory health, adult cardiovascular health as well as mortality. The observed gradients make it unlikely that these effects are related to PM2.5 or PM10 (which show little gradient with distance from busy roads), but

ultrafine particles are just one of many more specific exhaust components that do have strong gradients with distance.
In the presentation, some specific examples will be given of studies to illustrate the points made above.

The abstracts for papers and posters must contain unpublished information on your research subject: background, investigation methods, results and conclusions. Graphs and references are very welcome. Acronyms should be avoided. Abstracts with < 300 words can not be considered. General information on products which are already commercially available can not be accepted as presentations for the conference but are very welcome at the exhibition of particle filter systems and nanoparticle measurement instruments.

Short CV:

CV Bert Brunekreef, PhD

Professor of Environmental Epidemiology and Director
Institute for Risk Assessment Sciences, Utrecht University
Bert Brunekreef was born on March 10, 1953 in Utrecht, The Netherlands.

Academic education in Environmental Sciences at the University of Wageningen, the Netherlands, 1971-1979.
From 1979-2000, he has been employed by the Department of Environmental Health of the Wageningen University, first as assistant professor, since 1986 as associate professor, and since 1993 as full Professor. In 1985, he obtained his Ph.D. degree in Environmental Epidemiology from the University of Wageningen. In 1986/1987, he spent the academic year at the Harvard School of Public Health, studying health effects of air pollution episodes, and of living in damp homes.

In 1995, he served as the main organizer of the annual ISEE/ISEA conference which was held in the Netherlands that year. In 1998, he was chosen to be president of the ISEE for the years 2000 and 2001. Since the early 1990s, prof. Brunekreef has coordinated four EU funded studies (PEACE, TRAPCA, AIRALLERG and AIRNET) in the field of air pollution, allergy and health. He now acts a coordinator of the European Study of Cohorts for Air Pollution Effects (ESCAPE, 2008-2012). He has been partner in many other international collaborative studies. He has also been the PI on two studies funded by the US Health Effects Institute.

In 2000, his Wageningen Department was moved to Utrecht University where it merged with the existing RITOX Institute to create the 'Institute for Risk Assessment Sciences (IRAS)'. In 2005 IRAS absorbed the Veterinary Public Health Department, and prof. Brunekreef is Director of IRAS since January 1, 2005. IRAS has currently about 150 employees.

Prof. Brunekreef is Professor of Environmental Epidemiology in both the Faculties of Veterinary Medicine, and the Faculty of Medicine at the Utrecht University.

On several occasions, Bert Brunekreef served as advisor on national and international panels in the field of environmental health, including the Dutch National Health Council, of which he is a member, WHO and the US EPA.

Bert Brunekreef is co-author of more than 350 peer reviewed journal articles in the field of environmental epidemiology and exposure assessment. In recent years, he received the ISEE John Goldsmith award (2007), the European Lung Foundation Award (2007), an honorary doctorate of the Catholic University of Leuven, Belgium (2008), the Heineken Prize for Environmental Sciences (2008), and an Academy Professorship of the Dutch Royal Academy of Sciences (2009) to which he also was elected to become a member in 2009.

Return by e-mail latest 14th of April 2012 to ttm.a.mayer@bluewin.ch

Health effects of UFP – long term

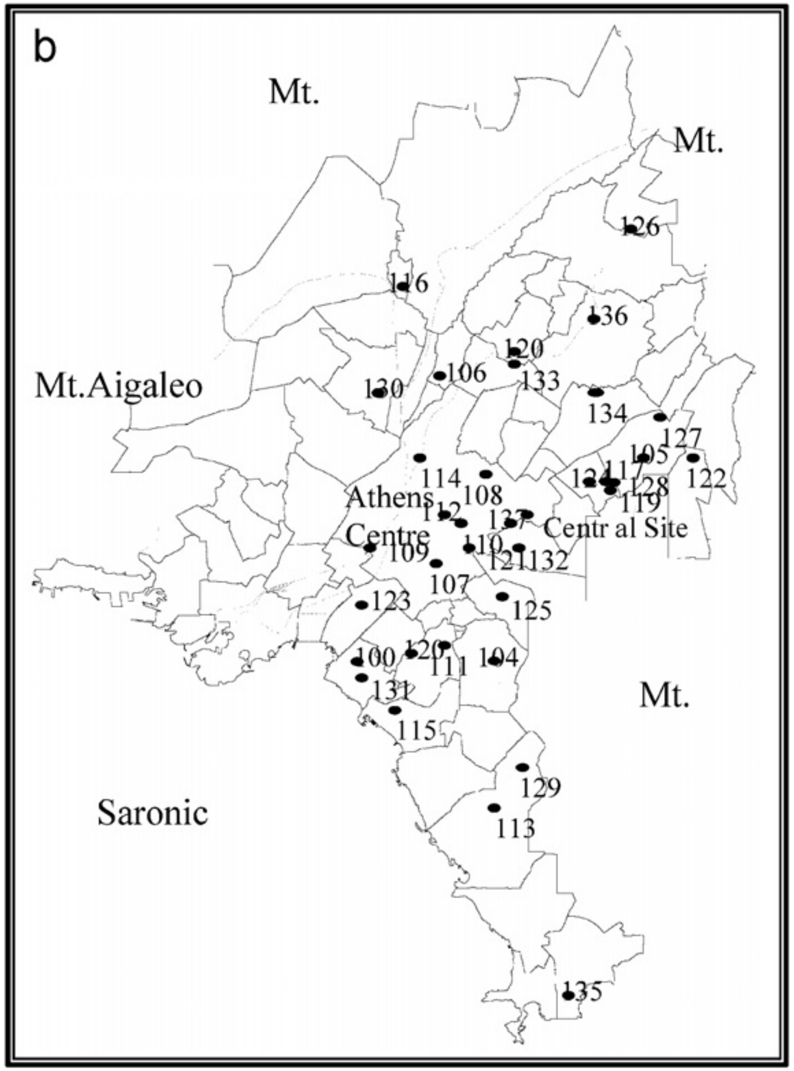
Bert Brunekreef, PhD

Institute for Risk Assessment Sciences

University of Utrecht, Netherlands

Universiteit Utrecht

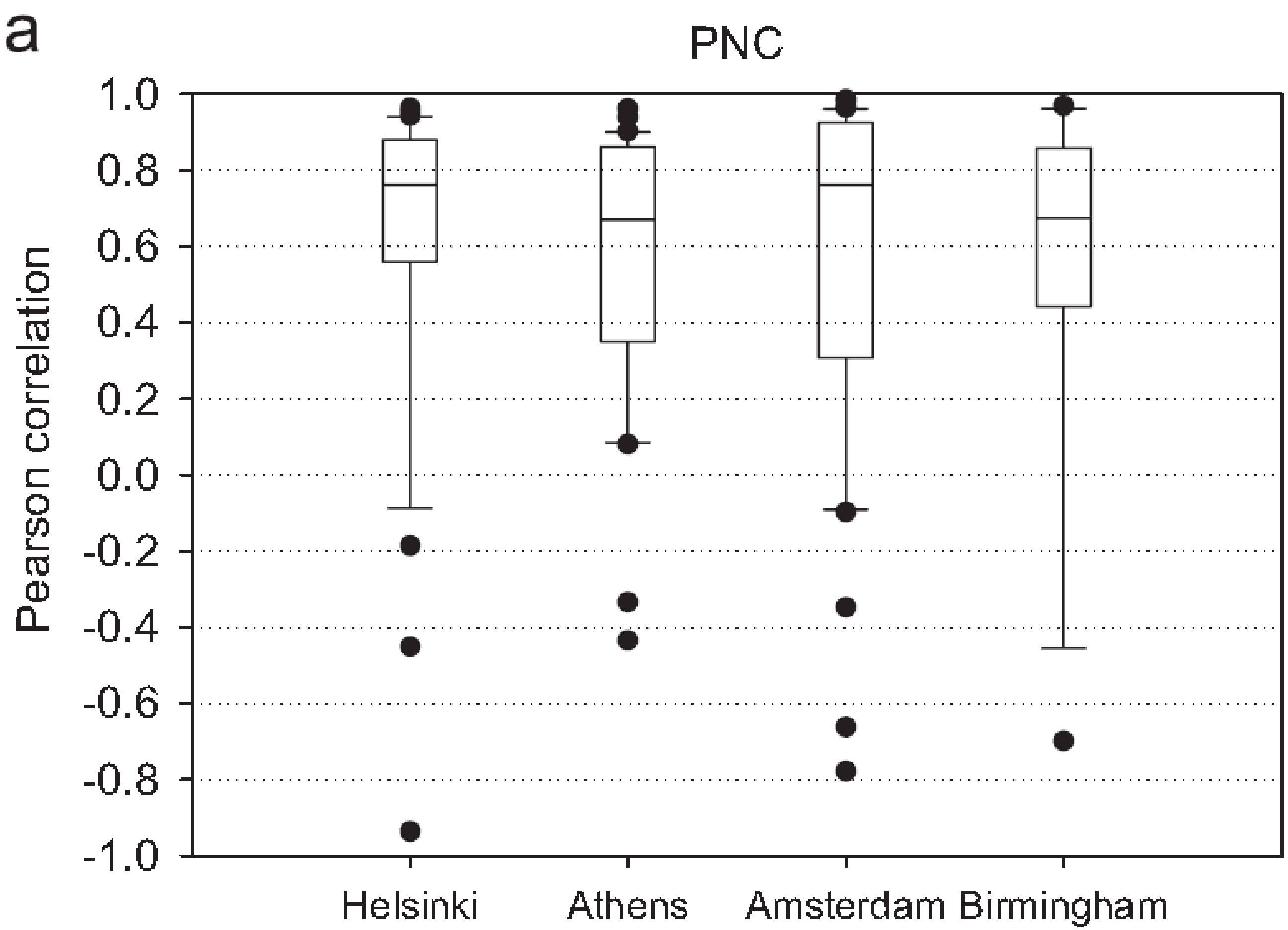
Spatial variation of particle number and mass over four European cities



Puustinen, AE 2008

Universiteit Utrecht

Spatial variation of particle number and mass over four European cities



Universiteit Utrecht

Puustinen, AE 2008

Spatial variation of particle number and mass over four European cities

Table 3

Median and interquartile range (in parentheses) of individual Pearson correlation coefficients between central site and home outdoor 24-h average concentrations for different particle indices[a]

	Helsinki	Athens	Amsterdam	Birmingham
PNC	0.76 (0.56 0.87)	0.67 (0.35 0.86)	0.76 (0.31 0.93)	0.67 (0.44 0.86)
$PM_{2.5}$	0.94 (0.84 0.98)	0.79 (0.51 0.93)	0.98 (0.95 0.99)	0.93 (0.85 0.98)
PM_{10}	0.86 (0.55 0.97)	0.83 (0.65 0.89)	0.98 (0.96 0.99)	0.94 (0.82 0.97)
PM_{10} $PM_{2.5}$	0.66 (0.46 0.93)	0.74 (0.16 0.84)	0.89 (0.62 0.95)	0.64 (0.17 0.86)
Soot	0.79 (0.56 0.95)	0.70 (0.52 0.92)	0.94 (0.86 0.98)	0.95 (0.90 0.97)

[a]Homes with three or more valid observations.

Universiteit Utrecht

Puustinen, AE 2008

Spatial and temporal variation of particle number concentration in Augsburg, Germany

Winter

r				
MON	1	**0.92** $n=227$	**0.89** $n=239$	**0.91** $n=228$
FH	0.95 $n=9$	1	**0.84** $n=236$	**0.88** $n=236$
BOU	0.89 $n=10$	0.87 $n=9$	1	**0.77** $n=252$
UNI	1.00 $n=9$	0.95 $n=9$	0.89 $n=10$	1

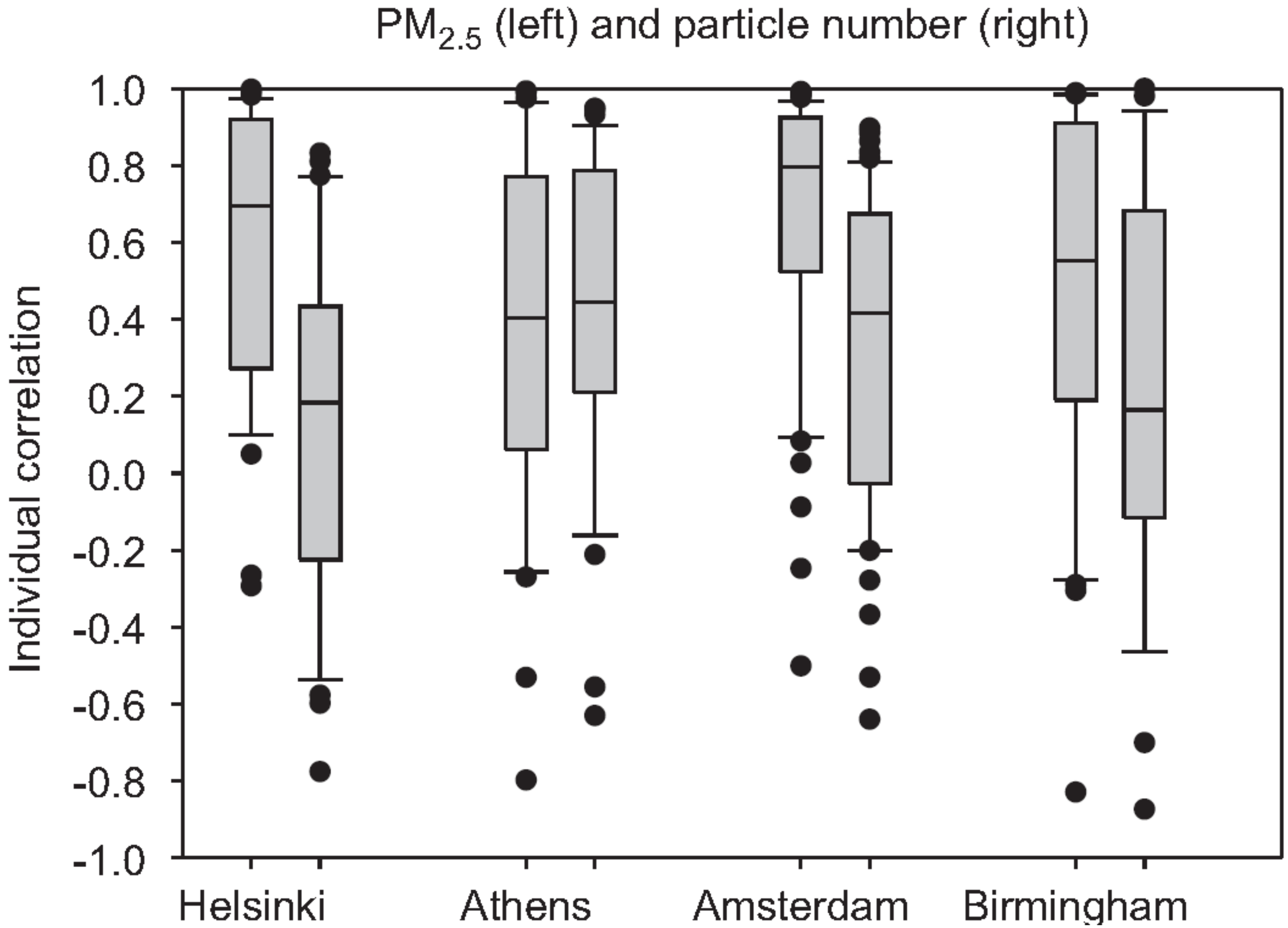
Spring

r			
MON_NC	1	**0.81** $n=866$	**0.81** $n=848$
FH_NC	0.85 $n=36$	1	**0.83** $n=886$
BOU_NC	0.86 $n=35$	0.86 $n=37$	1

Universiteit Utrecht

Cyrys, STOTEN 2008

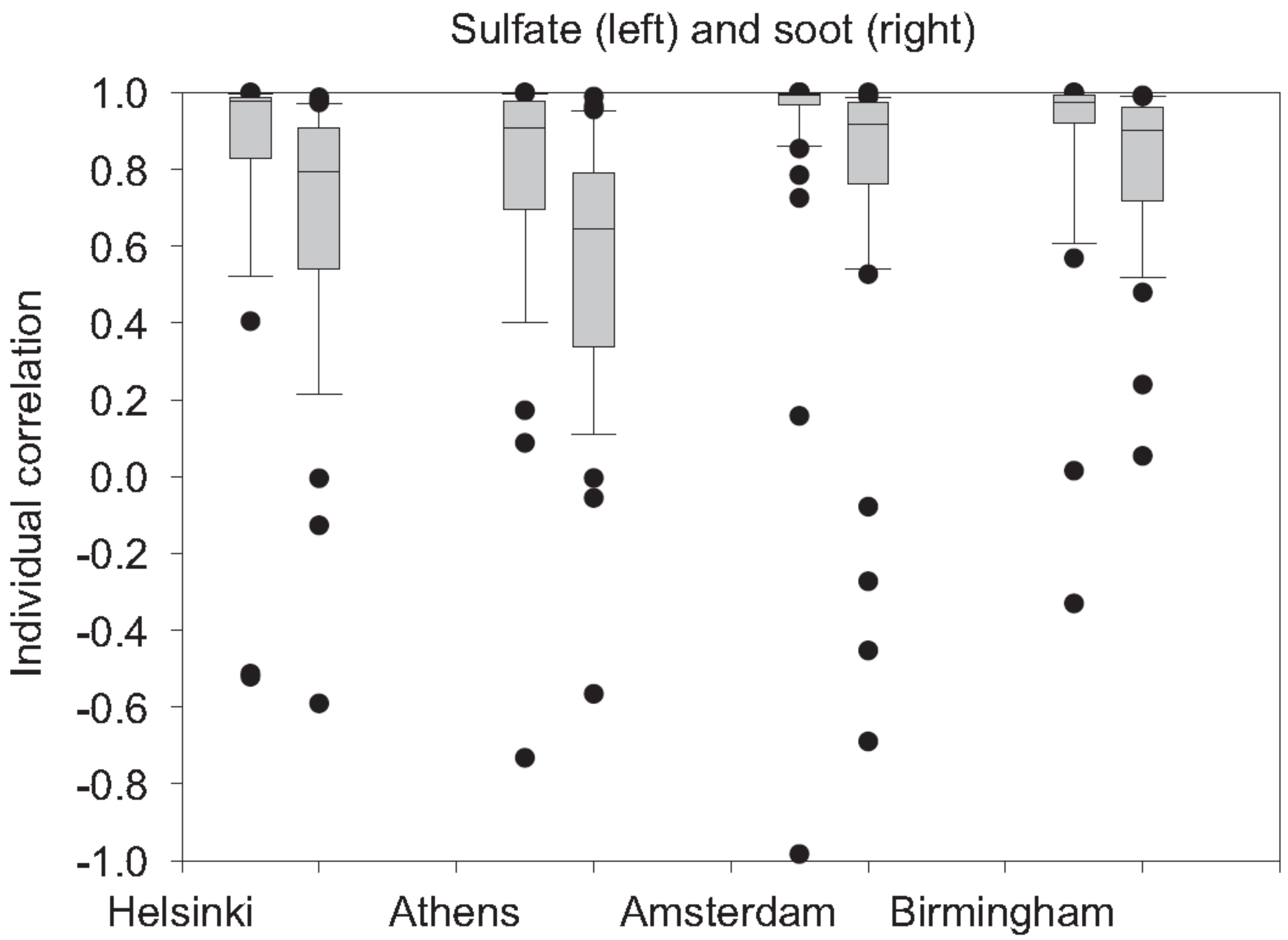
Indoor–outdoor relationships of particle number and mass in four European cities



Universiteit Utrecht

Hoek AE 2008

Indoor–outdoor relationships of particle number and mass in four European cities



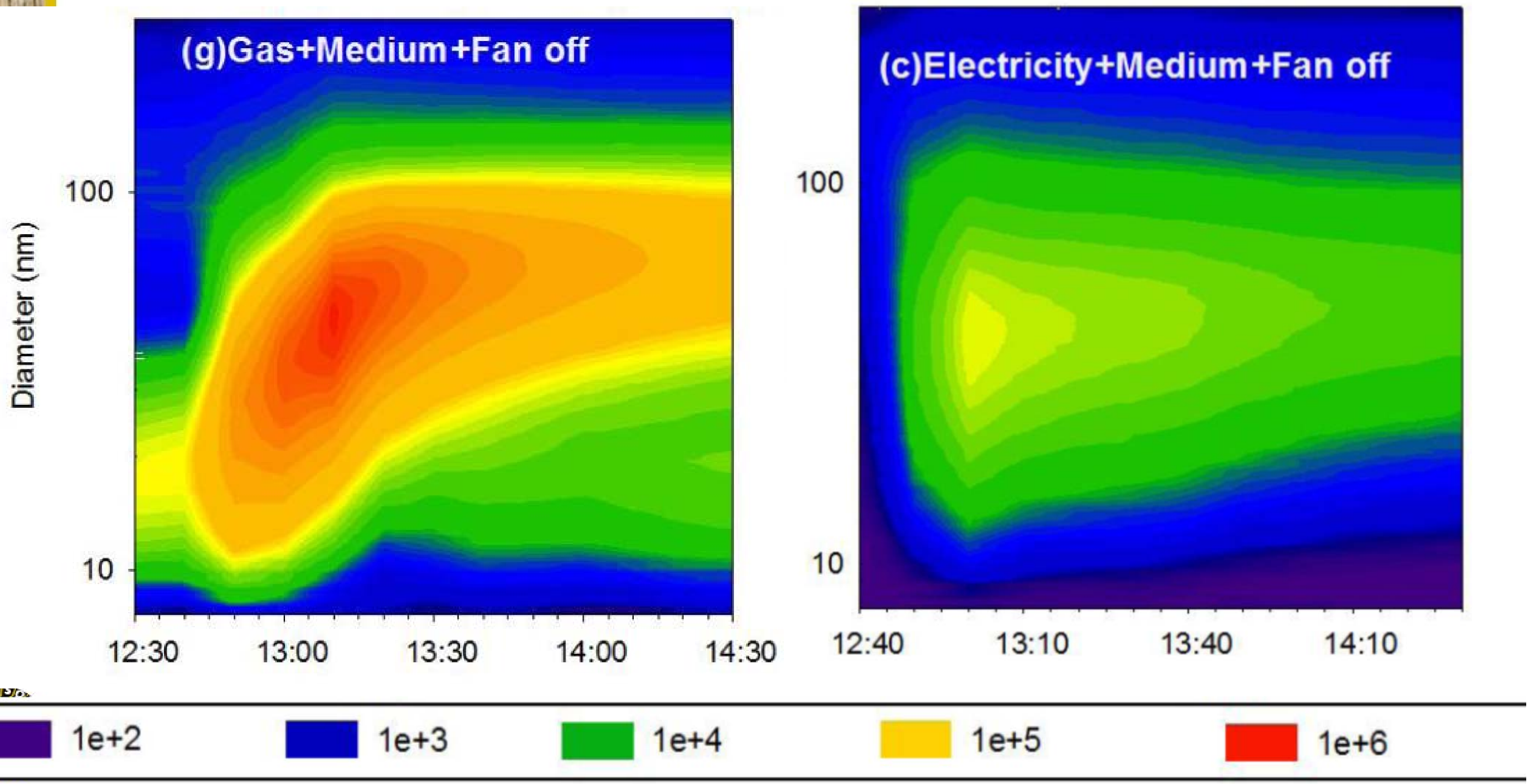
Universiteit Utrecht

Hoek AE 2008

Int. J. Environ. Res. Public Health **2010**

Measurement of Ultrafine Particles and Other Air Pollutants Emitted by Cooking Activities

Qunfang Zhang [1], Roja H. Gangupomu [2], David Ramirez [1] and Yifang Zhu [1,*]



Land Use Regression Model for Ultrafine Particles in Amsterdam

TABLE 2. Land Use Regression Model for Particle Number Concentration (cm^{-3})

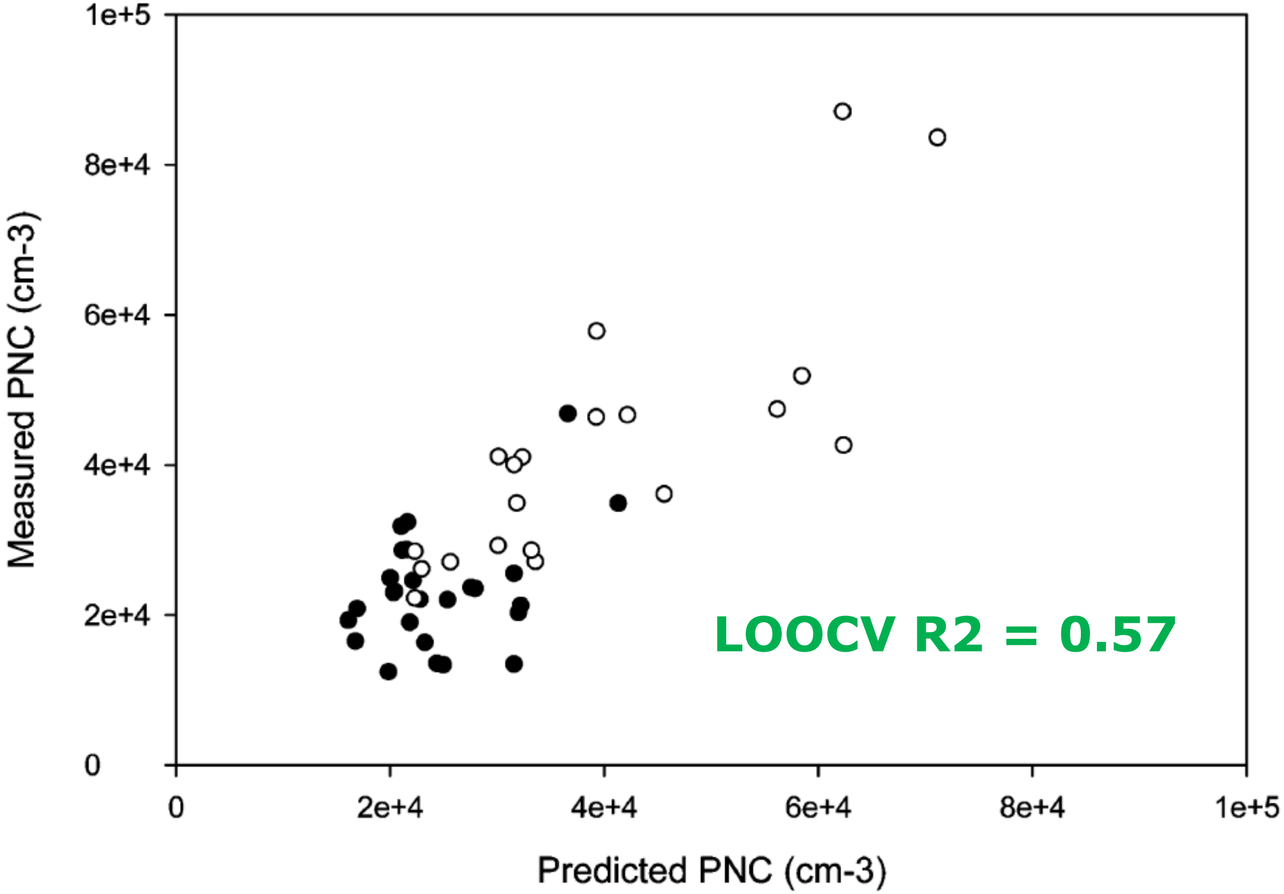
	regression coefficient[a]	standard error
intercept	14491	(3165)
product T.I. and inverse distance squared	29523	(3795)
address density, 300 m	10266	(3839)
port, 3000 m	6059	(3421)

[a] regression slopes multiplied by the difference between the 10th and 90th percentile for each of the three predictors (1102, 2653, and 4 149 780), intercept directly from model. The R^2 of the model was 0.67 (adjusted R^2 = 0.65). T.I. is traffic intensity.

Universiteit Utrecht

Hoek, EST 2011

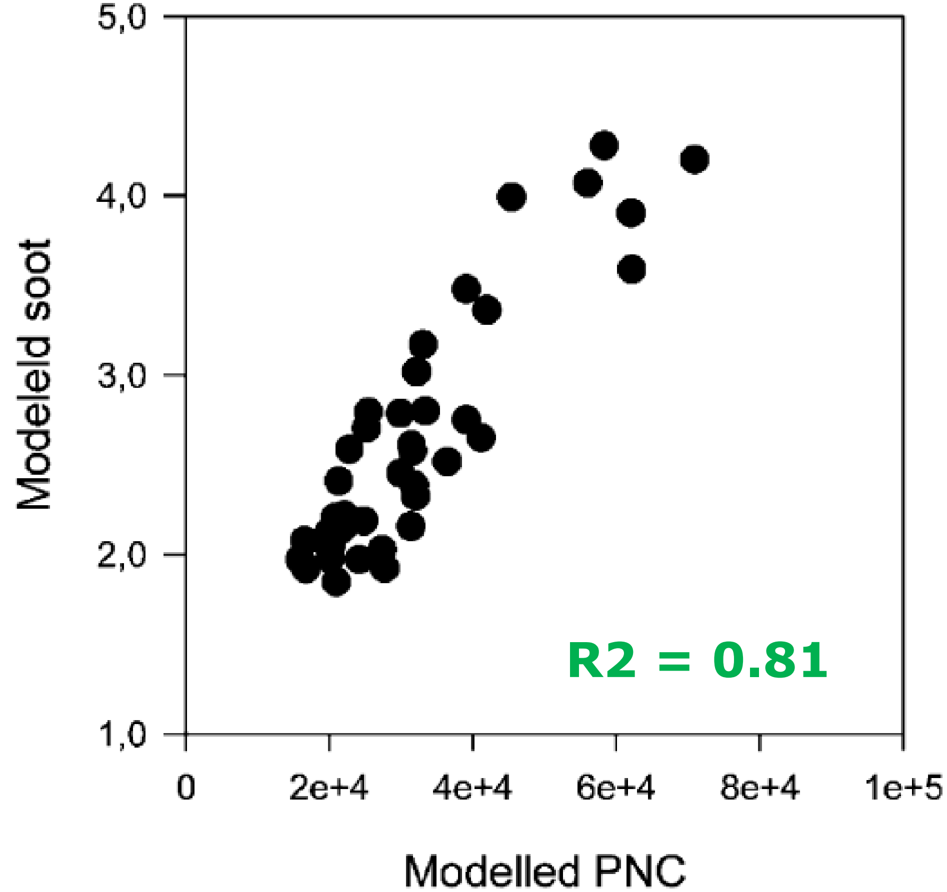
Land Use Regression Model for Ultrafine Particles in Amsterdam



Universiteit Utrecht

Hoek, EST 2011

Land Use Regression Model for Ultrafine Particles in Amsterdam



Universiteit Utrecht

Hoek, EST 2011

Source oriented studies: Traffic

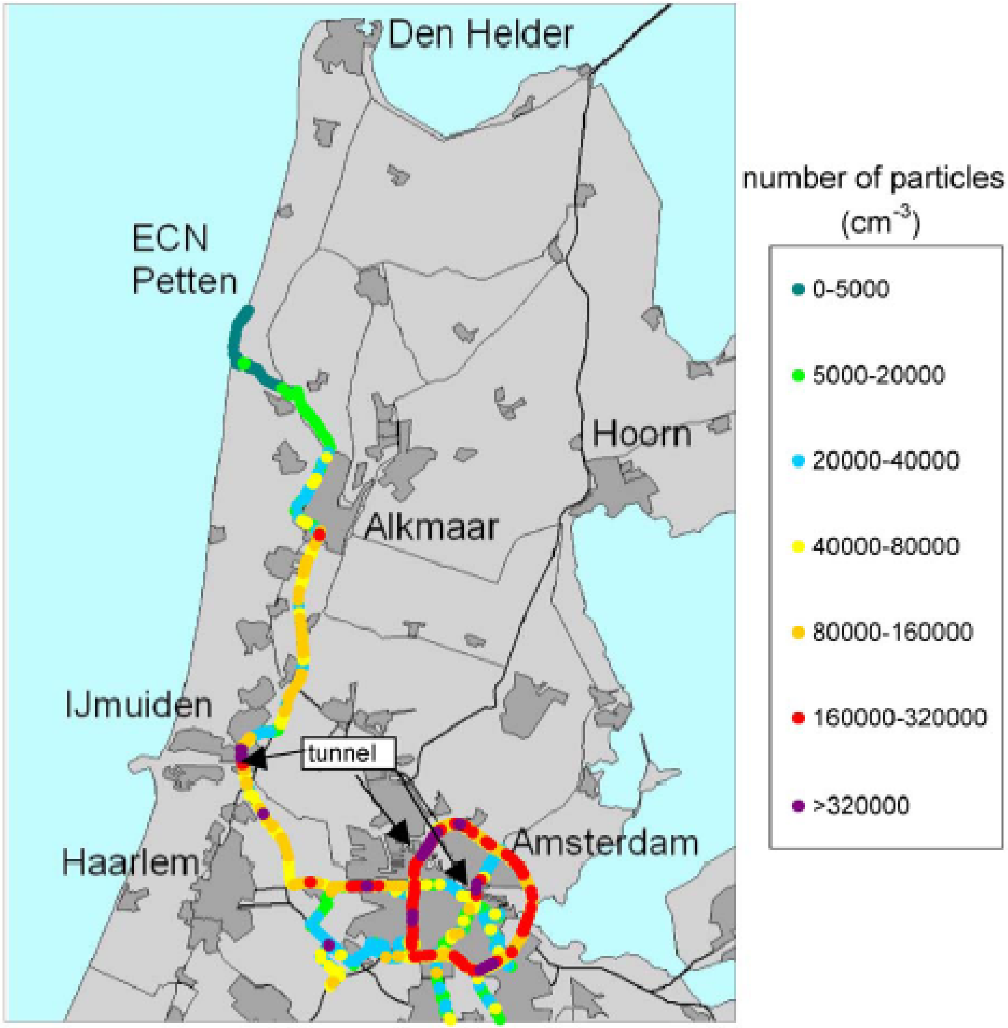
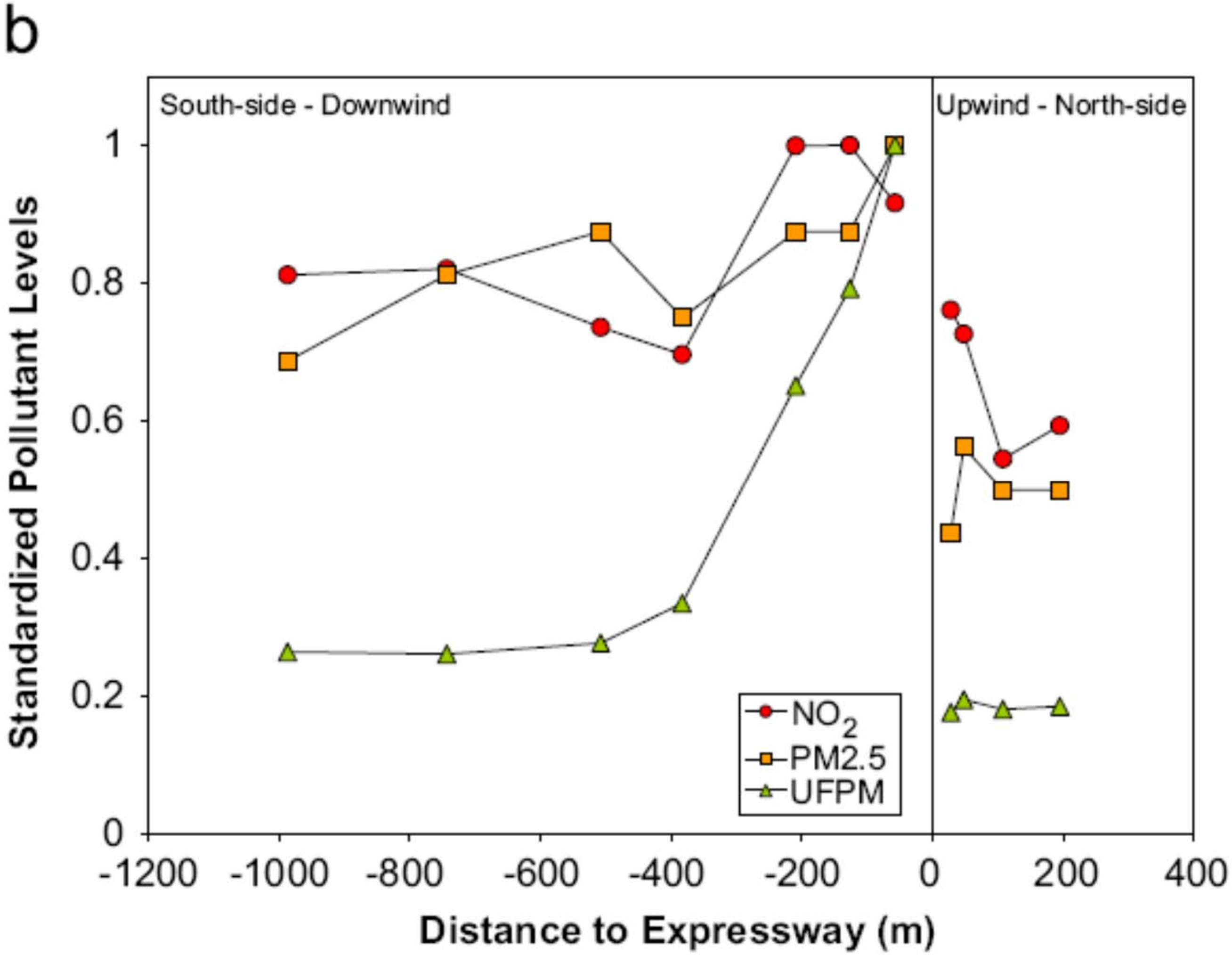


Fig. 2. Particle number concentrations along the way from the urban agglomeration of Amsterdam to the marine area near Petten (averages over 500 m; CPC-measurements).

Universiteit Utrecht

Correlation of nitrogen dioxide with other traffic pollutants near a major expressway

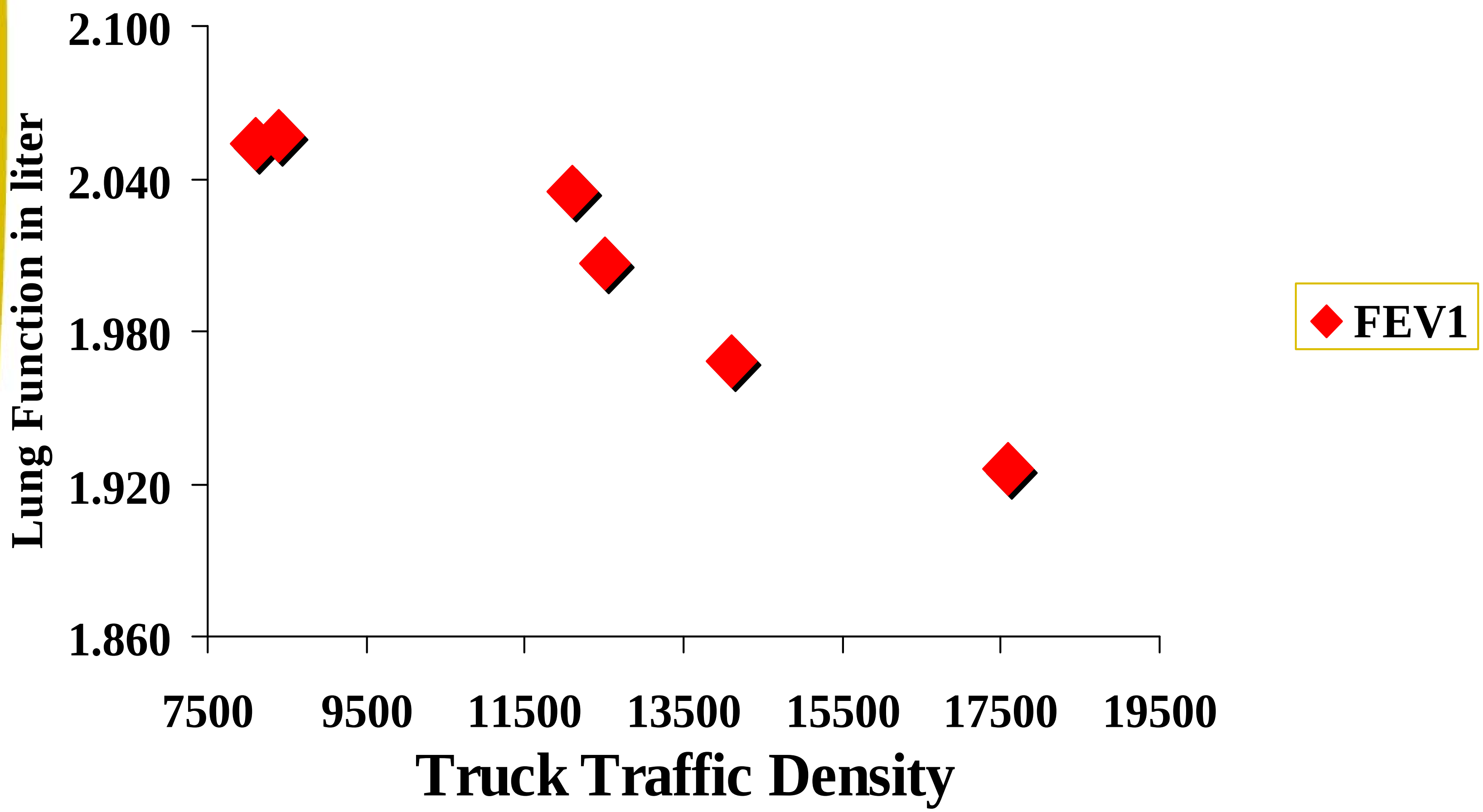


Universiteit Utrecht

Beckerman, AE 2008

Uni

Lung function and Truck Traffic



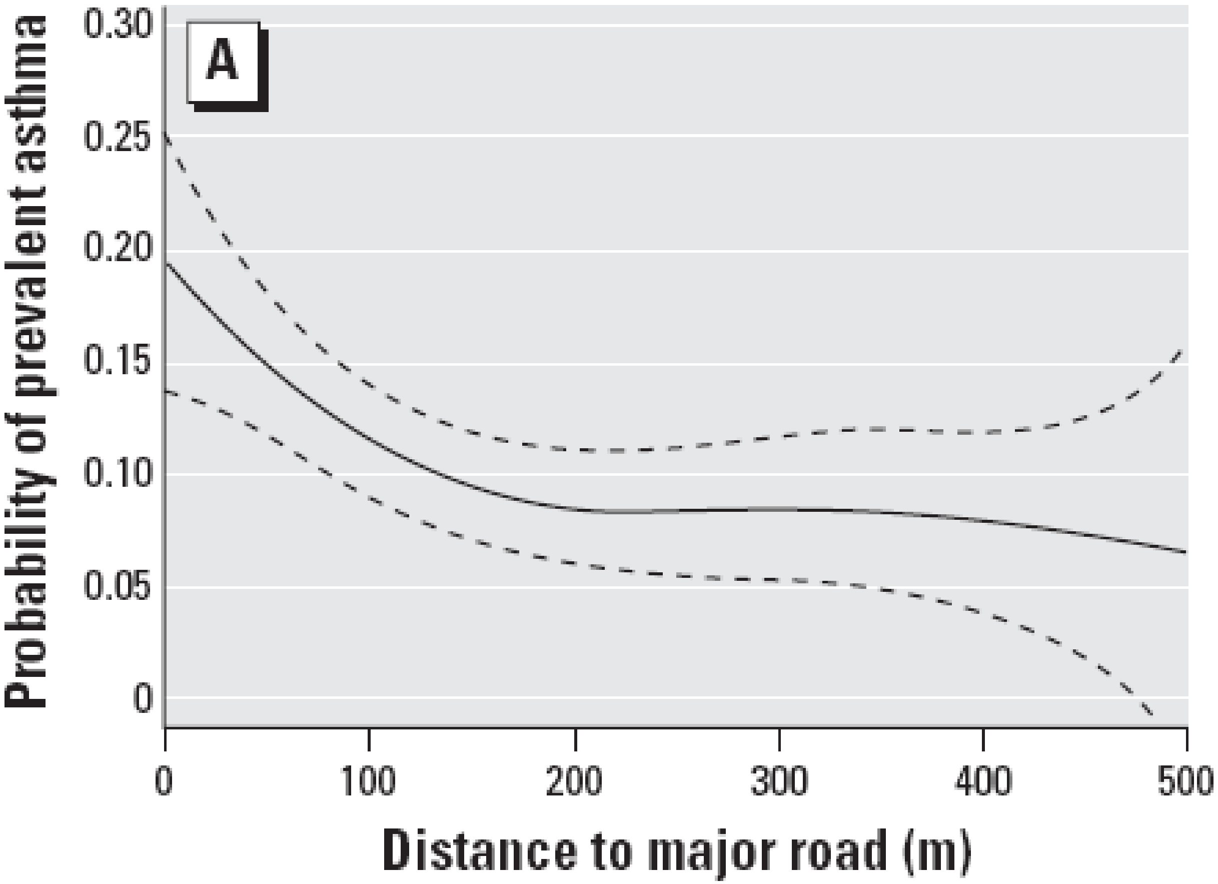
Universiteit Utrecht

Brunekreef, Epidemiology 1997

Traffic, Susceptibility, and Childhood Asthma

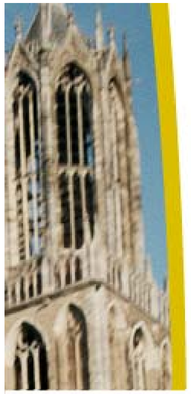
Rob McConnell,[1] Kiros Berhane,[1] Ling Yao,[1] Michael Jerrett,[1] Fred Lurmann,[2] Frank Gilliland,[1] Nino Künzli,[1] Jim Gauderman,[1] Ed Avol,[1] Duncan Thomas,[1] and John Peters[1]

[1]Department of Preventive Medicine, Keck School of Medicine, University of Southern California, Los Angeles, California, USA; [2]Sonoma Technology Inc., Petaluma, California, USA



Universiteit Utrecht

EHP 2006



Long-Term Exposure to Ambient Air Pollution and Cardiopulmonary Mortality in Women

Ulrike Gehring,†‡ Joachim Heinrich,* Ursula Krämer,§ Veit Grote,* Matthias Hochadel,* Dorothea Sugiri,§ Martin Kraft,‖ Knut Rauchfuss,¶ Hans Georg Eberwein,¶ and H.-Erich Wichmann*†*

	All Causes		Cardiopulmonary	
	Crude RR (95% CI)	Adjusted[†] RR (95% CI)	Crude RR (95% CI)	Adjusted[†] RR (95% CI)
Distance to road				
≤50 meters vs >50 meters	1.33 (0.96–1.83)	1.29 (0.93–1.78)	1.66 (1.01–2.73)	1.70 (1.02–2.81)
1-yr average				
NO_2	1.26 (1.10–1.43)	1.17 (1.02–1.34)	1.69 (1.34–2.15)	1.57 (1.23–2.00)
PM_{10}[‡]	1.12 (0.97–1.28)	1.08 (0.94–1.25)	1.38 (1.09–1.74)	1.34 (1.06–1.71)
5-yr average				
NO_2	1.29 (1.11–1.50)	1.19 (1.02–1.39)	1.89 (1.41–2.52)	1.74 (1.29–2.33)
PM_{10}[‡]	1.20 (1.05–1.37)	1.13 (0.99–1.30)	1.66 (1.30–2.12)	1.59 (1.23–2.04)

*Interquartile ranges were calculated from 1-yr averages and rounded to 16 $\mu g/m^3$ for NO_2 and 7 $\mu g/m^3$ for PM_{10}.
†Adjusted for socioeconomic status and smoking.
‡Calculated as $PM_{10} = 0.71 \times TSP$.

Universiteit Utrecht

Epidemiology 2006

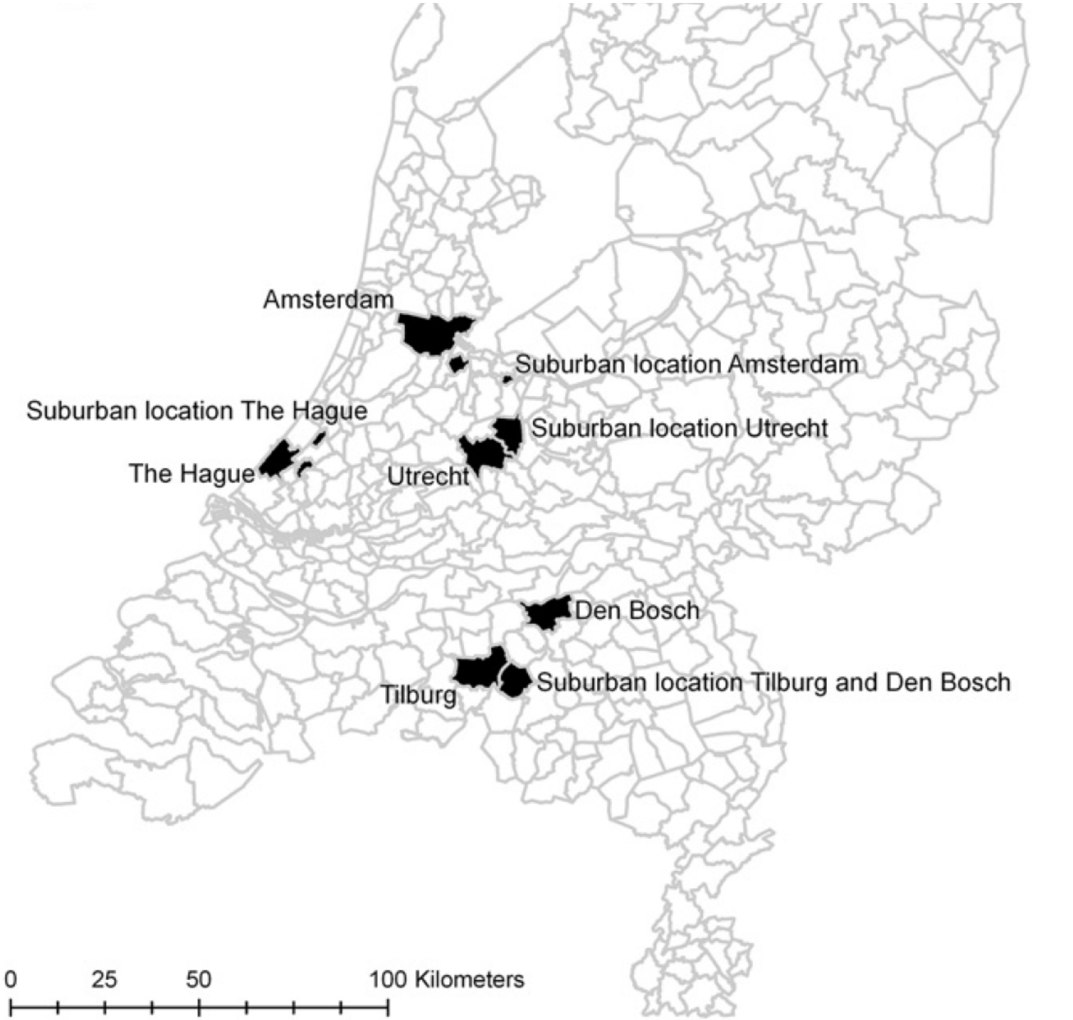
Dutch Accountability studies

- Busy roads in Amsterdam, The Hague, Utrecht, Tilburg, The Hague
- Background locations in same city/region
- Traffic measures planned to comply with EU regulations for PM10
- Health measurements in subjects living at street & background locations before & after implementation (symptom questionnaire, spirometry, eNO)

Contrast in air pollution components between major streets and background locations: Particulate matter mass, black carbon, elemental composition, nitrogen oxide and ultrafine particle number

Hanna Boogaard[a,*], Gerard P.A. Kos[b], Ernie P. Weijers[b], Nicole A.H. Janssen[c], Paul H. Fischer[c], Saskia C. van der Zee[d], Jeroen J. de Hartog[a], Gerard Hoek[a]

AE 2011



Universiteit Utrecht

Table 1

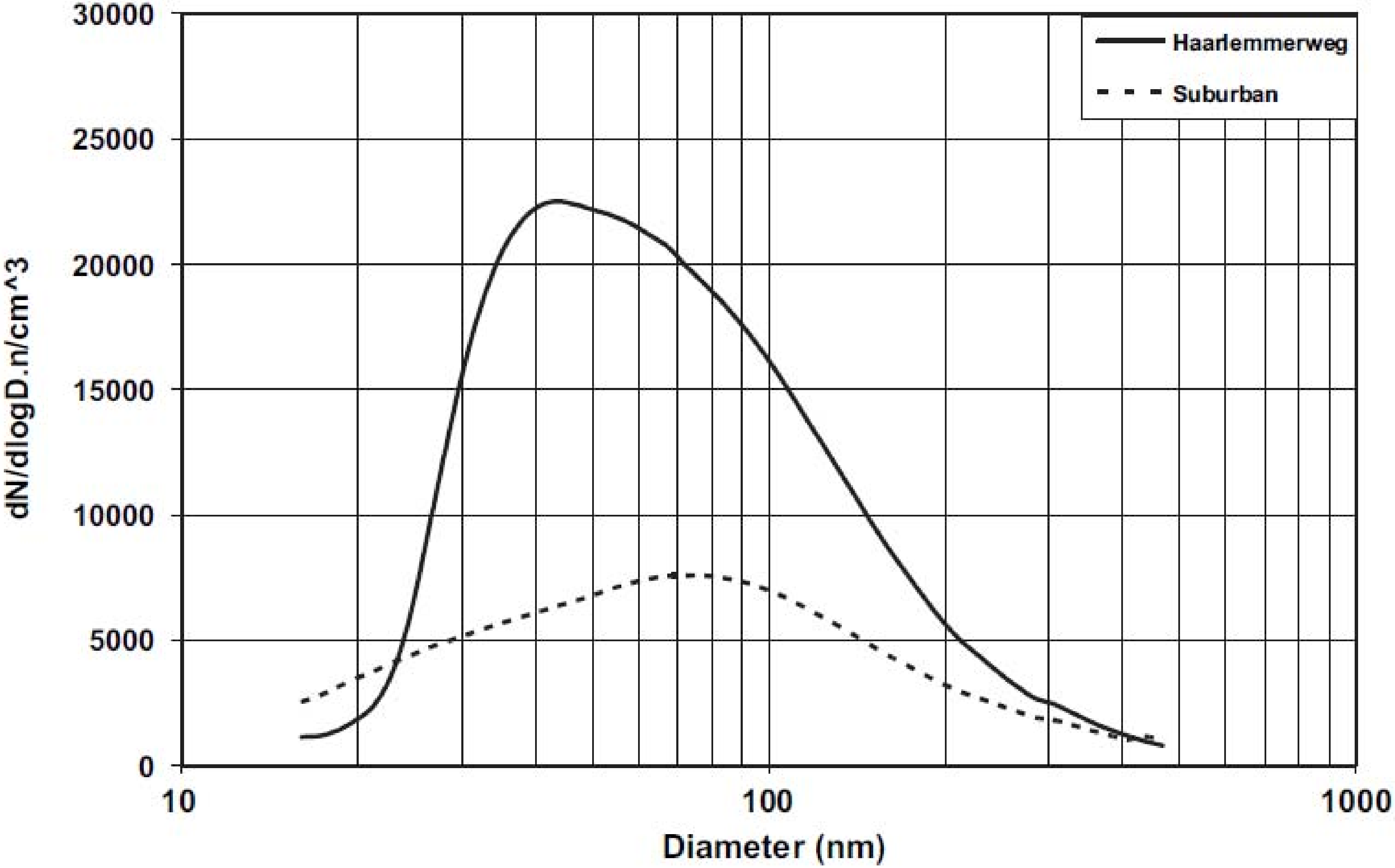
Detailed characteristics of the different streets.

Cities	Streets	Traffic intensity	Fraction[a]	
		Per 24-h	Middle	Heavy
Amsterdam	Haarlemmerweg	15 253	0.03	0.02
Amsterdam	Hoofdweg	9774	0.01	0.06
The Hague	Stille Veerkade	17 438	0.05	0.02
Den Bosch	Brugstraat	17 896	0.05	0.05
Den Bosch	Koningsweg	17 138	0.05	0.03
Tilburg	HVB	18 812	0.03	0.07
Utrecht	Vleutenseweg	13 553	0.06	0.05
Utrecht	Weerdsingel Wz	14 831	0.06	0.03

Table 2

Averages of different traffic-related air pollutants ($\mu g\ m^{-3}$) at the various streets and median ratio street vs urban background location in the same city.

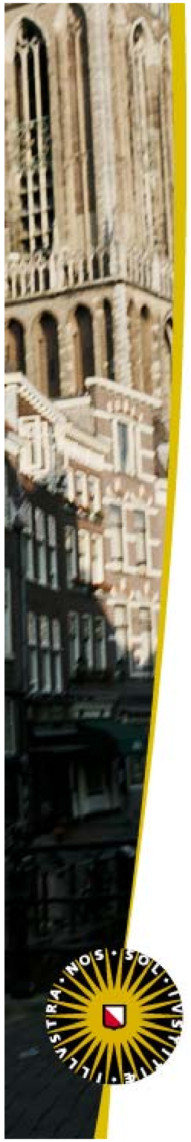
Streets	PM_{10}	$PM_{2.5}$	BC[a]	NO_2	NO_x
Haarlemmerweg	27.5	17.8	4.1	54.3	100.5
	1.2	1.2	2.1	1.5	2.0
Hoofdweg	22.4	15.1	2.7	47.5	75.6
	1.1	1.0	1.7	1.3	1.5
Stille Veerkade	32.2	19.4	4.4	54.1	109.9
	1.3	1.3	2.1	2.0	2.8
Overall ratio[b]	1.2	1.2	1.9	1.5	1.8
P value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

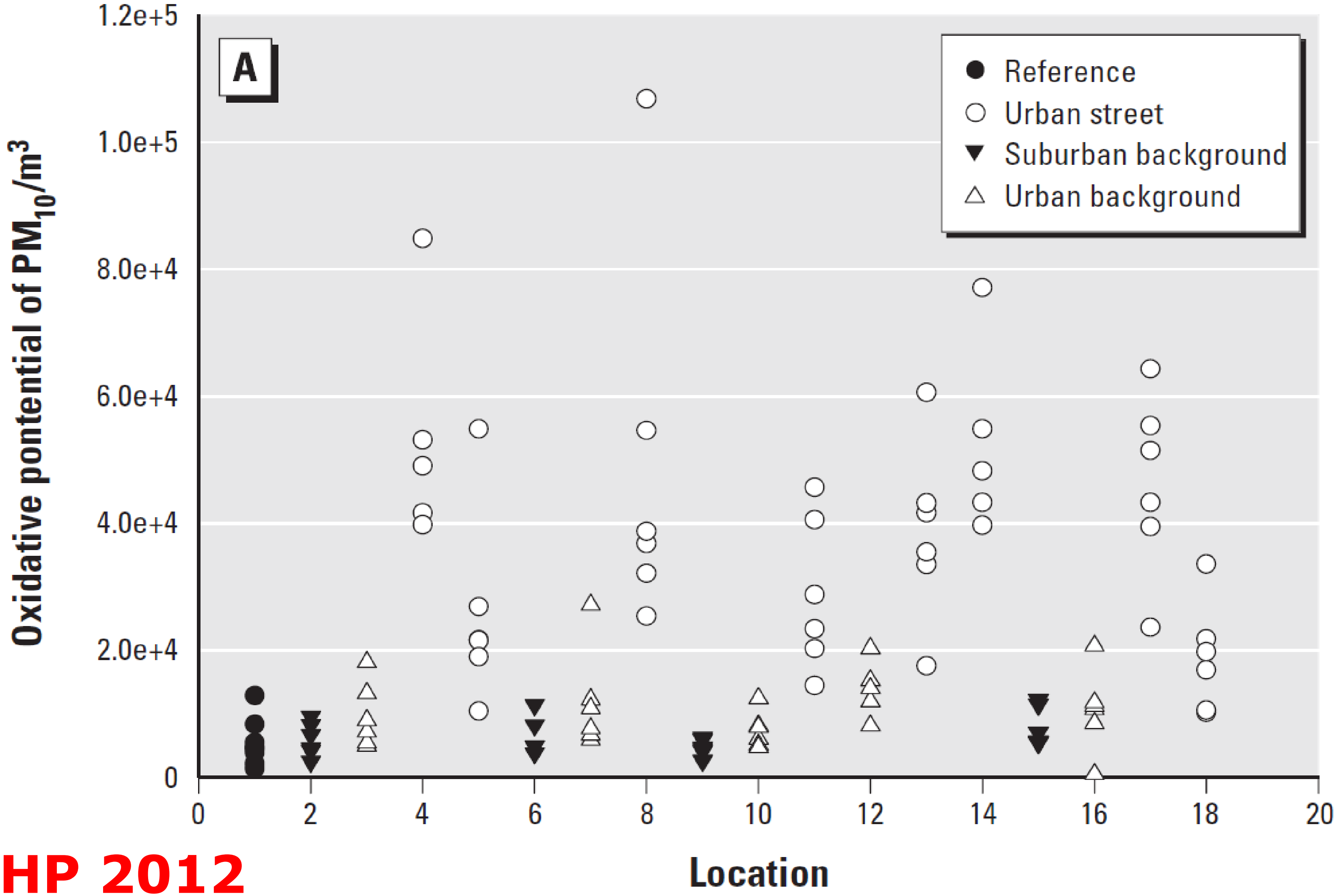


Universiteit Utrecht

Contrasts in Oxidative Potential and Other Particulate Matter Characteristics Collected Near Major Streets and Background Locations

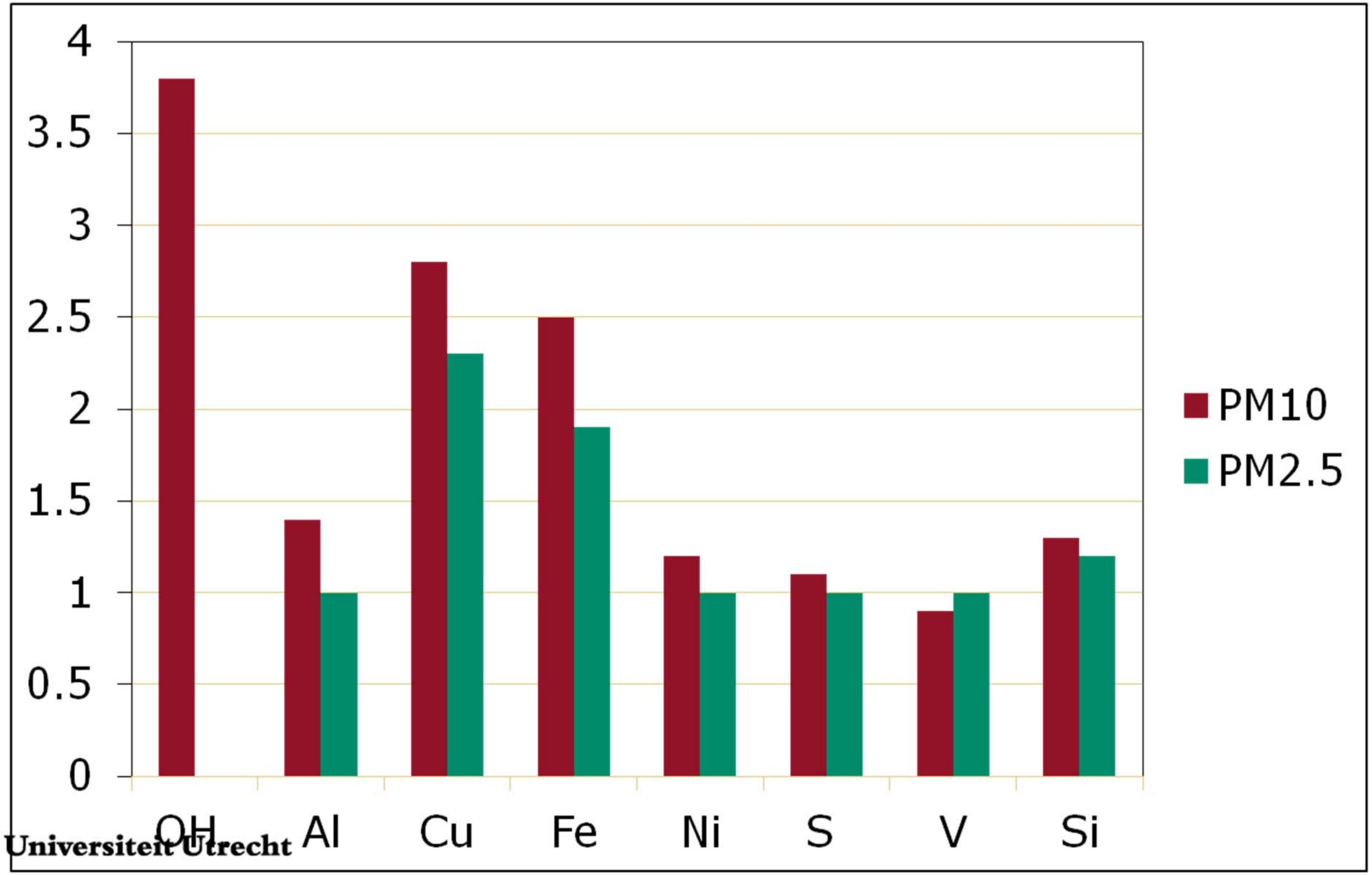
Hanna Boogaard,[1] Nicole A.H. Janssen,[2] Paul H. Fischer,[2] Gerard P.A. Kos,[3] Ernie P. Weijers,[3] Flemming R. Cassee,[2] Saskia C. van der Zee,[4] Jeroen J. de Hartog,[1] Bert Brunekreef,[1,5] and Gerard Hoek[1]





EHP 2012

OH. and elemental ratios street vs. background



Universiteit Utrecht

Table 1 Traffic policies implemented during study period

City	Urban streets	Traffic policies	Implementatic
Amsterdam	Haarlemmerweg	Low emission zone[1]	09-10-2008
	Hoofdweg	Low emission zone	09-10-2008
The Hague	Stille Veerkade	Low emission zone	16-04-2008
		Traffic circulation plan	20-11-2009
Den Bosch	Brugstraat	Low emission zone	01-09-2007
		Deal with local transport company not to drive here	24-11-2010
	Koningsweg	Low emission zone	01-09-2007
		Deal with local transport company not to drive here	24-11-2010
Tilburg	HVB	Low emission zone	01-09-2007
		Extension of the low emission zone	01-01-2010
Utrecht	Vleutenseweg	Low emission zone	01-07-2007
	Weerdsingel Wz	Low emission zone	01-07-2007

	Pre	Post	%
Haarlemmerweg	15 253	15 314	0.4
Hoofdweg	9774	8375	-14.3
Stille Veerkade	17 438	8471	-51.4
Brugstraat	17 896	18 170	1.5
Koningsweg	17 138	16 876	-1.5
HVB	18 812	19 010	1.1
Vleutenseweg	13 553	11 158	-17.7
Weerdsingel Wz	14 831	15 045	1.4

Cities	Locations	'Soot'		
		Pre	Post	Abs dif
Amsterdam	Haarlemmerweg	3.92	3.42	-0.50
	Hoofdweg	2.58	2.34	-0.24
The Hague	Stille Veerkade	4.26	2.52**	-1.74##
Den Bosch	Brugstraat	3.66	3.43	-0.23
	Koningsweg	2.84	2.34**	-0.50#
Tilburg	HVB	2.37	2.40	0.04
Utrecht	Vleutenseweg	2.06	2.78**	0.72#
	Weerdsingel Wz	3.36	3.63	0.27
	Average	3.10	2.85	-0.25

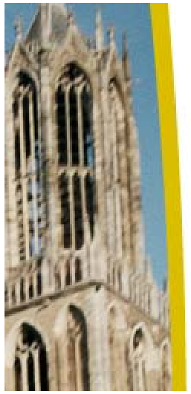
Soot before & after at background

Amsterdam UB	1.66	1.45**
The Hague UB	1.67	1.39*
Den Bosch UB	1.61	1.44
Tilburg UB	1.56	1.42
Utrecht UB	1.54	1.71
Average	1.61	1.48**

Effect estimates ΔFVC vs. Δpollutant

	IQR	Effect	SE	P value
PM10	5,5	0,47	0,53	0,38
PM2.5	2,6	-0,87	0,55	0,12
Soot	0,55	**-0,83**	**0,35**	**0,02**
NO2	5,4	**-1,03**	**0,46**	**0,02**
NOX	13,5	**-0,91**	**0,44**	**0,04**
S	152,3	-0,41	0,41	0,32
Cu	12,6	**-0,88**	**0,37**	**0,02**
Fe	385,2	**-1,11**	**0,51**	**0,03**
V	1,3	0,65	0,64	0,31

Universiteit Utrecht



Effect at Veerkade vs. matching controls

	N (baseline)	Effect	SE	P value
FVC	293 (3989 ml)	**4,92**	**1,69**	**0,00**
FEV1	293 (3028 ml)	**3,00**	**1,45**	**0,04**
PEF	293 (7844 ml/s)	2,43	2,10	0,25
Airway resistance	261 (0.34 kPa/l/s)	-15,34	11,34	0,18
Exhaled NO	321 (22.3 ppb)	5,29	13,80	0,70

Universiteit Utrecht

Observations

- Studies on long term exposure to UFP virtually absent
- Spatial contrasts in UFP to some extent predictable
- Indoor and outdoor UFP poorly correlated
- Strong UFP (& other pollutant...) gradient downwind from busy roads
- Traffic studies are about mixtures of UFP & other pollutants
- No basis for long term standard for UFP
- Nevertheless, control of sources seems sensible