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Title: Correlation between traffic-related ultrafine particle concentration, noise and traffic flow in the city of Basel: short-term measurements and urban spatial characteristics analysis

Background. The correlation between traffic-related air pollution and traffic noise differs significantly across different urban areas. Traffic noise and air pollution exposure models are usually built on similar traffic-related and land use predictors, which may mislead the interpretation of their true relationship. Thus, city specific studies and measurements are necessary when investigating the effects of traffic-related air pollution and traffic noise on cardiovascular health.

Aim. Our study is part of the Tri-TABS , Projet Tri-national Trafic Air, Bruit et Santé, a tri-national study on traffic related air pollution, noise and cardiovascular health. Our primary goal is to analyze, compare and contrast the spatial characteristics of traffic related air pollution and noise in three European cities: Basel (CH), Girona (ES) and Grenoble (FR). Specific aims are to measure ultrafine particles, traffic flow and traffic noise standardized protocol in each city, and to analyze the determinants of the correlation between air pollution and noise. In particular, we explored the relationship of particle number, noise and traffic counts in the urban area of Basel.
Methods. We adopted a 20-minutes protocol in which particle number, traffic noise and traffic counts were measured simultaneously during non-rush hours. Measurements were conducted in 60 sites across the city of Basel and repeated in three seasons: spring, summer and winter. All significant non-traffic events were noted during measurements sessions and used to exclude related data in the analysis.
For particle number concentrations, we used the portable instrument miniDiSC (miniature diffusion size classifier), which measures ultrafine particles in the range of 30-300 nm. For noise, we deployed Pulsar 30, a class 1 sound level meter. Detailed records of spatial characteristics of measurement locations were made. Few sites were selected in the city center to investigate noise-PN correlation in traffic restricted areas. Sites with bus/tram lines were chosen to investigate the effect of bus/tram noise on total traffic noise.

Results. Mean UFP concentration levels were highest in winter and show more variabilty than mean noise levels: 15838 ± 7536 #/cm^3 in spring, 12275 ± 9723 #/cm^3 in summer, 20767 ± 15052 #/cm^3 in winter, whereas mean noise levels did not differ much across the three monitoring seasons: 60.6 ± 6.5 dB in spring, 60.2 ± 6.7 dB in summer, 61.0 ± 6.8 dB in winter.

As expected, mean UFP levels at street sites are in general higher across the seasons, except in winter (Figure 1). City center sites (located in pedestrian areas with very low automobile traffic) show always higher UFP concentrations than urban background sites. Moreover, city center sites show higher levels of UFP than street sites, in winter, likely due to sources other than traffic.

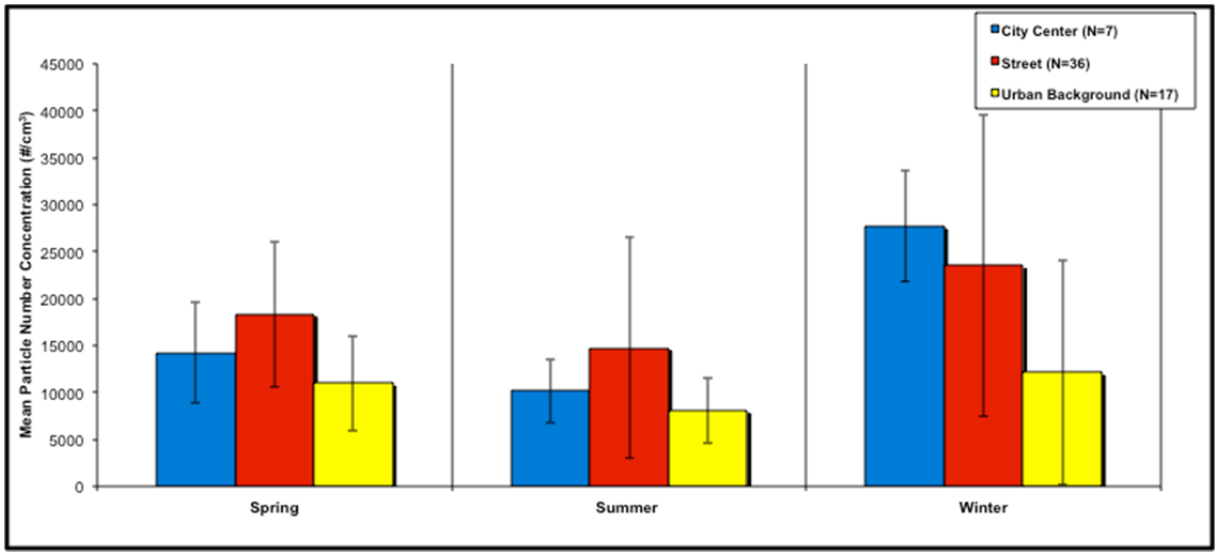

Figure 1. Mean PN concentrations over 3 seasons in 2011 in Basel

We also found that, especially in winter, the correlation between noise and traffic counts is higher than the PN-noise correlation (Table 1)

	Spring		Summer		Winter	
	PN	*LAeq*	*PN*	*LAeq*	*PN*	*LAeq*
LAeq	0.42	1	0.48	1	0.52	1
Total Vehicle Counts	0.28	0.55	0.38	0.60	0.18	0.63

Table 1. Spearman correlation of measured parameter across for all 60 sites in Basel.

Moreover, in Figure 2 we show how PN-noise correlation differs according to site type; although PN-noise correlation is generally low, city center sites show the highest correlation.

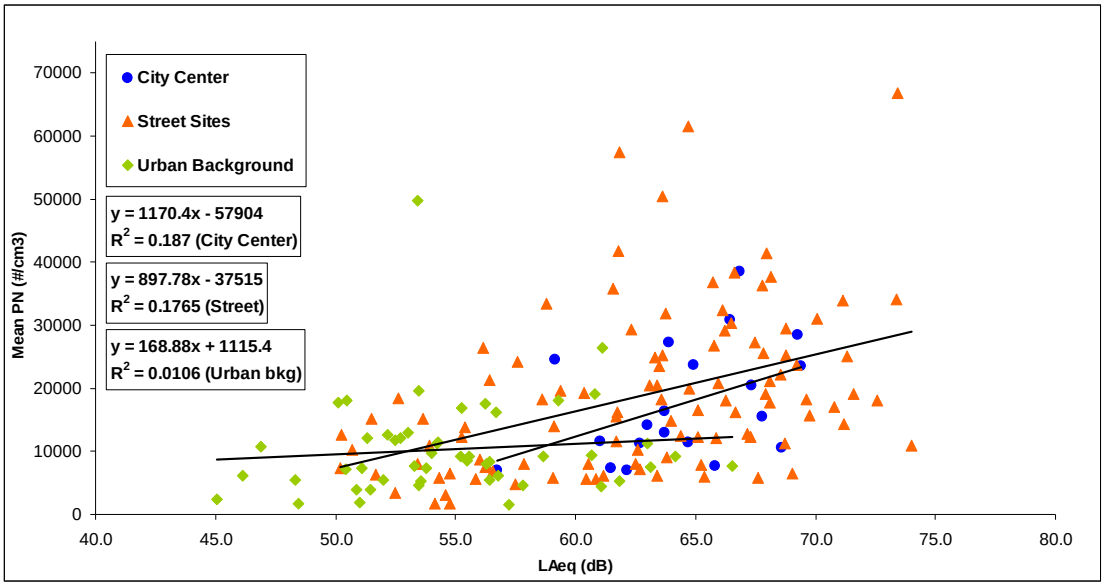

Figure 2. Traffic PN-noise correlation in Basel across 3 measurement seasons

Conclusions.

Our first results in Basel show moderate PN-traffic noise correlation (all seasons: R=0.4-0.5). Correlation between noise-traffic counts is higher than PN-traffic counts and varies in space within the city.

Comparison of these short-term measures with concurrent long-term PN measurements at the same sites and multivariate determinants analysis is currently underway.

Short CV:

2010 to present:	Research assistant, Environmental Exposures and Health Unit at Swiss Tropical and Public Health Institute in Basel, Switzerland
2009:	Master in Chemical and Biological Analysis at Université Paris Descartes, UFR Biomédicale
2008	B.A. in Chemistry at Wellesley College, USA

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Correlation between traffic-related ultrafine particles concentration, noise and traffic flow in the city of Basel: short-term measurements and urban spatial characteristics analysis

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Introduction

The correlation between traffic-related air pollution and traffic noise differs significantly across different urban areas. Traffic noise and air pollution exposure models are usually built on similar traffic-related and land use predictors, which may mislead the interpretation of their true relationship. Thus, city specific studies and measurements are necessary when investigating the effects of traffic-related air pollution and traffic noise on cardiovascular health.

Aims

In the context of Tri-Tabs (Projet Tri-national Trafic, Air, Bruit et Santé), on traffic related air pollution, noise and cardiovascular health in Basel (CH), Girona (ES), and Grenoble (FR), we explore, compare and contrast the spatial characteristics of traffic related air pollution and noise in three European cities. This paper focuses on the city of Basel.

Methods

- 60 monitoring sites in Basel in spring, summer & winter 2011 (Figure 1)
- 20 minutes protocol with synchronized measurements of particle number concentration and mean particle diameter (with miniDiSC), noise level (with Pulsar noise level meter), traffic counts (cars, trucks, motorcycles)
- Detailed site characterization
- All significant non-traffic events during measurements were noted and used to exclude related data from analysis
- Few sites were selected in the city center to investigate noise-PN correlation in traffic restricted areas
- Sites with bus/tram lines were chosen to investigate the effect of bus/tram noise on total traffic noise

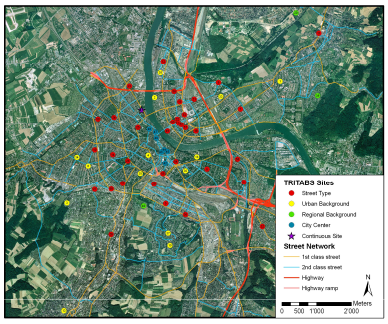

Figure 1. Basel sites and examples of measurements setups

Results

- As expected, **UFP concentration levels were highest in winter** and show more variabilty than noise levels (Table 1).
- **Mean noise levels did not differ** across the three monitoring seasons.

Table 1: Summary table of measurements for all 60 sites in Basel

Parameter	*Spring*	*Summer*	*Winter*
N	58	59	60
Mean Particle Number (#/cm^3)	15838 ± 7536	12275 ± 9723	20767 ± 15052
Mean Laeq (dB)	60.6 ± 6.5	60.2 ± 6.7	61.04 ± 6.8
Mean Auto Counts	69 ± 95	66 ± 92	84 ± 107
Mean Total Vehicle Counts	75 ± 101	70 ± 96	87 ± 110
Mean Particle Diameter (nm)	45.3 ± 10.0	44.7 ± 9.1	45 ± 8.4

We would like to acknowledge the field workers and funding support by ADEME/ANSES, France (French Environment &Energy Management Agency/ French Agency for Food, Environmental & Occupational Health & Safety.)

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- As expected, mean UFP levels at street sites are in general higher across the seasons, except in winter (Figure 2).
- City center sites show always higher UFP concentrations than urban background sites. Moreover, city center sites show higher levels of UFP than street sites, in winter, likely due to sources other than traffic.

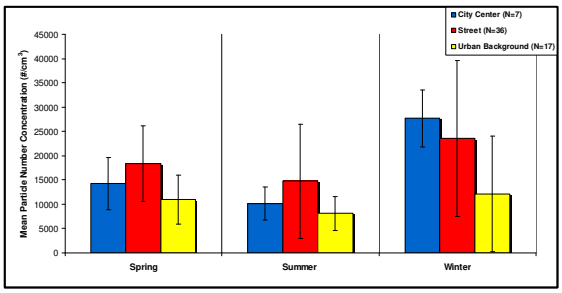

Figure 2: Mean PN concentrations over 3 seasons in 2011 in Basel

- In all seasons and especially in winter, the noise level-traffic counts correlation is higher than noise-PN correlation. In winter, PN-noise correlation inproves slightly (Table 2).

Table 2: Spearman correlation of measured parameters for all sites in Basel

	Spring		Summer		Winter	
	PN	*LAeq*	*PN*	*LAeq*	*PN*	*LAeq*
LAeq	0.42	1	0.48	1	0.52	1
Total Vehicle Counts	0.28	0.55	0.38	0.60	0.18	0.63

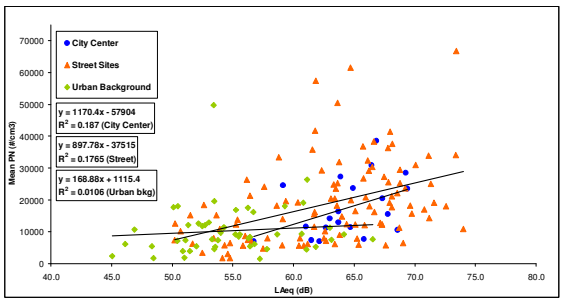

Figure 4: Traffic noise and PN correlation in Basel in all seasons

- Correlation varied by space within city, with street sites showing highest correlations

Table 3: Percentage of monitored sites with specific characteristics in the study

Site characteristics	*Sites in Basel*
"Slow" speed zone (max 30 km/h)	41%
Streets with only 1 running lane	43%
Traffic light within 100m	19%
Sites with bus stop nearby	33%
Mean street width	8m (range (4-27))
Streets with no gaps within 100m	25%

Conclusions and future work

- Our first results in Basel show moderate PN-traffic noise correlation (all seasons: R=0.4-0.5). Correlation between noise-traffic counts is higher than PN-traffic counts and varies in space within the city.
- Comparison of these short-term measures with concurrent long-term PN measurements at the same sites and multivariate determinants analysis is currently underway.

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